Impact of Smart Irrigation on Water Efficiency, Labor Reduction, and Crop Productivity: A Mango Farm Case Study

Abstract

This case study evaluates the impact of the DCON Ag Air Smart Irrigation System on a 9-acre mango farm. It compares traditional, semi-automated, and fully automated irrigation methods to analyze improvements in water usage, fertilizer efficiency, labor reduction, and crop yield. The results show significant savings in resources along with better crop quality and higher productivity, demonstrating the effectiveness of smart irrigation in modern farming.

Project Overview

This case study evaluates the impact of implementing **DCON Ag Air Smart Irrigation System** on a 9-acre farm by comparing traditional, semi-automated, and fully automated irrigation methods.

Objective

- Optimize water usage
- Improve fertilizer efficiency
- Reduce labor dependency
- Enhance crop yield & quality
- Increase overall farm profitability

Farm Details

- Location: Erode
- Total Area: 9 Acres
- Crop: Mango
- Irrigation Type: Drip Irrigation
- Technology Used: DCON Ag Air Controller

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Experimental Methodology

The total land was divided into **3 equal zones (3 acres each)** to compare different irrigation methods.

Figure: 1.1

Zone 1: Traditional Method

- **Irrigation (Manual Scheduling)**

  In this zone, irrigation was carried out manually based on the farmer's experience and visual observation of soil conditions. The irrigation schedule varied weekly depending on weather and field requirements, leading to inconsistent watering patterns. Typically, irrigation was performed 2 to 3 times per week, with each session lasting between 2 to 3 hours.

Week	Irrigation Days	Duration (Hours)
Week 1	Mon, Thu, Sat	2 hrs
Week 2	Tue, Fri	2 hrs
Week 3	Mon, Wed, Sat	2.5 hrs
Week 4	Tue, Thu, Sun	2–2.5 hrs
Week 5	Mon, Fri	2 hrs
Week 6	Wed, Sat, Sun	2.5 hrs
Week 7	Mon, Thu	2 hrs
Week 8	Tue, Fri, Sun	2–2.5 hrs

- **Water Usage (Approximate)**

Water usage was not measured precisely and depended on estimation. The average water consumption per irrigation ranged between 25,000 to 32,000 liters for 3 acres. Weekly water usage varied from 60,000 to 95,000 liters, indicating a lack of control and efficiency.

Week	Frequency (Days/Week)	Water per Irrigation (L)	Total Weekly Water (Litres)
Week 1	3 Days	25,000 – 28,000	75,000 – 84,000
Week 2	2 Days	26,000 – 29,000	52,000 – 58,000
Week 3	3 Days	29,000 – 32,000	87,000 – 96,000
Week 4	3 Days	25,000 – 30,000	75,000 – 90,000
Week 5	2 Days	23,000 – 26,000	46,000 – 52,000
Week 6	3 Days	27,000 – 32,000	81,000 – 96,000
Week 7	2 Days	25,000 – 28,000	50,000 – 56,000
Week 8	3 Days	26,000 – 30,000	78,000 – 90,000

- **Fertilizer Usage (Manual Application)**

Fertilizers were applied manually without precise calculation. The quantity and timing were based on farmer judgment, which often resulted in overuse or underuse. Weekly fertilizer costs ranged from ₹1,200 to ₹2,800, with total expenses reaching approximately ₹11,000 to ₹19,000 over 8 weeks.

Week	Application	Fertilizer Type	Quantity (Kg)	Cost per Kg (₹)	Weekly Cost (₹)
Week 1	Once	Urea / Complex	45 – 50	25 – 35	1,125 – 1,750
Week 2	Once	Urea / DAP	40 – 45	30 – 40	1,200 – 1,800
Week 3	Twice	Urea / Potash	50 – 60	35 – 45	1,750 – 2,700
Week 4	Once	Complex mix	45 – 55	30 – 40	1,350 – 2,200
Week 5	Once	Urea	35 – 40	25 – 30	875 – 1,200
Week 6	Twice	Urea / DAP	50 – 60	30 – 40	1,500 – 2,400
Week 7	Once	Complex mix	40 – 50	30 – 40	1,200 – 2,000
Week 8	Once	Urea / Potash	45 – 55	30 – 45	1,350 – 2,475

- **Labor Usage**

Labor played a major role in this zone, as all operations were manual. Typically, 2 to 3 workers were required for irrigation and fertigation activities. Weekly labor costs ranged between ₹3,500 and ₹7,500, resulting in a total cost of ₹32,000 to ₹42,000 over the study period.

