Food and Agriculture Organization of the United Nations

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Rythu Sadhikara Samstha
Farmer Empowerment Corporation

Re-thinking food systems in Andhra Pradesh, India

How Natural Farming could feed the future

Current challenges in India call for food systems that:

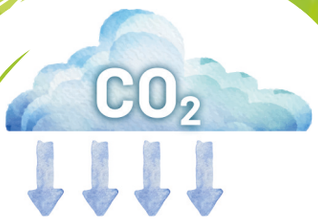
Produce sufficient, safe, healthy, adequate and nutritious food, accessible to all.

Make farming viable and resilient, reducing its inherent physical and economic hardships, risks and challenges.

Create employment and provide good incomes for smallscale producers, especially youth, to reduce inequalities.

Regenerate nature and biodiversity and reverse natural resources degradation, including soil, water, air and ecosystems

Strengthen local capabilities, self-sufficiency, autonomy and resilience to external shocks and crises.



Reduce greenhouse gas emissions and mitigate the effects of climate change

Re-thinking agriculture through a food systems approach

Food systems provide a wider lens, addressing the connections between food, health, employment, incomes, environment and the well - being of human communities.

The AgroEco2050 foresight study

- Led by the Government of Andhra Pradesh, CIRAD and FAO, AgroEco2050 is a collective future-building exercise engaging scientists, farmers, policy makers and institutions.
- It unveils hidden realities, processes, actors and parameters to explore broader visions for sustainable food systems by 2050.
- It builds on a huge diversity of data and knowledge to help democratic societies shape the futures they desire, rather than predicting or prescribing it.

AGROECO2050 aimed to clarify and quantify two different visions of what agriculture, food, nature, jobs and welfare in Andhra Pradesh might look like by 2050. One vision was based on the intensification of conventional industrial farming, while the other was based on taking natural farming (agroecology) to scale. The goal was to compare and understand the implications of these two different pathways and verify their coherence.

