EVALUATING & COMPARING ENVIRONMENTAL IMPACT OF FAIRTRADE CERTIFIED COTTON IN INDIA

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Global AgriSystem

FAIRTRADE INDIA

csm centre for social markets

switchasia

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ABBREVIATIONS

CAPI	Computer-Assisted Personal Interview
CFT	Cool Farm Tool
CO_2e	Carbon Dioxide Equivalent
COSP	Cost of Sustainable Production
EUDR	European Union Deforestation Regulation
EUR	Euro
FTMP	Fairtrade Minimum Price
FYM	Farmyard Manure
GHG	Greenhouse Gas
GOT	Ginning Out-Turn
Ha	Hectare
IC	In-Conversion
INR	Indian Rupee
Kg	Kilogram
m^3	Cubic metre
MLR	Multiple Linear Regression
NF-C	Non-Fairtrade Conventional
NF-IC	Non-Fairtrade In-Conversion
NF-O	Non-Fairtrade Certified Organic
PPM	Parts Per Million
PSM	Propensity Score Matching
SOM	Soil Organic Matter
T-test	Student's t-test

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The project research team includes Dr. Girish Chander (Team Leader), Jatin Saini (Project Manager), Dr. Raunak Singh (Data Analyst), and Naeem Khan (Research associate).

EXECUTIVE SUMMARY

Background

This study builds on the 2024 study, *'Evaluating Environmental Impact of Fairtrade Certified Cotton in India'*. The 2025 assignment seeks to deepen analytical depth not only to evaluate environmental impacts but also to identify evidence-based attribution of the impact of Fairtrade Certification. This study contributes to collecting field evidence on Fairtrade Certification to refine processes further and inform decisions on scaling good practices.

Methodology

The study covers five groups of farmers, each representing a different type of cotton production system. These include Fairtrade Organic Certified farmers, who follow Certified Organic standards as well as Fairtrade standards; Non-Fairtrade Organic Certified farmers, who follow only Organic Certification practices but are not Fairtrade Certified; Non-Fairtrade Conventional farmers who use chemical inputs under regular farming systems; Fairtrade In-Conversion farmers, who are in the transition process of shifting towards Organic Certification and already Fairtrade Certified; and Non-Fairtrade In-Conversion farmers, who are also in the transition process of shifting towards Organic Certification but without Fairtrade Certification. Most environmental and economic comparisons were made between Fairtrade Organic Certified, Non-Fairtrade Organic Certified and Non-Fairtrade Conventional farmers, as these groups are in similar agro-ecological conditions. In-Conversion farmers form a separate comparison group, as they operate in different regions and are in the middle of the transition process towards Organic Certification.

A rigorous data collection methodology was employed to ensure reliability and accuracy. A total of 516 farmers were selected across four states using a stratified, location-matched sampling method. Villages were randomly selected from areas where Producer Organisations are active, and neighbouring villages were added only when Non-Fairtrade farmers were absent in the selected villages with Fairtrade Certified farmers. Computer-Assisted Personal Interviews (CAPI) were conducted using the Kobo Toolbox application, and all farm plots were geo-referenced. The Data underwent several rounds of validation and cleaning before analysis.

Key Findings

This study focuses on environmental indicators, including GHG emissions, water productivity, water footprint, and residue management practices, as well as key economic indicators, such as yield, price, costs, and profitability. The environmental analysis shows a clear pattern. GHG emissions are lowest in Fairtrade Organic Certified farms. Fairtrade Organic Certified farmers show the lowest emission intensity, with emissions of about 0.76 kg CO_2e per kilogram of seed cotton, compared with 0.97 kg CO_2e/kg among Non-Fairtrade Organic Certified farmers and 1.1 kg CO_2e/kg among Conventional farmers.

Water productivity values remain broadly similar across all groups, although Fairtrade Organic Certified farmers show slightly better performance, driven by stable yields and more efficient irrigation practices. A geospatial assessment of all 516 farms indicates that none had forest cover in the year 2000, and no deforestation was detected within the mapped farm boundaries during 2001–2023, within the limits of the dataset and resolution.

The economic assessment shows that Fairtrade Organic Certified farmers achieved a lint yield of around 547 kg/ha. Among the mature systems from comparable regions, lint yield is similar for Non-Fairtrade Organic Certified (536 kg/ha) and Non-Fairtrade Conventional (568 kg/ha). The In-Conversion groups are from different locations and should be interpreted separately; their lint yields are lower at 449 kg/ha (Fairtrade In-Conversion) and 444 kg/ha (Non-Fairtrade In-Conversion). Because Fairtrade Organic Certified farmers also receive better cotton prices, their overall returns are higher. Their average revenue is about ₹1,15,270/ha, with a cultivation cost of ₹37,630/ha and a profit of about ₹77,642/ha. This price and profitability analysis relates to the 2024–25 crop season, which occurred before the revision of the Fairtrade Minimum Price (FTMP) and Fairtrade Premium; therefore, the effects of the revised FTMP/Premium are not reflected here. Cultivation costs for Fairtrade Certified Organic farmers remain moderate due to a balanced use of Organic inputs and labour, rather than a heavy reliance on external chemical fertiliser. In-Conversion farmers show lower yields and margins, reflecting transition-stage challenges and differences in input and labour needs during conversion. The costing figures presented here are based on an independent, uniform method applied across all farmer groups and differ from Fairtrade's internal Cost of Sustainable Production methodology.

Conclusions and Recommendations

Overall, the findings show that Organic systems offer strong environmental advantages, and Fairtrade support helps farmers strengthen these practices through training, knowledge sharing, and stronger market linkages that support better price realisation. While regional factors influence some results, the overall pattern is clear: within the production systems covered in this study (Fairtrade and Non-Fairtrade Organic Certified, Non-Fairtrade Conventional and In-Conversion groups), Fairtrade Organic Certified cotton farming represents a more sustainable pathway with lower emissions, moderate and stable yields, and better economic returns. These findings also provide practical evidence of agroecological principles in action within Fairtrade Organic Certified cotton systems.

The study also highlights the following areas where additional efforts can further improve outcomes:

- **Promote low-energy solar-based irrigation solutions** to reduce overall emissions, especially in areas with deep borewells or high pump usage
- **Continue long-term monitoring of environmental indicators** like yield, emissions, and water use for need-based planning and informed decision-making
- **Explore opportunities in climate-related value addition** in carbon sequestration-related programmes, carbon-credit pilots and other sustainable value-addition ideas that can diversify income sources.

INTRODUCTION

1.1. BACKGROUND

India remains one of the world's largest producers and exporters of cotton, accounting for roughly 24 percent of global output during 2023-24, with an estimated production of 316.11 lakh bales (≈ 5.5 million metric tonnes)[1]. Cotton plays a pivotal role in India's rural economy, supporting 6 million farmers directly and 50 million people indirectly across ginning, spinning, and textile value chains. The crop is cultivated mainly across ten states grouped into three agro-climatic zones (North, Central, South) and smaller emerging belts such as Odisha and Madhya Pradesh, which have become new Fairtrade focus regions.

While cotton underpins livelihoods, it also has a significant environmental footprint. The crop uses around 24 percent of the world's insecticides and 11 percent of its pesticides [Raja et al., 2022], contributing indirectly to Greenhouse-Gas (GHG) emissions through the energy embodied in agrochemical production and irrigation. Over-use of synthetic nitrogen fertilisers accelerates the release of nitrous oxide (N_2O) and lowers the soil's ability to retain moisture. Intensive cotton systems also drive water stress, soil salinity, and biodiversity loss in many regions of India.

In response, global sustainability initiatives-including the Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD)-are increasingly demanding transparent, traceable, and environmentally responsible cotton sourcing. The Government of India has also launched the Indian Textile Sustainability Mission to encourage climate-resilient and ethically produced fibres.

Against this backdrop, Fairtrade International's standards play a critical role in promoting sustainable cotton production through better prices, prohibition of hazardous chemicals, decent working conditions and community investment via the Fairtrade Premium. Building on the 2024 study, 'Evaluating Environmental Impact of Fairtrade Certified Cotton in India', the 2025 assignment seeks to deepen analytical understanding of environmental outcomes and examine supporting economic indicators while identifying evidence-based attribution to Fairtrade Certification.