Week	Workers	Days/Week	Total Hours	Cost/Day (₹)	Weekly Cost (₹)
Week 1	2	3	18–24 hrs	800	4,800
Week 2	2	2	12 hrs	800	3,200
Week 3	3	3	36–45 hrs	800	7,200
Week 4	2	3	18–24 hrs	800	4,800
Week 5	2	2	12 hrs	800	3,200
Week 6	3	3	36–45 hrs	800	7,200
Week 7	2	2	12 hrs	800	3,200
Week 8	2–3	3	18–36 hrs	800	4,800 – 7,200

Challenges:

- Overwatering / under-watering
- Fertilizer wastage
- Inconsistent crop growth

Zone 2: Semi-Automated System

- **Irrigation (Automated Scheduling)**

  In this zone, irrigation was controlled using automated timers and basic controllers with predefined schedules, ensuring consistent water application compared to manual methods. Fertigation activities were still carried out manually but required less effort due to better irrigation control. Overall, the system reduced dependency on continuous monitoring, and daily operations could be managed efficiently within approximately 30 mins of time spent, improving operational efficiency compared to the traditional method.

- **Water Usage (Controlled)**

  Water usage was more regulated due to automated scheduling. The average weekly consumption ranged between 50,000 and 75,000 liters for 3 acres, showing noticeable improvement compared to the manual system.

Week	Frequency (Days/Week)	Water per Irrigation (Litres)	Total Weekly Water (Litres)
Week 1	3 Days	20,000 – 24,000	60,000 – 72,000
Week 2	2 Days	22,000 – 25,000	44,000 – 50,000
Week 3	3 Days	24,000 – 28,000	72,000 – 84,000
Week 4	3 Days	21,000 – 26,000	63,000 – 78,000
Week 5	2 Days	20,000 – 23,000	40,000 – 46,000
Week 6	3 Days	23,000 – 27,000	69,000 – 81,000
Week 7	2 Days	21,000 – 24,000	42,000 – 48,000
Week 8	3 Days	22,000 – 26,000	66,000 – 78,000

- **Fertilizer Usage (Manual with Monitoring)**

Fertilizer application was still manual, but better tracking and planning were followed. This helped in reducing excessive usage. Weekly fertilizer costs ranged from ₹1,000 to ₹2,200.

Week	Application	Fertilizer Type	Quantity (Kg)	Cost per Kg (₹)	Weekly Cost (₹)
Week 1	Once	Urea / Complex	40 – 45	25 – 35	1,000 – 1,575
Week 2	Once	Urea / DAP	35 – 40	30 – 40	1,050 – 1,600
Week 3	Twice	Urea / Potash	45 – 55	35 – 45	1,575 – 2,475
Week 4	Once	Complex mix	40 – 50	30 – 40	1,200 – 2,000
Week 5	Once	Urea	30 – 35	25 – 30	750 – 1,050
Week 6	Twice	Urea / DAP	45 – 55	30 – 40	1,350 – 2,200
Week 7	Once	Complex mix	35 – 45	30 – 40	1,050 – 1,800
Week 8	Once	Urea / Potash	40 – 50	30 – 45	1,200 – 2,250

- **Labor Usage**

  Labor requirements were reduced as irrigation became automated. Typically, 1 to 2 workers were sufficient to manage operations. Weekly labor costs ranged from ₹2,500 to ₹5,000.

Week	Workers	Days/Week	Total Hours	Cost/Day (₹)	Weekly Cost (₹)
Week 1	2	2	12–16 hrs	800	3,200
Week 2	2	2	12 hrs	800	3,200
Week 3	2	3	24–30 hrs	800	4,800
Week 4	2	2	12–16 hrs	800	3,200
Week 5	1–2	2	10–12 hrs	800	2,400 – 3,200
Week 6	2	3	24–30 hrs	800	4,800
Week 7	1–2	2	10–12 hrs	800	2,400 – 3,200
Week 8	2	2–3	12–24 hrs	800	3,200 – 4,800

Overall Observation:

The semi-automated system improved water management and reduced labor dependency, but lacked precision in fertigation, limiting overall efficiency.