Two scenarios

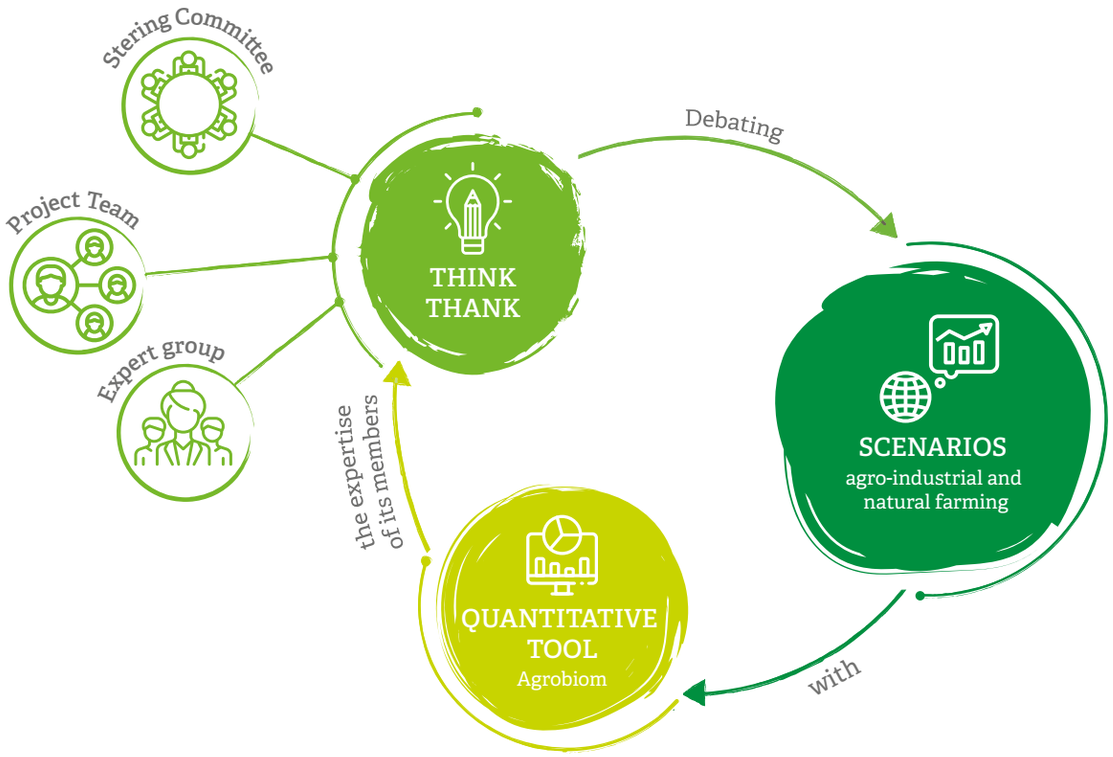
Industrial Agriculture Scenario

Consumerism-oriented society based on capital-intensive technology, fossil energy and robots, highly dependent on international trade and price competition, with standardization and mass-production of few food products, laboratory genetic and chemical inputs in agriculture, highly processed or fortified food, and centralized R&D tending towards large-scale farming with fewer farmers.

Natural Farming Scenario

A Sustainable Development Goals-oriented society based on higher income equality, moderate urbanization, diversified and chemical-free food production serving first local markets and local needs including environmental services, hybridizing scientific and indigenous knowledge, with community-managed natural farming employing a large number of happy people in agriculture and related small-scale industries.

AgroEco2050
a foresight platform with three-components



A learning journey

The Natural Farming scenario presented in AgroEco2050 is grounded in practicality, as it does not rely on untested, hypothetical technological leaps. Instead, it prioritizes strategies that offer clear benefits and are built on the application of existing knowledge and best practices that are currently within our reach.

AgroEco2050 views quantitative models as an inclusive and participatory endeavor. Most modelling exercises function as having a magic 'black box' where a small group of academics choose scenario variables, parameters and functions to optimize through complex mathematics. Instead, the quantitative model "Agribiom" is seen as a 'learning machine' for a diverse set of stakeholders, to take stock of past macroeconomic structural transformations, and to debate options for the future, using an interactive interface powered by millions of datapoints to test and refine the robustness of the scenario.

This approach allowed for a creative collaboration among a diverse group of stakeholders, from India and abroad, (scientists, farmers, government, civil society and private sector) through multiple workshops from 2019 to 2023, bringing their unique knowledge and visions to the table, enabling an exercise in participative democracy.