HIGHLIGHTS FROM THE 2024 STUDY

The 2024 assessment[2], conducted across six states and nine districts with a sample of 850 farmers, showed clear differences between Fairtrade Organic Certified farmers (FTO) and Conventional farmers. Fairtrade Organic Certified farmers recorded substantially lower GHG emissions (about 0.92 kg CO_2e/Kg) than conventional systems (about 1.86 kg CO_2e/Kg). Water productivity and water-use efficiency were higher among Fairtrade Organic Certified farmers, and their water footprint was nearly 25–30% lower than that of conventional farmers. The study also found negligible use of Highly Hazardous Pesticides (HHPs) among Fairtrade Organic Certified farmers and significantly reduced dependency on synthetic nitrogen fertilisers. From an economic standpoint, Fairtrade Organic Certified farmers achieved higher farmgate prices and stable profitability, driven by Organic price differentials and stronger market linkages.

These findings provided an important baseline for understanding environmental and livelihood outcomes associated with Fairtrade Organic Certified cotton. The present 2025 study builds on these earlier insights and extends the analysis to compare two Organic systems: Fairtrade Organic Certified and non-Fairtrade Organic Certified.

[1] https://texmin.gov.in/sites/default/files/Note%20on%20Cotton%20Sector.pdf
[2] https://www.Fairtrade.net/en/get-involved/library/evaluating-the-environmental-impact-of-Fairtrade-Certified-cotto.html

1.2. OBJECTIVES OF THE STUDY

In this context, the study was conducted with the following specific objectives:

- Compare environmental and economic performance across production systems-Fairtrade Certified cotton, Organic Certified cotton (non-Fairtrade), and Conventional cotton-and separate how much difference is linked to Fairtrade Certification versus Organic practices and other local factors.
- Evaluate the environmental performance of Fairtrade-Certified cotton farms using indicators such as GHG emissions, water footprint, water productivity, and fertiliser use.
- Document field-level changes in agronomic practices (fertiliser and pesticide management, water-use efficiency, crop residue handling) to understand pathways of impact resulting from Fairtrade standards.
- Analyse economic outcomes across farming systems, focusing on yield (seed cotton/lint kg per ha), farmgate price (₹ per kg and ₹ per tonne), cost of cultivation, gross margin (₹ per ha), and market or price-premium awareness.
- Summarise clear, actionable findings to help Fairtrade, Producer Organizations and partners strengthen farm practices and improve sustainability outcomes in cotton.

1.3. SIGNIFICANCE OF THE STUDY

Cotton farmers in India are increasingly transitioning toward sustainable models to address high input costs, and climate vulnerability. Among these, Organic cultivation has proven effective in restoring soil health and reducing chemical dependency. This study contributes to collecting field-based evidence related to Fairtrade Certification for identification of additional practices and certifications which can create positive impact on farms and farmer livelihood while further informing decisions on scaling of good practices.

The findings of the study will specifically contribute to:

Learning for Fairtrade and Producer Organizations:
The results can help the Fairtrade system and Producer Organizations understand key gaps and good practices and use these insights to strengthen future training and farmer support.

Evidence for partners and brands:
The findings can provide comparative evidence across production systems that could support sustainability reporting and internal learning for supply chain partners. The study does not present this as a Certification 'proof', but as evidence from the sampled areas.

Informing broader discussions:
The results may inform broader discussions on sustainable cotton production and preparing farmers to address challenges of climate change by sharing field evidence and lessons from the study areas.

APPROACH AND METHODOLOGY

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2.1. OVERVIEW OF THE APPROACH

The approach for the Fairtrade Cotton Impact Research 2025 builds on the 2024 study's foundations. Still, it adopts a more attribution-focused design to determine how much of the environmental impact can be directly linked to Fairtrade Certification, distinct from that of Organic and Conventional systems.

The methodology integrates quantitative and qualitative components, field-verified primary data and statistical modelling. It also ensures consistency with the 2024 research design to enable longitudinal comparison while introducing refinements for improved representativeness and analytical precision.

2.2. RESEARCH DESIGN

The study evaluates five distinct farming categories to enable a clear comparison of production systems and Certification effects:

1. **Fairtrade Organic Certified**
2. **Fairtrade In-Conversion (Organic)**
3. **Non-Fairtrade Organic Certified**
4. **Non-Fairtrade In-Conversion (Organic)**
5. **Non-Fairtrade Conventional**

- **Fairtrade Organic Certified (FTO), Non-Fairtrade Organic Certified (NF-O), and Non-Fairtrade Conventional farmers are in similar regions**; therefore, these three groups can be directly compared.
- **Fairtrade In-Conversion (FT-IC) and Non-Fairtrade In-Conversion (NF-IC)** farmers are in a separate region (Tamil Nadu). These two groups can be compared only with each other.
- **In-Conversion farmers cannot be compared with Organic or Conventional farmers**, as they belong to different agro-climatic zones and farming conditions.

To strengthen comparability, a Propensity Score Matching (PSM) analysis was also conducted using key farmer characteristics.

Fairtrade Organic Certified Farmers had the highest score (1.00). Non-Fairtrade Organic Certified farmers (0.97) and Non-Fairtrade Conventional farmers (0.86) were also close to this profile, showing that these three groups share similar characteristics and can be compared directly. In-Conversion groups had lower scores (0.40–0.52) because they are from different regions and agro-climatic zones. These scores support our comparison approach. Mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified and Conventional) can be compared with each other, while In-Conversion groups are compared separately.

2.3. STUDY AREAS AND SAMPLING

A total of **516 cotton farmers** were sampled across **eight districts in four states** (Madhya Pradesh, Odisha, Gujarat, and Tamil Nadu). Sampling followed a multi-stage stratified random approach, where:

1. Districts were selected based on the concentration of Fairtrade Certified Producer Organisations (POs).
2. Villages were randomly selected from the list of villages where the Producer Organisation (PO) is active. In some cases, if Non-Fairtrade farmers were not available in the same selected village, then additional neighbouring villages were included. These neighbouring villages were chosen only to ensure the availability of Non-Fairtrade farmers from the same agro-ecological area.
3. Selection of farmers for survey: After finalising the villages, farmer lists were taken from Producer Organisations. From these lists, farmers were randomly selected within each category. This ensured balanced, unbiased representation of each group. Field data collection took place from 27th August to 30th September, 2025, through structured surveys.

Table 1: *Overall distribution of the sample for the farmers' survey*

STATE	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION	TOTAL
Madhya Pradesh	76	49	41	4	0	**170**
Odisha	73	48	23	15	10	**169**
Gujarat	25	23	12	0	0	**60**
Tamil Nadu	0	2	10	53	52	**117**
Total	174	122	86	72	62	**516**
	34%	**24%**	**17%**	**14%**	**12%**	

2.4. DATA COLLECTION AND QUALITY ASSURANCE

QUANTITATIVE DATA COLLECTION

Primary data were collected using a Computer-Assisted Personal Interview (CAPI) platform (Kobo Toolbox). Questionnaires were digitised in the respective regional language to ensure proper comprehension.

Each interview included:

- Household demographic details
- Agronomic practices (seed, fertiliser, pest management, water use)
- Economic variables (input costs, yield, price)
- GPS coordinates of each farm plot

ENUMERATOR TRAINING AND QUALITY ASSURANCE

Enumerators and supervisors underwent training covering research ethics, data accuracy, and consent procedures. Field monitoring teams conducted random back-checks (~10% of the sample), and automated logic checks were embedded in CAPI forms to ensure data integrity.

2.5. ANALYTICAL FRAMEWORK

ENVIRONMENTAL ANALYSIS

The environmental analysis assessed the sustainability of cotton farming systems through four major components:

GHG emissions - measuring total and source-wise emissions from fertiliser use, irrigation energy, and residue management

Water indicators - assessing irrigation volume, source type, and water-use efficiency per tonne of seed and lint cotton

Deforestation assessment - evaluating forest cover and forest loss within farm boundaries

All indicators were derived from farmer-level survey data and geospatial analysis.