Improvements:

- Better water control
- Reduced labor
- More consistent irrigation

Zone 3: DCON Ag Air (Full Automation)

- **Irrigation (Smart Automation)**

  In this zone, irrigation was fully automated using the DCONG Ag Air system, operating based on real-time soil moisture data and system intelligence. Irrigation was applied only when required, ensuring optimal water availability for crops. Fertigation was also automated with precise control, reducing wastage, and improving nutrient efficiency.

  Due to complete automation, daily monitoring and operation required only approximately **30 minutes of time**, significantly reducing labor effort and improving overall efficiency.

- **Water Usage (Optimized)**

  Water usage was significantly reduced due to precise control. Weekly consumption ranged between 35,000 and 55,000 liters for 3 acres, representing substantial savings compared to other zones.

Week	Frequency	Water per Irrigation (Litres)	Total Weekly Water (Litres)
Week 1	2–3 Days	15,000 – 18,000	30,000 – 45,000
Week 2	2 Days	16,000 – 19,000	32,000 – 38,000
Week 3	3 Days	18,000 – 20,000	54,000 – 60,000
Week 4	2–3 Days	15,000 – 19,000	30,000 – 57,000
Week 5	2 Days	14,000 – 17,000	28,000 – 34,000
Week 6	3 Days	17,000 – 20,000	51,000 – 60,000
Week 7	2 Days	15,000 – 18,000	30,000 – 36,000
Week 8	2–3 Days	16,000 – 19,000	32,000 – 57,000

- **Fertilizer Usage (Automated Fertigation)**

  Fertilizer application was automated and precisely controlled. Nutrients were delivered in exact quantities based on crop requirements, minimizing wastage. Weekly fertilizer costs ranged from ₹800 to ₹1,800.

Week	Application	Fertilizer Type	Quantity (Kg)	Cost per Kg (₹)	Weekly Cost (₹)
Week 1	Split dosing	Liquid mix	30 – 35	30 – 40	900 – 1,400
Week 2	Split dosing	Liquid mix	28 – 32	30 – 40	850 – 1,300
Week 3	Split dosing	NPK mix	35 – 40	35 – 45	1,200 – 1,800
Week 4	Split dosing	Liquid mix	30 – 35	30 – 40	900 – 1,400
Week 5	Split dosing	Urea	25 – 30	25 – 30	625 – 900
Week 6	Split dosing	NPK mix	35 – 40	30 – 40	1,050 – 1,600
Week 7	Split dosing	Liquid mix	28 – 32	30 – 40	850 – 1,300
Week 8	Split dosing	NPK mix	30 – 35	30 – 45	900 – 1,575

- **Labor Usage**

Labor requirement was minimal, as most operations were automated and monitored through a mobile interface. Only basic supervision was needed. Weekly labor costs ranged between ₹1,500 and ₹3,000.

Week	Workers	Days	Total Hours	Cost/Day (₹)	Weekly Cost (₹)
Week 1	1	2	6–8 hrs	800	1,600
Week 2	1	2	6–8 hrs	800	1,600
Week 3	1	2	8–10 hrs	800	1,600
Week 4	1	2	6–8 hrs	800	1,600
Week 5	1	1–2	4–6 hrs	800	800 – 1,600
Week 6	1	2	8–10 hrs	800	1,600
Week 7	1	1–2	4–6 hrs	800	800 – 1,600
Week 8	1	2	6–8 hrs	800	1,600

Advantages:

- Precision farming
- Minimal human error
- Complete farm control remotel

Final Comparison: Traditional vs Semi-Automated vs Fully Automated

1. Water Usage Comparison (3 Acres – Weekly Average)

Parameter	Traditional	Semi-Automated	DCON Ag Air (Full Auto)
Weekly Water Usage	60,000 – 95,000 L	50,000 – 75,000 L	**35,000 – 55,000 L**
Water Control	Low	Moderate	**High (Precise & Need-Based)**
Water Savings	—	~15–25%	**~40–50%**

Insight:
DCON Ag Air achieves the **highest water efficiency**, reducing wastage significantly through real-time control.