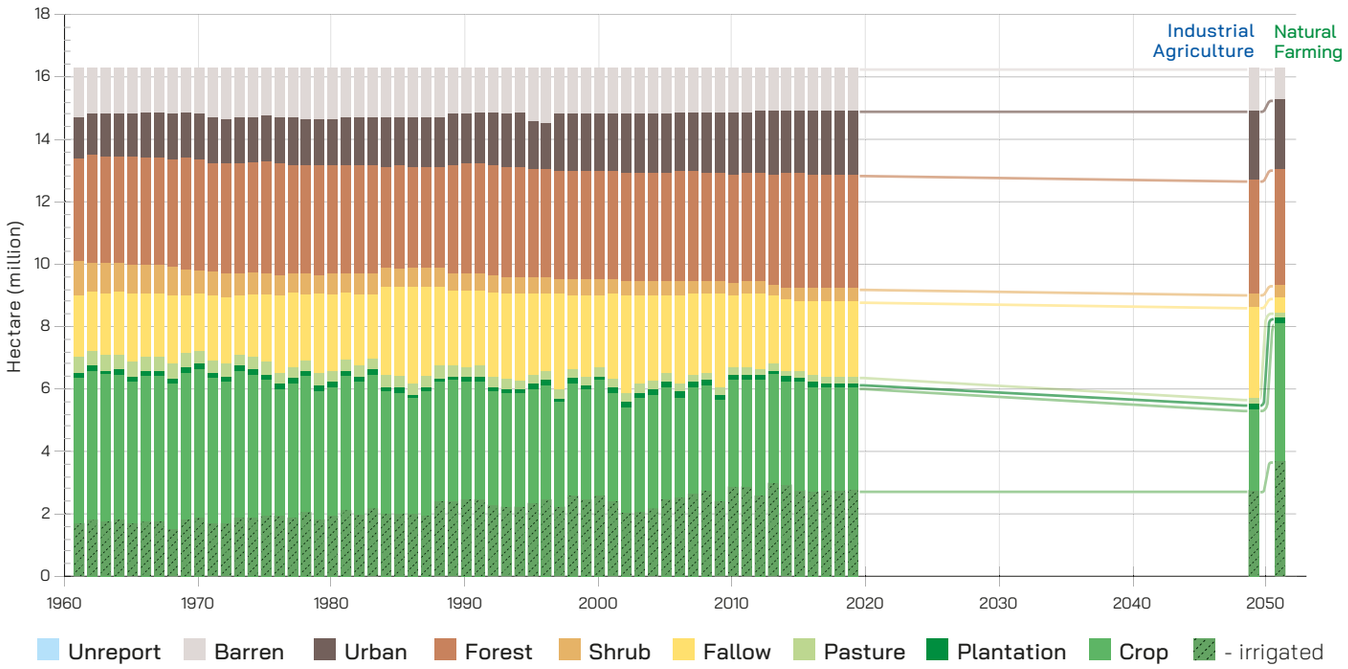
Quantifying key parameters for 2050

1 Land use

Land use: number of hectares under different uses according to official Indian statistical categories.[1]

Cultivated land declines in the Industrial Scenario with a focus on best irrigated lands, while it increases in the Natural Farming scenario, through the regeneration and green cultivation of vast fallow areas, particularly in semi-arid areas through regenerative approaches.

Figure 1.
Land use in industrial agriculture and natural farming scenarios, 1961-2050 (hectares)



1 Except for "Urban" (used here for "other land occupied by buildings, roads and railways or under water"); mainly based on EPWRF (2021) annual statistical series; annual crops and plantations (net area) are combined as "cultivated area"

Quantifying key parameters for 2050

2 Population and employment

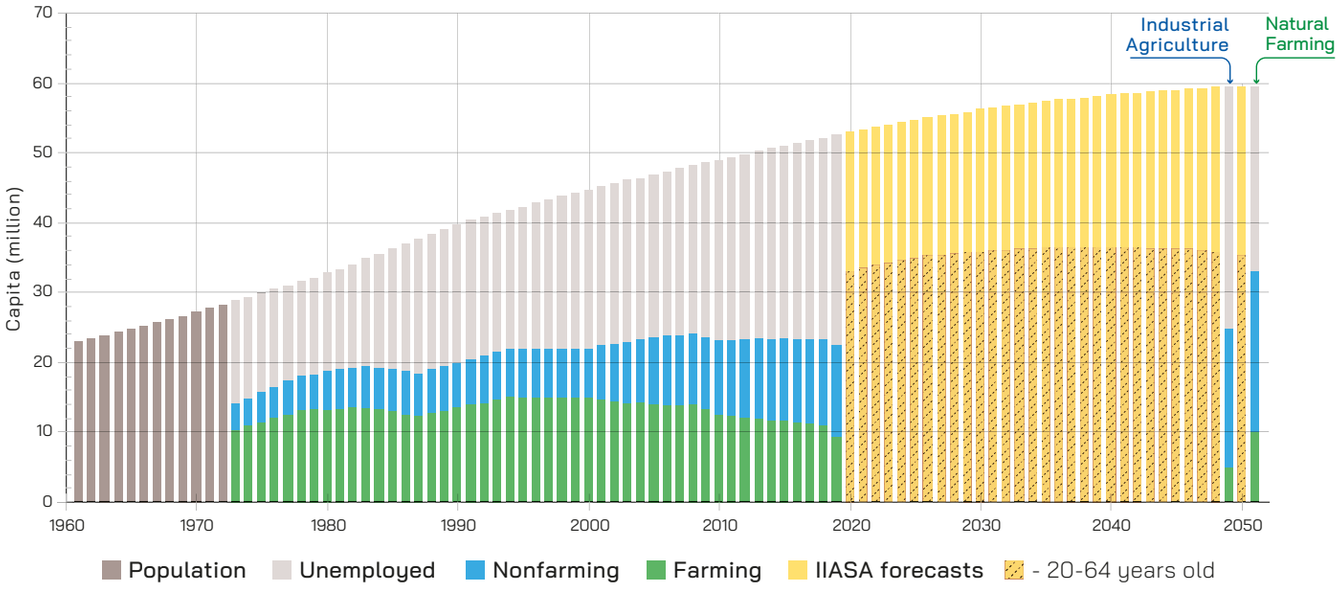
Population: number of inhabitants by age and gender, based on 2011 Indian censuses.[2]

Labour force: estimated with all 20-64 years old, whether they are employed or not, able/willing to work or not.

Employment: employed persons, based on National Sample Surveys until 2019.