Greenhouse Gas (GHG) Emissions and Water Indicators – Cool Farm Tool

Cool Farm Tool (CFT) is an internationally recognised model for calculating on-farm GHG emissions and water footprint. The methods and emission factors used by Cool Farm Tool are, in the vast majority, originating from IPCC 2019[3]. Earlier studies (Jonathan Hiller et al. 2011; Benjamin Kayatz et al. 2019) validate that Cool Farm Tool provides reliable metrics for GHG emissions, biodiversity impacts, as well as a practical, reliable way to assess agricultural water use, and offers a means to engage growers and stakeholders in identifying efficient water management practices. As the Cool Farm Tool enables a more holistic assessment of environmental sustainability in farming, we used it in our study. The tool uses farm-level inputs such as fertiliser type, irrigation, residue management, and yield to estimate total emissions (Kg CO_2e/Ha and Kg CO_2e/Kg of seed cotton).

Deforestation Analysis

Geospatial analysis was conducted in Google Earth Engine to assess forest cover and forest loss using the Hansen Global Forest Change dataset (2000–2023).

For each farm polygon, three indicators were calculated:
1. Forest area inside the farm boundary in the year 2000
2. Forest loss between 2001 and 2023
3. Percentage forest loss relative to the year 2000

Important Note: Forest cover and forest loss were assessed using the Hansen Global Forest Change dataset (spatial resolution: 30m × 30m) for 2000–2023. While widely used for regional analysis, this resolution is limiting for smallholder farms and may lead to underdetection or misclassification of small-scale forest loss within small-farm polygons. Hence, results should be read as indicative trends, not exact plot-level values.

[3] IPCC. 2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories. Technical Report, IPCC, 2019.

ECONOMIC ANALYSIS

The following economic indicators were calculated to understand the financial performance of different cotton farming systems. All indicators were calculated using farmer-reported values from the primary survey.

Yield: Yield was calculated as lint yield per hectare. Seed cotton quantities reported by farmers were converted into lint yield using the average ginning-out-turn which is 35% therefor 100 kg seed cotton = 35Kg lint.

Price: Price received by farmers was taken as the actual farmgate price per quintal or per tonne of seed cotton. For comparability, prices were converted into price per tonne.

Cost of Cultivation: Cost of cultivation included all major input expenses such as seed, fertilisers, manures, pesticides, labour (family + hired), machinery use, irrigation, and other variable costs.

The cost, revenue and profitability analysis in this report follows an independent methodology that was applied uniformly across all production systems covered in the study. This approach is different from Fairtrade's internal Cost of Sustainable Production (COSP) calculation methodology.

Gross Margin / Profit:
Gross margin was calculated as:
Gross Margin = Total Revenue – Cost of Cultivation

STATISTICAL AND ATTRIBUTION MODELLING

To isolate the effect of Fairtrade Certification:

Descriptive Statistics
Key indicators were compared across Fairtrade Organic Certified, Non-Fairtrade Organic Certified, Non-Fairtrade Conventional and In-Conversion groups.

t-Tests / ANOVA
Used to check whether the differences between farmer groups were statistically significant, especially for yield, cost, emissions and water indicators.

Multiple Linear Regression (MLR)
Emission-source variables were used to see their impact on total GHG emissions. Additional regression models were run to examine how different types of farmer training influence emission levels, identifying which factors influence yield and GHG emissions.

Propensity Score Matching (PSM): A PSM check was done using farmer characteristics such as land size, irrigation, age and education.

2.6. ASSUMPTIONS & LIMITATIONS

ASSUMPTIONS

1. It is assumed that the conversion rate of seed cotton to Lint is 35%, based on the industry average, which ranges between 30% and 40%.

2. The conversion rate from EUR to INR is assumed to be ₹1 = €0.0098. This rate was used to ensure consistency in financial comparisons and calculations throughout the study.

3. The information provided by the farmers regarding their farming practices, inputs, and outputs is assumed to be reliable and truthful.

4. The volume of water utilised in the cotton field of all samples has been calculated with an approximation approach by considering factors such as the horsepower of motors, operational time, and the depth of groundwater.

5. The Cool Farm Tool uses field data to estimate GHG emissions according to predefined rules and assumptions. The results from the Cool Farm Tool are assumed to be reliable and appropriate for our analysis.

LIMITATIONS

While the study design allows robust attribution, certain limitations are acknowledged:

STATE-WISE FARMER COVERAGE

In our study, most of the In-Conversion farmers are from Tamil Nadu, and only a few are from Odisha. There are no Organic farmers in Tamil Nadu, and there are no In-Conversion farmers in Gujarat and Madhya Pradesh. Because of this uneven coverage, we cannot directly compare the In-Conversion farms with the Organic farms, as both categories are not present in all states.

COMPARABILITY OF IN-CONVERSION WITH MATURE SYSTEMS:

The In-Conversion farmer groups are from different geographic locations than the mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified and Non-Fairtrade Conventional). Therefore, In-Conversion results should be interpreted separately, and comparisons should be made mainly within the In-Conversion groups, rather than directly against mature systems.

FARMER RECALL

Many cost and yield figures depend on farmer recall. Farmers sometimes give round figures or approximate numbers. This can lead to minor under- or over-reporting.

DEFORESTATION DATA RESOLUTION

Forest loss was assessed using the Hansen Global Forest Change dataset (30m × 30m). This resolution is suitable for broad-area analysis but is limiting for smallholder farms, and small-scale tree cover loss may be under-detected or misclassified.

PRICE VARIATION

Prices of inputs and cotton change from district to district. The study uses average prices, so some local variations may not be fully captured.

WATER USAGE MEASUREMENT

Accurate measurement of the volume of water used by farmers was not feasible; instead, it has been calculated with an approximation approach by considering factors such as horsepower of motors, operational time, and the depth of water bodies.

DEPENDENCE ON FARMERS' MEMORY

The reliance on self-reported data by farmers over the last crop cycle was a limitation, as it depends on their memory and willingness to provide accurate information.

NATIONAL AVERAGES

This study represents national averages on key indicators, which may mask regional variations in agricultural practices and environmental impacts. Because of the diverse climates, soil types, and socio-economic conditions across India's regions, the findings may not fully capture local nuances. Consequently, significant variations in outcomes and sustainability impacts cannot be reflected in the national averages used in this study.

LIMITED SAMPLE SIZE

Due to the limited number of samples, disaggregation data at the state or district level could not be done.

COSTING METHODOLOGY DIFFERENCE

The cost, revenue and profitability analysis in this report follows an independent methodology that was applied uniformly across all production systems covered in the study. This approach is different from Fairtrade's internal Cost of Sustainable Production (COSP) calculation methodology.

LENGTH OF QUESTIONNAIRE

The questionnaire used in this study was quite extensive, encompassing all necessary aspects to gather comprehensive data. However, its length posed challenges, making it difficult to keep farmers engaged throughout the process.

COMPARABILITY ACROSS STUDIES

Some indicators may differ from earlier studies due to changes in sample locations and farmers covered, seasonal and weather conditions, and differences in yield and input use during the study year. Therefore, direct year-to-year comparison should be interpreted with caution.

Nonetheless, integrating field data with CFT modelling provides a highly credible, statistically sound foundation for assessing the environmental and economic impacts of Fairtrade Certification.

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SOCIO-DEMOGRAPHIC PROFILE OF FARMERS

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3.1. AGE DISTRIBUTION

In all figures presented in Chapter 3, the analysis is based on two broad farmer groups. The first group is Fairtrade farmers, which includes Fairtrade Organic Certified farmers and Fairtrade In-Conversion farmers. The second group is Non-Fairtrade farmers, which includes Non-Fairtrade Conventional farmers, Non-Fairtrade Organic farmers, and Non-Fairtrade In-Conversion farmers.

Results (Figure 1) indicate that most Fairtrade farmers (63% farmers) fall within the **40–60 years** range compared to Non-Fairtrade (55%). In contrast, the Non-Fairtrade group has a slightly higher proportion of younger farmers below 40 years, i.e. total 39% compared to 27% under Fairtrade.