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2. Fertilizer Usage & Cost (8 Weeks Total)

Parameter	Traditional	Semi-Automated	DCON Ag Air
Weekly Cost	₹1,200 – ₹2,800	₹1,200 – ₹2,800	**₹800 – ₹1,800**
Total Cost (8 Weeks)	₹11,000 – ₹19,000	₹11,000 – ₹19,000	**₹6,500 – ₹12,000**
Application Method	Manual	Manual (Monitored)	**Automated (Precision Dosing)**
Efficiency	Low	Low	**High**

Insight:
Automated fertigation reduces **fertilizer wastage by ~30–40%** while improving nutrient absorption.

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3. Labor Usage & Cost (8 Weeks Total)

Parameter	Traditional	Semi-Automated	DCON Ag Air
Workers Required	2–3	1–2	**1**
Weekly Cost	₹7500	₹5,500	**₹3000**
Total Cost (8 Weeks)	₹60,000	₹44,000	**₹24,000**
Effort Required	High	Medium	**Very Low**

Insight:
Full automation reduces **labor dependency by up to 60–70%**.

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4. Irrigation Efficiency

Parameter	Traditional	Semi-Automated	DCON Ag Air
Scheduling	Manual	Flow & Volume Based	**Flow, Volume, Sensor + Fertigation**
Consistency	Low	High	**High**
Human Error	High	Minimal	**Minimal**
Monitoring Time	High	~30 mins/day	**~30 mins/day (Remote)**

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5. Crop Performance

Parameter	Traditional	Semi-Automated	DCON Ag Air
Crop Growth	Uneven	Improved	**Uniform & Healthy**
Yield Quality	Inconsistent	Better	**High Quality**
Productivity	Moderate	Good	**Maximum**

Overall Benefits Summary

The transition from traditional to fully automated irrigation demonstrates a clear progression in efficiency, control, and profitability. The Fully Automated Irrigation and Fertigation system delivers superior performance across all critical parameters, making it a reliable solution for sustainable and precision agriculture.

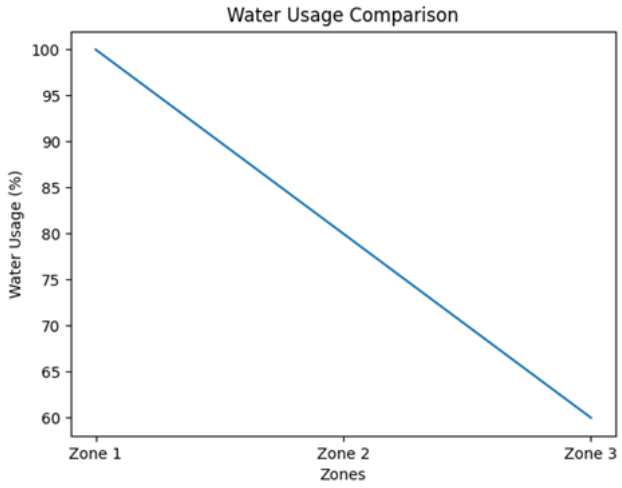
Key Parameter	Traditional Method	Semi-Automated System	DCON Ag Air (Full Automation)
Water Efficiency	Low	Moderate	High (Optimized Usage)
Fertilizer Efficiency	Low	Moderate	High (Precision Dosing)
Labor Requirement	High	Moderate	Low (Minimal Intervention)
Automation Level	None	Partial	Full Automation
Operational Control	Manual	Scheduled Control	Smart & Remote-Based
Human Error Risk	High	Moderate	Minimal
Crop Consistency	Inconsistent	Improved	Uniform & Healthy Growth
Overall Profitability	Low	Moderate	High