In the Industrial Agriculture scenario, with half the number of farmers of 2019, the unemployment rate remains at 30%. In the Natural Farming scenario with more farmers (10 million) unemployment decreases to 7%.

Figure 2.
Population and employment in industrial agriculture and natural farming scenarios, 1961-2050



Note: IIASA – International Institute for Applied Systems Analysis (KC et al., 2018)

Source: Dorin, 2023.

2 Data till 2011, on KC *et al.* (2018) for 2011-2101 projections by Indian state.

Quantifying key parameters for 2050

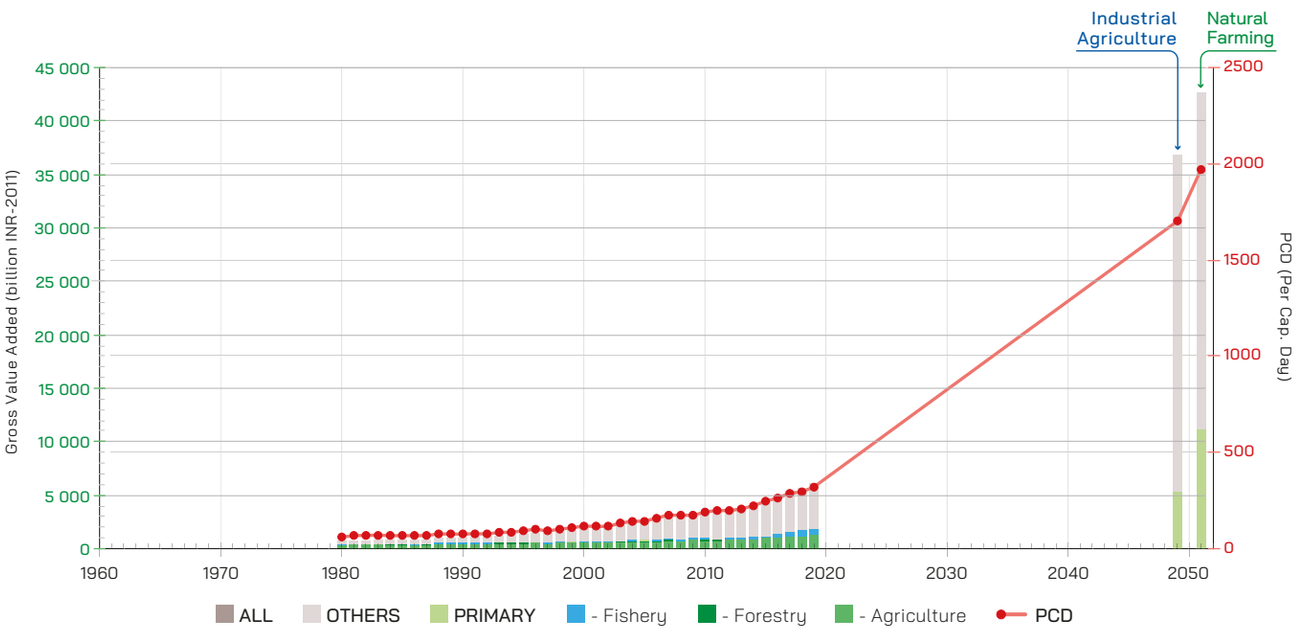
3 Economic growth and inequality

Economic growth: Gross value added (GVA) by branch of activities.[3]

Inequality: estimated using the "farmer-nonfarmer income gap" and the "Labour Income Ratio" (Dorin et al. 2013) calculated with GVA and employment by branch of activity.

The Natural Farming scenario involves a large area of land with many farmers producing diversified, nutritious, healthy food with low production costs and better market values, hence the agricultural GVA grows. In turn, the total GDP will increase, also thanks to less unemployment, less inequality, healthier and happier people than in an Industrial Agriculture scenario.

Figure 3.
Gross value added in industrial agriculture and natural farming scenarios, 1980-2050 (INR 2011-12)



3 Mostly based on CMIE (2020) and EPWRF (2021) annual statistical series in current and constant rupees; the "farm" or "primary" sector combines crop, livestock, fishery and forestry

Quantifying key parameters for 2050

4 Food yields and production

Food yield: aggregated annual production of all plant food in calories equivalent, divided by the net cultivated area, then by 365 days to get daily values in kcal/ha (Dorin *et al.*, 2013).