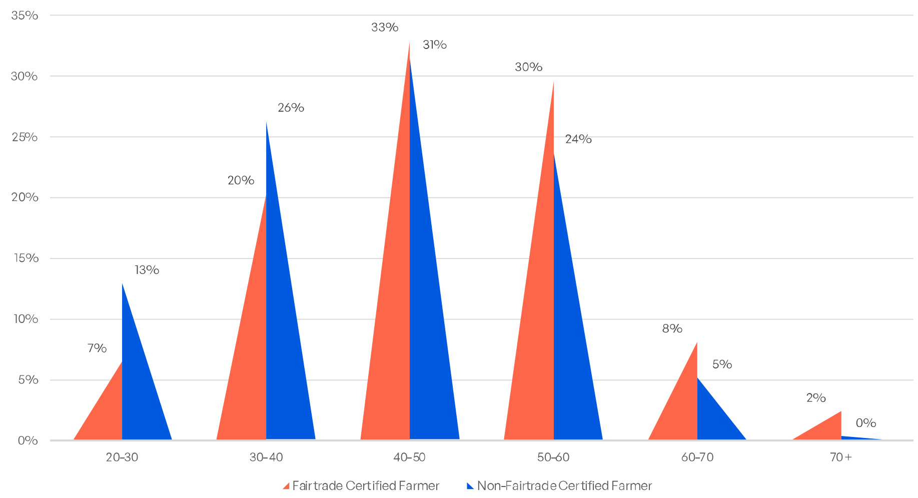

Figure 1: *Age distribution of surveyed farmers under the study*

3.2. GENDER DISTRIBUTION OF FARMERS

Cotton cultivation across both systems remains **predominantly male-managed,** though the share of **female farmers is relatively higher among Non-Fairtrade participants (27%)** (Table 2 below).

Table 2: *Gender distribution of sample farmers*

GENDER	FAIRTRADE CERTIFIED FARMERS	NON-FAIRTRADE CERTIFIED FARMERS
Female	16%	27%
Male	84%	73%

3.3. EDUCATION QUALIFICATION

The educational profiles of Fairtrade and Non-Fairtrade farmers are largely comparable, with both groups showing a similar overall spread across basic and secondary education levels. (Figure 2). **About 45% of Fairtrade farmers and 47% of Non-Fairtrade farmers have no formal education (including the illiterate and the literate without formal education), indicating** that both systems engage a similar farmer base in terms of schooling background. The share of farmers educated up to **secondary and higher secondary levels (10th –12th)** is slightly higher in Fairtrade farmers (26%) than in Non-Fairtrade farmers (23%). The proportion of **graduates and above** remains low and identical (7%) in both groups.

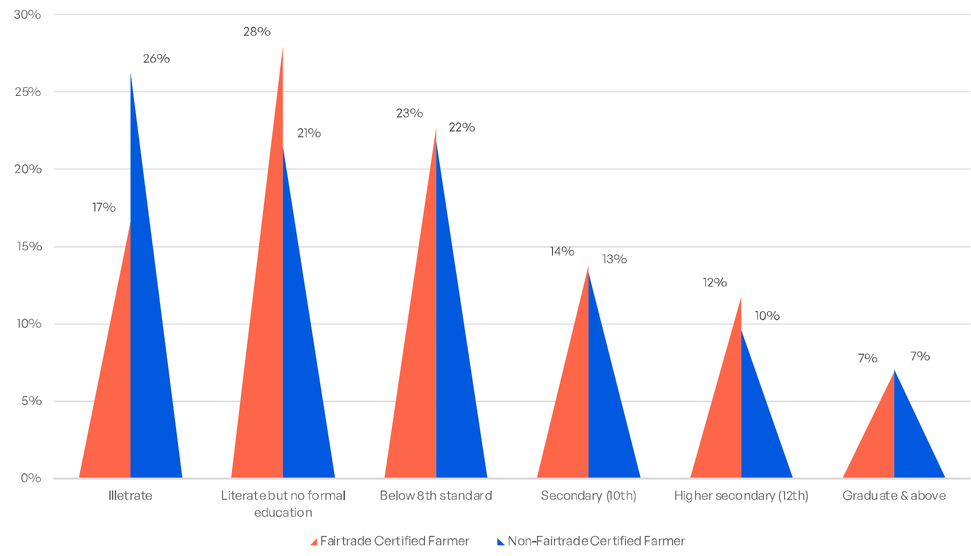

Figure 2: *Education qualification of farmers*

3.4. LAND HOLDING OF FARMERS

The land distribution of Fairtrade and Non-Fairtrade farmers is **broadly comparable**, with both groups dominated by marginal and smallholders. Nearly **three-fourths of farmers in each group operate on less than 2 ha** of land (Figure 3).

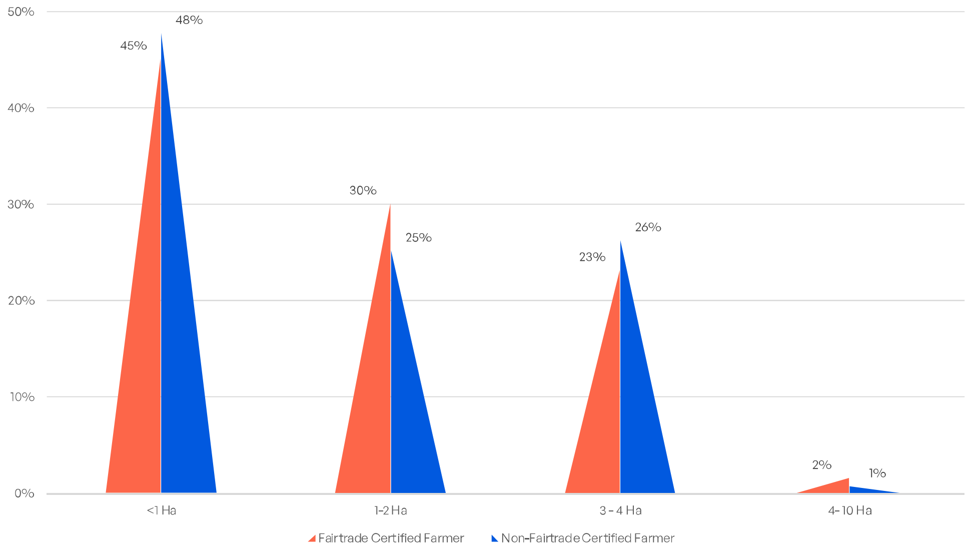

Figure 3: *Land holding of farmers*

Overall, both Fairtrade and Non-Fairtrade farmers represent typical smallholder cotton producers.

3.5. YEARS OF ORGANIC CERTIFICATION

Experience in Certification reflects the maturity of compliance systems and the extent of farmers' familiarity with sustainable production practices. The average number of years under Organic Certification was assessed separately for Fairtrade Organic Certified farmers and Non-Fairtrade Organic Certified farmers only, excluding In-Conversion farmers and conventional farmers from the sample.

Table 3: *Average years of Organic Certification*

FARMER CATEGORY	AVERAGE YEARS OF ORGANIC CERTIFICATION
Fairtrade Organic Certified Farmers	5.0 years
Non-Fairtrade Organic Certified Farmers	4.9 years

Both Fairtrade and Non-Fairtrade Organic Certified Farmers have been Certified for a **similar duration of around five years,** indicating comparable maturity in their adoption of organic standards.

3.6. IRRIGATION

Irrigation access is a crucial determinant of productivity, water-use efficiency, and climate resilience in cotton cultivation. Table 4 compares the proportion of irrigated and rainfed farms among Fairtrade and Non-Fairtrade farmers. The distribution of irrigation types is almost identical across Fairtrade and Non-Fairtrade farms, indicating that both operate under comparable agro-climatic and water-resource conditions.

Table 4: *Irrigation pattern of sample farmers*

IRRIGATION TYPE	FAIRTRADE CERTIFIED FARMERS	NON-FAIRTRADE CERTIFIED FARMERS
Irrigated	48%	46%
Rainfed	52%	54%

4 ANALYSIS

4.1. ENVIRONMENTAL ANALYSIS

The environmental component of the Fairtrade Cotton Impact Research 2025 examines how different certification systems influence on-farm resource use and emissions.

GREENHOUSE GAS (GHG) EMISSIONS

A. Overview

Greenhouse gas (GHG) emissions are a key measure of cotton's environmental footprint. In this study, GHG emissions were quantified using the Cool Farm Tool (CFT). The analysis covers **only field-level emissions,** including emissions from **fertiliser production, fertiliser application, residue management, on-farm energy use, crop protection and carbon stock change**[4]. Off-farm processes, such as ginning, transport to buyers, and manufacturing, were **not included** in the system boundary.

