Arbeitsgemeinschaft Tropische und Subtropische Agrarforschung (ATSAF) e.V.
Council for Tropical and Subtropical Agricultural Research

**ATSAF Academy**
Academy for International Agricultural Research for Development

# Junior Scientists Tandems
# Final Report

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**Start and end date of stay at CIFOR/ APCNF : April 2025 to september 2025**

**Title: Long-Term Assessment of Soil Properties under Andhra Pradesh Community Managed Natural Farming (APCNF) Compared with Conventional Rice Cropping Systems.**

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## Introduction

India possesses one of the world's largest agricultural landscapes, with 159 million hectares of arable land supporting over 15% of the national GDP (Yadav et al., 2021). Over the past several decades, intensive chemical-based agriculture—particularly following the Green Revolution—has led to increased crop yields but also significant environmental degradation, soil nutrient imbalances, declining soil organic carbon (SOC), and growing dependence on synthetic fertilizers (Bhattacharyya et al., 2015; Pimentel, 1996). Rising fertilizer prices, global supply-chain disruptions, and the long-term decline in the crop response ratio further highlight the urgent need for sustainable, low-input farming systems (World Bank Group, 2022; Kalarani et al., 2023).

The Andhra Pradesh Community Managed Natural Farming (APCNF) program represents one of the world's most ambitious agroecological transitions. With an emphasis on eliminating synthetic inputs, strengthening soil biology, improving water-use efficiency, and enhancing farmer-led knowledge systems, APCNF challenges the conventional paradigm of input-intensive agriculture. By utilizing organic amendments such as *Bijamrita*, *Jiwamrita*, mulching, crop rotation, and biological pest management, APCNF seeks to restore soil health and long-term sustainability.

This master's research project investigates the long-term (>5 years) impacts of APCNF on soil organic carbon, soil health indicators, and climate resilience in rice-based cropping systems. By comparing APCNF to conventional rice monocropping, the study contributes to scientific understanding of agroecological transitions in tropical agricultural landscapes

## Research Objectives

This research is conducted under the academic supervision of **Prof. Dr. Torsten Müller**, University of Hohenheim, and **Dr. Leigh Ann Winowiecki**, Global Lead for Soil and Land Health at CIFOR–ICRAF (CGIAR). Field-level mentorship is provided by **Dr. Zakir Hussain, Dr. Hima Bindu and Dr. Neelima** through Raithu Sadhikara Samstha (RySS), the implementing agency for APCNF in Andhra Pradesh.

The objectives of the study are:

### 1. Assess Soil Organic Carbon (SOC) Storage and Soil Health Indicators

- Quantify SOC at two depths 0–30 cm (Topsoil) & 30-60 cm (Sub-soil) depth under APCNF and conventional farming.
- Assess soil health parameters such as infiltration, bulk density, water-holding capacity, microbial activity, soil respiration, and biological activity.
- Analyse how these variables influence soil resilience to climate variability.

2. Compare Input Use Efficiency and Sustainability

- Compare fertilizer, pesticide, water, and labor requirements.
- Evaluate the long-term sustainability and resource efficiency of both systems.
- Examine environmental impacts and economic implications.

3. Understand Farmers' Perceptions

- Document farmers' experiences with APCNF and conventional systems.
- Explore perceived benefits, challenges, adoption pathways, and climate resilience strategies.

## Research Location

The research is conducted in **West Godavari district**, one of Andhra Pradesh's prime rice-producing regions. The region is characterized by:

- **Soil types:** Alfisols and Vertisols, which together represent over 90% of cultivable land in the state (Rao et al., 2013).
- **Climate:** Tropical with high humidity, monsoon-driven rainfall, and mean temperatures ranging from 25–34°C.
- **Cropping systems:** Predominantly rice monocropping under conventional farming and rice–pulse/legume rotations under APCNF.

The experimental fields are hosted by **Raithu Sadhikara Samstha (RySS)** in collaboration with **CIFOR–ICRAF**, where long-term natural farming research trials are already established. All field activities strictly follow APCNF protocols and ongoing trial conditions.

## 4. Field Experiment & Methodological Approach

4.1 Experimental Design

**A paired-comparison design is used, with each farm containing:**

- **Two treatments:**
    1. Natural Farming (APCNF Rice followed by PMDS)
    2. Conventional Farming (Rice followed by Rice)
- **Plot size:** 6 × 6 m (not strictly, adjusted according to real-time situations)
- **Replications:** 2 (Latin square design)
- **Total plots per Treatment: 4**
- **Depths** : 2 (Top soil 0-30 cm & Sub Soil 30-60 cm)
- **Samples** : 2 samples per plot (each per depth) , 16 samples in total (8 from conventional farms, 8 from natural- agro ecologicalfarms)

### 4.3 Soil Sampling

Soil samples are taken:

- Before rice transplanting after Pre-monsoon dry sowing of Legumes/pulses/green manure seeds.
- At depths **0–30 cm** and **30–60 cm**
- Using a Z-shaped sampling pattern
- Five cores per plot combined into one composite sample

### 4.4 Soil Analysis Parameters

All samples are analysed at the Eurekha Labs, Guntur, using methods from Ramana Reddy et al. (2012). Parameters include:

- **Chemical:** pH, EC, SOC, N, $P_2O_5$, $K_2O$, micronutrients (Cu, Fe, Mn, Zn)
- **Physical:** texture, bulk density, water-holding capacity,
- **Biological:** earthworm abundance

### 4.5 Interviews and Surveys

Structured interviews and focus group discussions are conducted to understand:

- Farmer perceptions of soil fertility
- Input costs and management challenges
- Observed climate resilience
- Benefits and constraints of APCNF

### 4.6 Data Analysis

- **ANOVA** for comparing soil parameters
- **Paired t-tests** for APCNF vs. conventional
- **Regression modelling** for SOC–soil property interactions
- **Thematic coding** for qualitative data

## 5. Research Work Experience with CIFOR–ICRAF and RySS (APCNF)

During the research period, I gained comprehensive field and analytical experience through close collaboration with CIFOR–ICRAF scientists and the RySS APCNF implementation team. Key aspects of this experience include:

### 5.1 Technical Learning

- Applying soil sampling protocols in tropical monsoon conditions
- Understanding long-term experimental designs in agroecology

- Working with standardized soil health indicators
- Observing real-time farmer-led agroecological innovations

### 5.2 Working with CIFOR–ICRAF

My time with the organization deepened my understanding of:

- Global soil health frameworks
- Land restoration methodologies (LDSF in Valamarru site, west godavari, AP, India)
- The importance of measuring SOC for climate reporting
- Integrating scientific research with community-based programs

### 5.3 Learning from APCNF Implementation

Working directly with RySS field teams gave me insights into:

- How large-scale agroecological transitions are operationalized
- Challenges of input-free farming in smallholder contexts
- The role of farmer scientists, mentors, ICRP´s and women's self-help groups
- Practical constraints farmers face during transitions
- Local innovations that enhance soil biology and reduce pest pressures

This hands-on experience strengthened my ability to link scientific concepts with on-ground realities in Indian agriculture.

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## 6. Personal Reflection

This research project has been one of the most impactful phases of my academic and professional journey. Conducting my thesis within a global research institution and India's largest agroecological program has shaped my understanding of:

### 1. The complexity of soil systems

I learned how strongly soil health, carbon sequestration, and biological activity respond to farming practices. Seeing these differences firsthand in APCNF fields has deepened my commitment to soil-centric agriculture.

### 2. Farmer knowledge and local ecosystems

Interacting with farmers across West Godavari gave me a renewed appreciation for indigenous knowledge and the lived realities of agricultural communities.

### 3. The importance of collaborative research

Working under the joint guidance of University of Hohenheim, CIFOR–ICRAF, and RySS taught me the value of integrated research combining ecology, agronomy, and community-led development.

### 4. Personal growth

This experience strengthened my scientific thinking, field research skills, and confidence in pursuing a career in sustainable agriculture, soil science, and climate resilience.

## 7. Acknowledgments

I express my sincere gratitude to the following individuals and institutions for their invaluable support:

- **Prof. Dr. Torsten Müller**, University of Hohenheim — for his academic guidance, constructive feedback, and constant encouragement throughout the thesis development.
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- **Mr. Nookaraju** : District project manager (DPM) Apcnf initiative, west godavari for managing all logistics from the beginning of my journey, till end and for ensuring my safety and security throughout my entire stay.
- **Dr. Neelima**, Thematic Point Person, RySS Science Team — for helping coordinate field logistics and ensuring smooth research execution.
- **Dr. Hima Bindhu**, Senior Associate, RySS–IGGAARL — for her continuous support, field coordination, and valuable inputs in refining the research design.
- **Mr. Veera Swamy Chintamani :** Mentor, Lead Natural farmer & farmer scientist – for helping me with providing excellent field level knowledge from farmers point of view on soil health

Special thanks to all the farmers and I am deeply grateful for their collective guidance and support, without which this research would not have been possible. I would like to thank the CIFOR-ICRAF & APCNF staff for their daily support and assistance in the field. Their team spirit, kindness, and generosity made this experience truly enriching and unforgettable

- **Finally, A BIGGEST THANKS** to **ATSAF-JST**, for your invaluable support and for inspiring me to aim beyond my limits.

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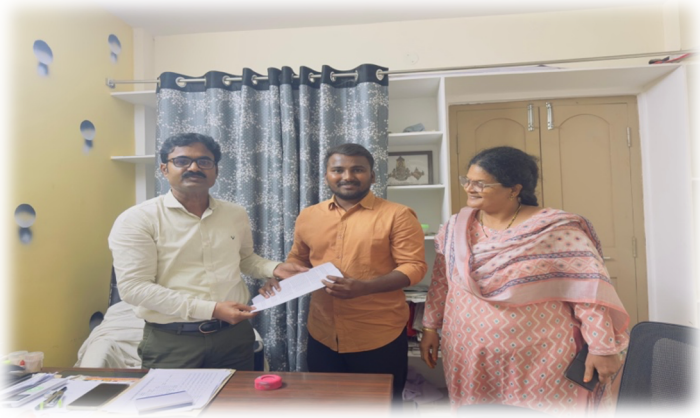
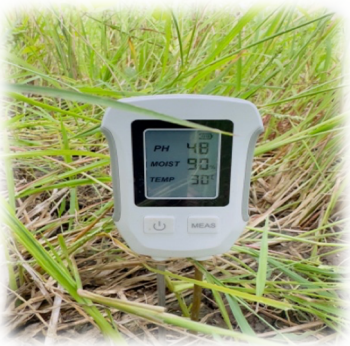
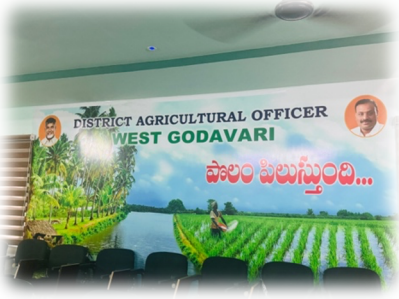
**Few pictures from the project days:**







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