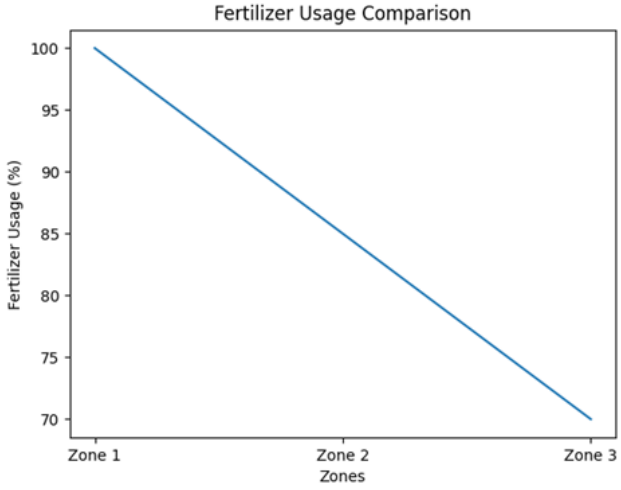
Return on Investment (ROI) Analysis

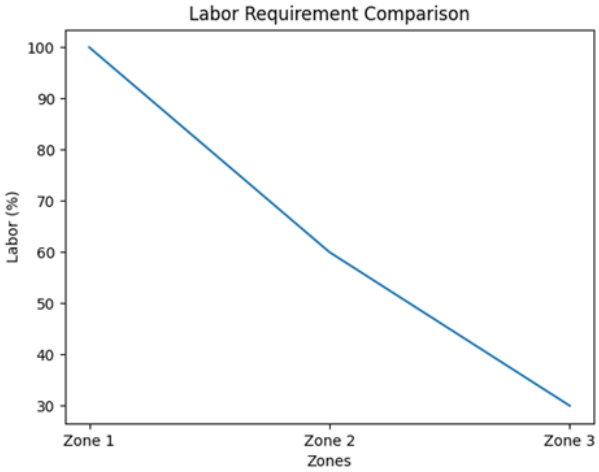
The implementation of the DCON Ag Air Smart Irrigation System demonstrated a strong financial advantage when compared to traditional and semi-automated irrigation methods. The return on investment is driven by significant reductions in water consumption, fertilizer usage, and labor costs, along with improved crop productivity and quality.

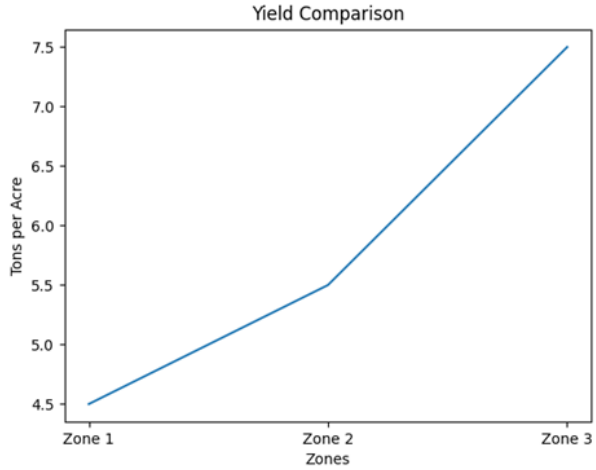
Cost Component	Traditional	Semi-Automated	Full Automation
Water Usage *(Operational Cost Impact)*	High	Medium	Low
Fertilizer Cost	₹11,000 – ₹19,000	₹8,000 – ₹15,000	₹6,500 – ₹12,000
Labor Cost	₹32,000 – ₹42,000	₹20,000 – ₹30,000	₹12,000 – ₹20,000

Graph:






Labor Requirement Comparison
Labor (%)
100
90
80
70
60
50
40
30
Zone 1
Zone 2
Zone 3
Zones


Yield Comparison
Tons per Acre
7.5
7.0
6.5
6.0
5.5
5.0
4.5
Zone 1
Zone 2
Zone 3
Zones

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- Effect of irrigation regimes on mango productivity
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- Influence of irrigation scheduling on mango yield
- Drip irrigation impact on mango yield and quality
- Fertigation efficiency in orchard crops
- Water use efficiency in fruit crops
- Precision irrigation techniques in horticulture
- Role of evapotranspiration in irrigation planning
- Soil moisture-based irrigation scheduling
- Sustainable irrigation practices in semi-arid regions
- IoT-based smart irrigation system design and implementation
- Optimal irrigation scheduling using predictive models
- Precision irrigation robotics and automation
- Sensor-based irrigation control systems
- Cloud-based farm monitoring systems
- Wireless irrigation automation technologies
- Smart agriculture and precision farming techniques
- AI-based irrigation decision support systems
- Micro irrigation adoption trends in India
- Water conservation technologies in agriculture
- Fertilizer management practices in orchards
- Labor optimization in agriculture using automation
- Case studies on drip irrigation success in India
- Precision farming implementation reports
- Sustainable agriculture and resource efficiency studies
- Climate impact on irrigation practices
- Agricultural water scarcity and management strategies
- Best practices in fertigation systems
- Irrigation scheduling tools and software guidelines
- Manufacturer technical manuals for smart irrigation controllers