Results are expressed **per hectare and per kilogram of seed cotton**, allowing meaningful comparison across production systems that differ in yield. The analysis distinguishes between:

MATURE SYSTEMS – Fairtrade Organic Certified (FT-O), Non-Fairtrade Organic Certified (NF-O), and Non-Fairtrade Conventional (NF-C)

TRANSITION SYSTEMS – Fairtrade In-Conversion (FT-IC) and Non-Fairtrade In-Conversion (NF-IC)

B. GHG Emissions – Mature Systems

- Fairtrade Organic Certified farms show the lowest emission intensity, with per-kg emissions that are about 30% lower than Non-Fairtrade Conventional farms and 21% lower than Non-Fairtrade Organic Certified farms.
- When net emissions per ha are considered (i.e., after adjusting for carbon stock change), Fairtrade Organic Certified farms still perform better, with net emissions about 36% lower than Non-Fairtrade Conventional farms and 23% lower than Non-Fairtrade Organic Certified farms.
- Because these systems operate in similar agro-climatic zones, the contrast reflects differences in **management efficiency rather than environmental conditions.** The per-kilogram comparison reinforces that Fairtrade Organic Certified cotton achieves **higher carbon efficiency** per unit of output.

Table 5: *Average GHG emissions in kg CO_2e (FT and NFT Certified Organic vs Conventional farms)*

STATE	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL
Sample Size	174	115	74
Average Emissions per kg of Seed cotton	0.76	0.97	1.10
Carbon Stock Changes per kg of Seed cotton*	-0.11	-0.13	-0.08
Average Net Emission per kg of Seed cotton	0.65	0.84	1.02
Average Emissions per ha	1140	1430	1662
Average Net Emission per ha	970	1236	1546

**Carbon stock changes are modelled rather than directly measured and should be interpreted as trends rather than verified sequestration.*

[4] *In this assessment, carbon stock change reflects biomass accumulation from on-farm trees.*

Statistical Significance (t-test):

- When comparing net emissions per ha between Fairtrade Organic Certified and Non-Fairtrade Organic Certified farmers, the p-value was 0.047. This means that Fairtrade Organic Certified farmers have significantly lower emissions per ha than Non-Fairtrade Organic Certified farmers at the 5% significance level (95% confidence level).
- When comparing net emissions per Ha between Fairtrade Organic Certified with Non-Fairtrade Conventional farmers, the p-value was 0.001, showing a big and highly significant difference. Fairtrade Organic Certified farmers emit much lower GHGs per hectare.

C. GHG Emissions – Transition Systems

- Fairtrade In-Conversion farms show lower **average emissions per kg of seed cotton, at 0.84** compared to **1.61** for Non-Fairtrade In-Conversion farms (Table 6). This is about **48% lower** total emissions.
- When **net emissions** are considered (after adjusting for carbon stock change), Fairtrade In-Conversion farms still perform better. Net emissions are **0.71 vs 1.56 kg CO_2e per kg of seed cotton (about 55% lower).**
- The sharp contrast (≈ 48% reduction in net emissions per kg of cotton) demonstrates that Fairtrade interventions during the conversion phase, such as **organic-input training, soil-fertility management, and peer monitoring,** help farmers reduce input intensity well before full certification. The same pattern is also seen in the per-hectare results.

Table 6: *Average GHG emissions in kg CO_2e (FT and NFT In-Conversion farms)*

INDICATORS	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Sample size	68	62
Average Emissions per kg of Seed cotton	0.84	1.61
Carbon Stock Changes per kg of Seed cotton*	-0.13	-0.05
Average Net Emission per kg of Seed cotton	0.71	1.56
Average Emissions per ha	1002	1938
Average Net Emission per ha	850	1871

**Carbon stock changes are modelled rather than directly measured and should be interpreted as trends rather than verified sequestration.*

Statistical Significance:

When comparing net emissions between Fairtrade In-Conversion with Non-Fairtrade In-Conversion farmers, the p-value was also 0.001, showing a statistically significant difference. The Fairtrade system clearly has lower emissions than the Non-Fairtrade system.

Key Insights about GHGs

Across both mature and transition systems:

Fairtrade Certified farms consistently record lower GHG emissions, reflecting more efficient resource management.

Average emission reduction ranges from **21–30 %** in mature systems to **over 48 %** in transition systems.

Because yields and irrigation access are broadly similar, differences are driven mainly by **fertiliser type, nutrient recycling, and adoption of low-emission agronomic practices.**

The analysis demonstrates that **Fairtrade complements Organic farming**, strengthening its climate-mitigation potential and accelerating the shift toward low-carbon cotton production.

D. Emissions by Source

The source-wise distribution of GHG emissions helps identify which activities contribute most to total on-farm emissions and where Fairtrade practices deliver measurable environmental gains. Table 7 summarises the average GHG emissions from major sources across all certification categories.

1. **Fertiliser-related emissions (production + application)** are the largest contributor across all systems, accounting for roughly 90% of total emissions in Non-Fairtrade In-Conversion farms and 34% in Fairtrade Organic Certified farms.
2. The stark difference between **Fairtrade and Non-Fairtrade In-Conversion** systems highlights the efficiency of Fairtrade training and input optimisation during the transition to organic production.
3. **Fairtrade Organic Certified** farms show relatively higher residue-management emissions (34%) due to the **composting of crop residues,** which produces biogenic CO_2 but contributes positively to soil-carbon sequestration.
4. Non-Fairtrade Conventional farms show the **highest fertiliser-application emissions (39%)** because of heavy reliance on urea and other synthetic fertilisers, coupled with limited organic recycling.
5. **Energy-use emissions** are most prominent in Fairtrade Organic Certified (31%) and Non-Fairtrade Organic Certified (35%) farms, largely due to irrigation pumps and mechanical operations in irrigated clusters such as Gujarat.
6. **Carbon-stock changes** across systems confirm a net carbon gain under all farmer categories, particularly Fairtrade Organic Certified, Non-Fairtrade Organic Certified and In-Conversion.

Table 7: *Source-wise distribution of GHG emissions (kg CO_2e per Kg of seed cotton)*

SOURCE*	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Residue management	0.26 (34%)	0.25 (25%)	0.18 (16%)	0.03 (4%)	0.07 (4%)
Fertiliser production	0.16 (21%)	0.23 (24%)	0.22 (20%)	0.58 (70%)	1.24 (77%)
Fertiliser application	0.10 (13%)	0.15 (15%)	0.43 (39%)	0.17 (20%)	0.24 (15%)
Energy use	0.24 (31%)	0.34 (35%)	0.27 (24%)	0.03 (3%)	0.03 (2%)
Off-farm transport	0.003 (0%)	0.004 (0%)	0.003 (0%)	0.030 (4%)	0.046 (3%)
Total Emissions	0.76 (100%)	0.97 (100%)	1.10 (100%)	0.84 (100%)	1.61 (100%)
Carbon Stock Changes	-0.11 (-15%)	-0.13 (-14%)	-0.08 (-7%)	-0.13 (-15%)	-0.05 (-3%)

**Crop-protection emissions contribute less than 1% of total emissions in all treatments and are therefore not presented in detail. In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.*

Statistical Significance (t-test) for Emissions by Source

- Fairtrade Organic Certified vs Non-Fairtrade Organic Certified: Fertiliser application emissions showed a significant difference ($p = 0.001$).
- Fairtrade Organic Certified vs Non-Fairtrade Conventional: Significant differences were found in fertiliser production and energy-use emissions ($p < 0.05$).
- Fairtrade In-Conversion vs Non-Fairtrade In-Conversion: Energy-use emissions were significantly different ($p < 0.05$).

Crop-Residue-Management Practices

Crop-residue management directly influences emission patterns. Table 8 summarises how farmers across systems manage post-harvest residues.

- Burning is lower in **Fairtrade Organic Certified and Non-Fairtrade Organic Certified** (≈15–16%) than in **Non-Fairtrade Conventional** (≈31%).
- Many Fairtrade farmers incorporate residues in the soil or mulch them (52%), which supports better soil health and moisture. Fairtrade Organic Certified Farmers also compost more residues (≈14%); composting may show some emissions in calculations, but it is a controlled alternative to open burning and helps build soil organic matter over time.

Table 8: *Crop-Residue-Management practices by farmer category (%)*

PRACTICE	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Burned in the field	15%	16%	31%	23%	11%
Left distributed/ incorporated/mulched	52%	52%	40%	52%	58%
Removed for use or sale	20%	19%	15%	14%	26%
Removed for non-forced-aeration compost	14%	12%	12%	11%	4%

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

The emission-by-source analysis demonstrates that:

- **Fairtrade systems substantially reduce total GHG emissions** relative to comparable Non-Fairtrade systems through better fertiliser management and organic recycling.
- Composting can lead to some short-term emissions during decomposition under residue management. However, it also improves soil fertility and can support higher soil organic matter over time. Overall, it is a better option for residue handling than open burning.
- Fairtrade In-Conversion farmers achieve early gains in emission efficiency, confirming that Fairtrade support mechanisms accelerate the adoption of low-carbon practices even before organic certification.
- Fairtrade certification may complement organic certification through structured training, follow-up, and guidance on input use. These support activities can encourage better farm practices and improved input use, which align with the emission patterns observed in this study.

E. Additional Statistical Analysis of GHG Emissions

To better understand the factors that influence GHG emissions, additional statistical techniques were applied. These include a regression analysis of emission drivers that combines both emission sources and training variables. Together, these methods help explain why emissions differ across farmer groups and what farm-level behaviours contribute most to the total footprint.

Regression Analysis: Key Drivers of Emissions

A multiple regression model was used to assess the contributions of individual sources to total emissions. The model explains around 71% of the variation in emissions (R^2 = 0.708), showing that the selected variables capture the main drivers of the emission profile.

The results show that:

Fertiliser Production
has the strongest influence on total emissions (coefficient: 1.167)

Fertiliser Application
also adds to emissions, though to a smaller extent (coefficient: 0.233)

Energy Use
shows a significant positive influence (coefficient: 0.582), mainly linked to diesel and electricity used for irrigation and field operations.

Crop Protection
shows the lowest impact and is statistically insignificant in this dataset (coefficient: 0.014, p = 0.97), contributing less than one per cent to total emissions.

Residue Management
contributes moderately to emissions (coefficient: 0.306), especially where residue burning or high-volume composting takes place.

Regression Results: Training and Its Influence on GHG Emissions

A separate regression was carried out to examine whether farmer training is associated with GHG emissions. Training information was collected from the survey, in which farmers reported the types of training they had attended (e.g., crop practices, input use, soil fertility, pest management, residue handling, composting).

- **Organic Farming Training:** Strong negative association, farmers receiving this training tend to show lower emissions
- **Soil Health & Fertility Training:** Clear negative association, linked with better nutrient management and lower emissions
- **Pest & Disease Management Training:** Weak negative association, no meaningful impact on emissions
- **Health & Safety Training:** Positive but not significant, no consistent relationship with emissions

Overall, the regression results show that only organic farming training and soil health and fertility training are linked with lower GHG emissions. **According to the survey data, 72% of Fairtrade Organic Certified Farmers reported receiving organic farming training compared to 56% among Non-Fairtrade Organic Certified Farmers.** This greater exposure to organic practices is reflected in the lower emissions recorded among Fairtrade farmers.

WATER FOOTPRINT AND PRODUCTIVITY

A. Overview

Water is a critical input in cotton cultivation, and its efficient use determines both environmental sustainability and farm profitability. The study assesses **water productivity** (the amount of seed cotton produced per cubic meter of water) and **water footprint** (the total volume of water used to produce one kilogram of seed cotton).

Both parameters were calculated using the **Cool Farm Tool (CFT)** framework, integrating field data on irrigation type, frequency, and yield. The analysis compares Fairtrade and Non-Fairtrade systems to understand how certification and agronomic practices affect water-use efficiency.

B. Results and Discussion

- Water productivity values are broadly similar across all systems, ranging between 0.26 and 0.32 kg of cotton per m^3 of water (Table 9). The small variations largely reflect differences in irrigation frequency,yield and different regions rather than Certification type.
- Within that comparable set, Fairtrade In-Conversion farms show slightly better performance, lower water footprint (3,903 L/kg) than Non-Fairtrade In-Conversion (4,120 L/kg)-suggesting early progress in irrigation efficiency during the transition period.
- Among the mature systems, **Fairtrade Organic Certified farms record a marginally lower water footprint (3,579 L/kg)** than both Non-Fairtrade Organic Certified and Conventional farms, indicating a small but consistent efficiency gain. Overall, the data indicate that water use efficiency is largely comparable among farming systems, with Fairtrade Organic Certified farms achieving slightly lower water consumption per unit of output.

Table 9: *Water productivity and water footprint of cotton under different farming systems*

PRACTICE	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Sample size	174	115	74	68	62
Average Water Productivity (kg/m^3)	0.31	0.32	0.31	0.26	0.27
Average Water Footprint (L/kg)	3,578.69	3,696.58	3,685.16	3,902.61	4,120.89

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

Compared to the 2024 report, the conventional group shows a different water productivity value in this round. This can happen due to differences in **sample areas and the farmers covered, rainfall/irrigation conditions during the season, and yield levels,** which directly affect water productivity calculations.

Overall, the analysis suggests that water management practices across the systems are **broadly similar,** with only small differences observed across farmer groups, which may also reflect local conditions.

FERTILISER USE AND EFFICIENCY

A. Overview

This section summarises (i) the **type of fertilisers** used across farmer groups, and (ii) **complementary agronomic practices** (cropping patterns and tillage) that influence nutrient cycling and overall input efficiency.

B. Type of Fertiliser Used

Organic sources dominate in Fairtrade IC (91%) and Non-Fairtrade IC (82%), reflecting transition pathways that emphasise compost/FYM/bio-inputs (Table 10).

In **mature organic systems**, usage splits between "no fertilisers used" and "organic only" (FT-O: 48% & 52%; NF-O: 40% & 60%). Here, "organic only" means farmers applied only organic inputs (such as FYM/compost/bio-inputs). "No fertilisers used" means no nutrient input was applied during the season, as reported by the farmer.

In-Conversion farmers rely mainly on organic inputs: Organic-only use is very high in the transition groups-Fairtrade In-Conversion (91%) and Non-Fairtrade In-Conversion (82%). A small share of Non-Fairtrade In-Conversion (3%) reported using both chemical and organic inputs, showing that a few farmers are still partly dependent on chemical fertilisers during the transition period.

Conventional farms show the highest share of chemical-only use (41%), with additional clusters reporting no fertiliser (41%) and a smaller group using organic only (16%) or both (2%). Taken together, chemical dependence is concentrated in conventional farms.

Table 10: *Type of fertiliser used by farmers (%)*

TYPE OF FERTILISER USED	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Both chemical and organic Fertilisers	0%	0%	2%	0%	3%
Chemical Fertilisers only	0%	0%	41%	0%	0%
No Fertilisers used	48%	40%	41%	9%	5%
Organic Fertilisers only	52%	60%	16%	91%	82%

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

C. Application of Farmyard Manure (FYM)

Farmyard manure (FYM) is the most used organic Fertiliser across all systems. It is central to nutrient recycling and soil organic matter replenishment[5].

FYM application is **highest in the In-Conversion farms** (around 4.7–4.8 tonnes/acre), as these farmers actively rebuild soil fertility during transition (Table 11).

Among the mature organic systems, **Fairtrade Organic Certified Farmers apply slightly less FYM (2.39 MT/acre)** compared to Non-Fairtrade Organic Certified (2.92 MT/Acre).

This difference likely reflects **better training and input optimisation among Fairtrade farmers,** thereby reducing excess application without compromising soil health. The difference in FYM rates also corresponds with the **variation in Fertiliser-related emissions** observed in the GHG analysis: emissions from Fertiliser use and application were lower for Fairtrade Organic Certified farms, demonstrating improved nutrient-use efficiency through training and monitoring under Fairtrade programs.

Table 11: *Average application of FYM applied per acre by farmer group*

FARMER CATEGORY	AVERAGE FYM APPLICATION RATE (KG/ACRE)
Fairtrade Organic Certified	2,394
Non-Fairtrade Organic Certified	2,922
Non-Fairtrade Conventional	2,723
Fairtrade In-Conversion	4,700
Non-Fairtrade In-Conversion	4,750

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

Since nutrient efficiency is also shaped by crop and land-use practices, these are discussed below.

D. Cropping Practices Affecting Nutrient Cycling

INTER-CROPPING

Intercropping is highest among Fairtrade Organic certified farmers (35%) when compared to Non-Fairtrade Organic and Non-Fairtrade Conventional farmers. This can contribute to biological nitrogen support.

MIXED CROPPING

appears in FT-O and NF-O (30% each) and Conventional (36%), potentially diversifying biomass inputs.

CROP ROTATION

is notably higher in both IC groups (48–52%), which can help break pest cycles and moderate nutrient mining.

MONO-CULTURE

is highest in Conventional (32%). However, 'only monoculture' is also relatively high among Non-Fairtrade Organic Certified, suggesting that crop diversification is not automatic under organic practices.

[5] *In the Cool Farm Tool, farmyard manure is treated as having zero emissions for the production stage. This is because the emissions associated with producing manure are allocated to the livestock system and not counted within the crop system boundary.*

Table 12: *Cropping practices influencing soil fertility (%)*

PRACTICE	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Mixed cropping	30%	30%	36%	0%	0%
Inter-cropping	35%	25%	10%	30%	44%
Crop rotation	14%	14%	17%	48%	52%
Only Monoculture	19%	27%	32%	20%	3%

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

Farmers reported using a range of supporting crops in all these systems. Cowpea, green gram and maize are the most common in both mixed cropping and inter-cropping, adding nitrogen and improving soil cover. Red gram is mainly used in intercropping with cotton, while wheat and sorghum are widely used in crop rotation cycles to rest the soil and manage moisture. These crop choices help diversify biomass returns and support better nutrient cycling on farms.

E. Tillage and Land Management

Reduced/zero tillage is concentrated in both the Organic groups and the **Conventional group** (FT-O: 50%/35%; NF-O: 51%/34%, NF-C: 54%/27%), which tends to **preserve soil structure** and **reduce SOM losses (Table 13)**. **Full tillage** dominates in **IC** (≈70%), which can increase disturbance and raise nutrient replacement needs. This could also be the reflection of practices in the specific region where the IC sample was collected.

Table 13: *Tillage practices among farmers (%)*

PRACTICE	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Full tillage	15%	14%	19%	69%	70%
Minimum tillage	50%	51%	54%	18%	20%
Zero tillage	35%	34%	27%	13%	10%

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

F. Key points and Fertilisers Use and Efficiency

- Fertiliser-use trends reveal a clear shift from chemical dominance in Conventional systems to organic nutrient reliance in Fairtrade and Organic systems.
- FYM is the most common nutrient source across all groups, with variation in application rate linked to training, availability, and farm-level management decisions.
- The lower FYM rates among Fairtrade Organic Certified Farmers are apparently achieved through efficient and targeted use, supported by training on nutrient management under Fairtrade programs.
- Complementary practices-reduced tillage, crop rotation, and intercropping-further enhance nutrient-use efficiency and align with the observed lower Fertiliser-related GHG emissions in Fairtrade and Organic systems.
- Collectively, these results highlight how knowledge-based nutrient management complements organic principles and supports soil regeneration across Fairtrade and Organic cotton landscapes.

DEFORESTATION ASSESSMENT

This analysis was carried out to check whether any of the cotton farms had forest cover in the year 2000[6] and whether any forest loss occurred between 2001 and 2023. This analysis suggests that no deforestation was detected within the mapped farm boundaries during the assessed period, within the limits of the dataset and spatial resolution used.

The exact field boundaries of all **516 farms** were analysed in Google Earth Engine using the **Hansen Global Forest Change Dataset (2000–2023).**

For each farm polygon, three indicators were calculated:

1. Forest area inside the farm boundary in the year 2000
2. Forest loss between 2001 and 2023
3. Percentage forest loss relative to the forest area in 2000

This analysis compares only two points in time: the **Year 2000 and 2023.** All 516 farms showed **zero hectares of forest cover in the year 2000.**

Across the sampled farms, the analysis detected zero hectares of forest loss within the mapped farm boundaries during 2001–2023. Since no forest cover was detected within these farm polygons in 2000, the calculated forest loss percentage is also 0%. Within the limits of the Hansen dataset (2000–2023) and its spatial resolution, the results indicate no detected deforestation within the sampled farm boundaries over the assessed period.

Although no forest loss was detected within the farm boundaries between 2000 and 2023, farmers maintain a variety of trees on their farmland that contribute to on-field vegetation cover. Tree presence was recorded across all groups, with the proportion of farmers having trees on their fields as follows:

48%	32%	43%	51%	42%
Fairtrade Organic Certified	Non-Fairtrade Organic Certified	Non-Fairtrade Conventional	Fairtrade In-Conversion	Non-Fairtrade In-Conversion

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different location.

Farmers reported several long-lived species on their farm boundaries and field edges, including **neem, tamarind, mango, coconut, babool (acacia), guava and palm** trees. Neem was the most common species, reported by a large number of farmers across regions. Although forest cover within farm boundaries did not change, the presence of on-farm trees adds ecological stability and supports small amounts of natural carbon storage. These trees improve microhabitats, add organic matter, and positively influence long-term GHG outcomes.

[6] *The analysis captures land-use change only from the year 2000 onward. Any forest loss or land conversion that happened before 2000 is not included in the assessment*

4.2. ECONOMIC ANALYSIS

YIELD PERFORMANCE

Yield levels are broadly comparable across all systems (440–570 kg/ha) (Table 14).

Fairtrade and Non-Fairtrade Organic Certified farms achieve slightly lower but stable yields (536–547 kg/ha), demonstrating effective adaptation of organic practices.

Non-Fairtrade Conventional farms record the highest yields (568 kg/ha), consistent with greater use of synthetic inputs.

In-Conversion farms, operating in different agro-climatic zones, show yields around 444-449 kg/ha and should be compared **within their own category** only. Overall, yield gaps between organic and conventional systems remain small (<10%), highlighting that yield trade-offs under Fairtrade-Organic systems are minimal.

Cotton yield reflects the combined influence of soil fertility, irrigation, and management practices.

Table 14: *Average lint yield across farming systems*

FARMER CATEGORY	YIELD (LINT COTTON, KG/HA)
Fairtrade Organic Certified	547
Non-Fairtrade Organic Certified	536
Non-Fairtrade Conventional	568
Fairtrade In-Conversion	449
Non-Fairtrade In-Conversion	444

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

PRICE ANALYSIS

Price realisation is a decisive factor influencing overall farm profitability. Prices reported below represent the **average farm-gate rate for raw (seed) cotton,** converted to ₹ per tonne, based on farmer recall and Producer Organisation records. This price analysis relates to the 2024–25 season, which was before the increase in the Fairtrade Minimum Price (FTMP) and Fairtrade Premium.

- Average farm-gate prices vary modestly, ranging from ₹ 70,000 – ₹ 74,000 per tonne, with Fairtrade Organic Certified Farmers obtaining the highest average price (₹ 74,019) (Table 15).
- The price premium for Fairtrade Organic Certified and Non-Fairtrade Organic Certified cotton (≈ 2–3%) over Conventional cotton reflects quality based bonuses and organised group marketing through Producer Organisations.

- In-Conversion farmers (both Fairtrade and Non-Fairtrade) report similar prices (around ₹70,000 per tonne). This is because they are still in the conversion stage and are not yet eligible for full organic or Fairtrade premiums. Also, these In-Conversion groups are from different locations, so their prices should be interpreted separately from the mature systems.
- The narrow spread in price levels shows that price differentials are modest, but when coupled with lower input costs under Fairtrade Organic Certified systems, they substantially enhance net profitability. The stability of Fairtrade pricing mechanisms also cushions farmers from local market fluctuations, ensuring more predictable returns than conventional open-market sales.

Table 15: *Average price of seed cotton*

FARMER CATEGORY	AVERAGE PRICE (₹ / TONNE OF SEED COTTON)	AVERAGE PRICE (€/ TONNE OF SEED COTTON)
Fairtrade Organic Certified	74,019	725
Non-Fairtrade Organic Certified	73,695	722
Non-Fairtrade Conventional	72,069	706
Fairtrade In-Conversion	70,458	690
Non-Fairtrade In-Conversion	70,032	686

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

COST, REVENUE AND PROFITABILITY

The cost, revenue, and profitability analysis in this report follows an independent methodology applied uniformly across all production systems covered in the study. This approach is different from Fairtrade's internal Cost of Sustainable Production (COSP) calculation methodology.

FAIRTRADE ORGANIC CERTIFIED AND NON-FAIRTRADE ORGANIC CERTIFIED

Farmers achieve the highest net profits (Table 16), primarily due to reduced input costs and access to Organic/ Fairtrade price premiums.

FAIRTRADE ORGANIC CERTIFIED FARMERS

Earn an average profit of ₹77,642 per hectare, about 10% higher than Conventional farms, despite slightly lower yields.

IN-CONVERSION FARMERS

Especially Non-Fairtrade IC, record the lowest profit margins due to transitional costs and absence of Certification premiums in Non-Fairtrade IC.

MATURE SYSTEMS

Cost of cultivation is lower in the organic groups (Fairtrade Organic Certified and Non-Fairtrade Organic Certified: about ₹36k–38k/ha) compared to Non-Fairtrade Conventional (₹46.8k/ha). As a result, profits are higher in the Organic groups (₹75k–78k/ha) than in conventional (₹70k/ha), even though revenues are broadly similar.

IN-CONVERSION SYSTEMS

Are from different locations, so their results should be interpreted within the In-Conversion segment and not compared directly with mature systems. Within In-Conversion farmers, Fairtrade In-Conversion shows a lower cost of cultivation (₹57,507/ha) than Non-Fairtrade In-Conversion (₹70,469/ha). Revenue is similar (₹90,474/ha vs ₹88,762/ha), so profit is higher for Fairtrade In-Conversion (₹32,967/ha) than Non-Fairtrade In-Conversion (₹18,293/ ha).

Table 16: *Economic performance of different cotton farming systems*

INDICATORS	FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE ORGANIC CERTIFIED	NON-FAIRTRADE CONVENTIONAL	FAIRTRADE IN-CONVERSION	NON-FAIRTRADE IN-CONVERSION
Average Revenue (₹/Ha)	1,15,270	1,12,145	1,17,043	90,474	88,762
Average Cost of Cultivation (₹/Ha)	37,630	36,391	46,777	57,507	70,469
Average Profit (₹/Ha)	77,642	75,755	70,264	32,967	18,293
Average Revenue (€/Ha)	1,130	1,099	1,147	887	870
Average Cost of Cultivation (€/Ha)	369	357	458	564	691
Average Profit (€/Ha)	761	742	689	323	179

In-Conversion results should be interpreted separately and not directly compared with mature systems (Fairtrade Organic Certified, Non-Fairtrade Organic Certified, and Non-Fairtrade Conventional), as the groups are from different locations.

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CONCLUSION AND RECOMMENDATIONS

5

5.1. CONCLUSION

The results of this study show a clear pattern across environmental and economic dimensions. The study confirms that Organic systems naturally reduce dependence on chemical fertilisers and show lower Greenhouse Gas emissions. At the same time, Fairtrade support helps strengthen these benefits by improving field practices and giving farmers better access to technical guidance and more remunerative markets.

An environmental analysis shows that Fairtrade Organic Certified farmers have the lowest net GHG emissions among all groups. Fairtrade Organic Certified farmers recorded the lowest emission intensity at about 0.76 kg CO_2e/kg of seed cotton, compared to 0.97 kg CO_2e/kg among Non-Fairtrade Organic Certified farmers and 1.1 kg CO_2e/kg among Conventional farmers. At the farm level, emissions per hectare follow the same pattern, with Fairtrade Organic Certified farms having lower emissions than Non-Fairtrade Organic Certified and Conventional farms.

Geospatial analysis using the Hansen Global Forest Change dataset (2000–2023), within the limits of its spatial resolution, did not detect forest cover in 2000 or forest loss within the mapped farm boundaries during 2001–2023. This suggests that no deforestation was detected within the sampled farm locations over the assessed period.

Economic outcomes also show a positive pattern. Fairtrade Organic Certified farmers recorded an average lint yield of about 547 kg/ha, which is slightly higher than Non-Fairtrade Organic Certified farmers **(around 536 kg/ha)** and close to that of Conventional farmers (around 568 kg/ha). Fairtrade Organic Certified farmers earn around **₹1,15,270 per hectare in revenue,** with an average profit of about **₹77,642 per hectare,** which is higher than most comparable groups. Overall cultivation costs remain moderate, reflecting a mix of labour, Organic inputs and locally available resources rather than heavy dependence on external chemical inputs. In-Conversion farmers, in both Fairtrade and Non-Fairtrade categories, continue to face higher overall cultivation efforts during the transition period, which affects margins in the short term. These results suggest that Fairtrade Organic Certified systems balance stable yields with better prices and controlled costs, leading to more resilient economic outcomes.

Overall, the study demonstrates that Fairtrade Organic Certified cotton farming offers clear environmental and economic advantages and provides strong evidence of agroecological principles in practice, as reflected in Fairtrade's Policy on Sustainable Agriculture[7]. The findings show lower Greenhouse Gas emissions and better performance on key farm practices such as nutrient and input management, field operations, and residue handling. These results reflect the ecological dimension of agroecology, including more sustainable resource use, reduced environmental pressure, and stronger climate resilience. Fairtrade support also strengthens farmers through regular technical guidance and Producer Organization systems, which improve decision-making, build local capacity, and reinforce collective systems of support. This is also consistent with the social and economic dimensions of agroecology, including farmer empowerment, stronger rural institutions, fairer market systems, and more sustainable livelihoods. On the economic side, Fairtrade Organic Certified farmers show stronger profitability, supported by better market linkages and improved price realization in the study areas. While some differences are influenced by local conditions, the overall findings indicate that Fairtrade Organic Certified cotton represents a practical example of how agroecological principles can contribute to lower emissions, reasonable profitability, and better climate resilience at farm level.

[7] https://www.fairtrade.net/en/get-involved/news/sustainable-farming-is-the-key-to-sustainable-food-systems.html

5.2. RECOMMENDATIONS

The findings of this study highlight important strengths within Fairtrade Organic Certified systems and also point to areas where further improvement can support stronger environmental and economic outcomes. Based on the results, the following recommendations can help farmers, Producer Organisations and sector partners improve:

1

STRENGTHEN SUPPORT DURING THE ORGANIC TRANSITION PERIOD:
In-Conversion farmers face higher variable cultivation costs. Additional support on input preparation, weed management, composting techniques and planning can help reduce the burden during the conversion period and stabilise their margins.

2

PROMOTE LOW-ENERGY IRRIGATION SOLUTIONS:
Energy-use emissions differ across groups, especially in areas with deep borewells. Encouraging efficient pumps, solar-based irrigation and better water-distribution practices can help reduce overall emissions and pumping costs.

3

INTEGRATE WATER-ENERGY MANAGEMENT INTO FARM TRAINING AND PLANNING:
Integrate water-energy management into farm training and planning: Irrigation is one of the main drivers of on-farm energy use. Simple actions such as better irrigation scheduling, routine pump maintenance, avoiding over-irrigation and promoting drip or solar-based systems can save water and reduce energy use. These topics should continue to be included in Producer Organisation training.

4

CONTINUE LONG-TERM MONITORING OF ENVIRONMENTAL INDICATORS:
Regular environmental monitoring like yield, emissions, and water use can help Producer Organisations track changes over the years. Maintaining a consistent dataset will support better planning and decision-making.

5

GHG REDUCTION PATHWAYS:
Focus on the main emission sources in cotton such as chemical fertilisers application, irrigation energy use and residue management. Promote efficient pumping, solar-based irrigation where feasible, and reduce residue burning through mulching or incorporation.

6

STRENGTHEN COORDINATION ON TRAINING AND FIELD SUPPORT
Fairtrade's role in training and knowledge transfer is visible across farmer groups. Continued coordination between Fairtrade and Producer Organisations can help scale good practices, especially those related to nutrient management, residue management and soil improvement.

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REFERENCES

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Notes

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