Food production: estimated in kilocalories (carbohydrates, proteins and fats) from the annual tonnages of production of biomasses edible in their primary form.[4]

In Industrial Agriculture, food yield of few monocrops would follow past trends regardless of the costs for farmers, natural resources and consumer health, while in Natural Farming yields increase would be less, but much better balanced in macronutrients, richer in micronutrients and fibers, with zero chemicals (fertilizers, pesticides) and no antibiotics. Overall, the food production (yield* cultivated area) per capita would be significantly higher in Natural Farming than Industrial Agriculture.

Figure 4. Caloric plant food yield per hectare in industrial agriculture and natural farming scenarios, 1973-2050 (daily kcal/ha)

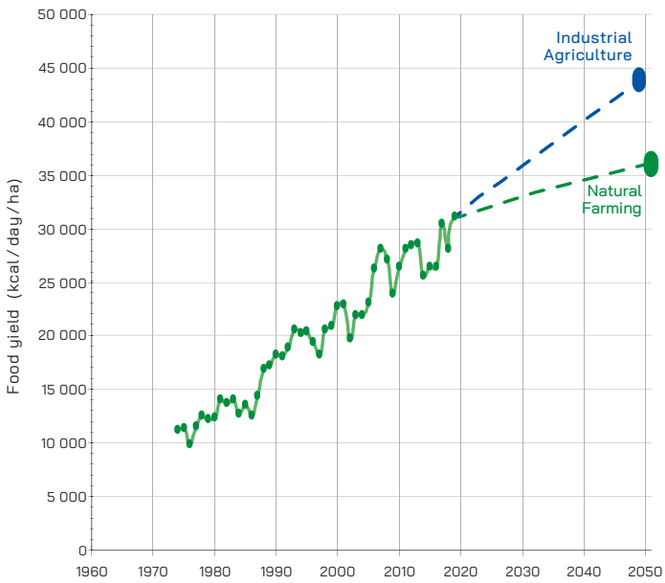
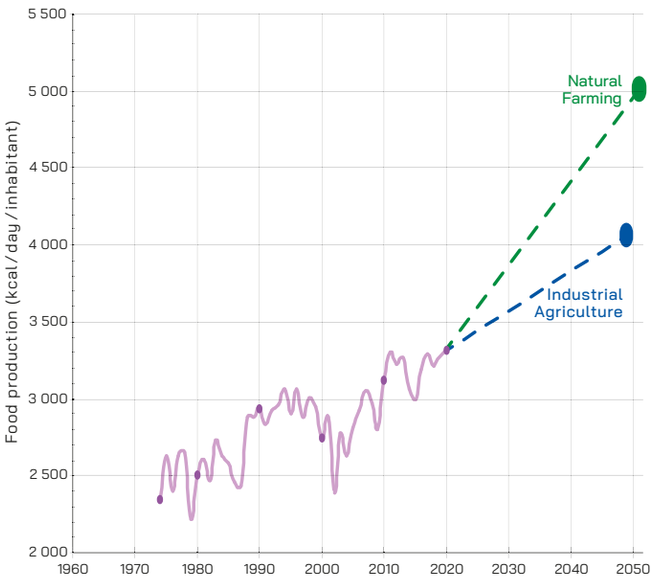


Figure 5. Caloric plant food production per capita in industrial agriculture and natural farming scenarios, 1973-2050 (daily kcal/ha)



4 Available in statistical series, mainly from CMIE (2020) and EPWRF (2021); it includes cereals, pulses, sugar, oilseeds, some vegetables and fruits, milk, eggs, meats and fishes

Natural Farming and Industrial Agriculture scenarios by 2050 in figures

	2019	2050 Scenario 100% Industrial Agriculture	2050 Scenario 100% Natural Farming
Population (million capita)	**52.6** (+1.2%)*	**59.5** (+0.4%)∞	**59.5** (+0.4%)∞
Labour force (20-64 years)	32.5	35.4 (+0.3%)∞	35.4 (+0.3%)∞
Unemployment (of the 20-64 years)	10.1 (31%)^	10.6 (30%)^	2.4 (7%)^
Employment	22.4 (69%)^	24.8 (70%)^	33.0 (93%)^
- Farmers	9.3 (42%)^	5.0 (20%)^	10.0 (30%)^
- Nonfarmers	13.1 (58%)^	19.8 (80%)^	23.0 (70%)^
Cropland area (million ha)	**6.2** (–0.0%)*	**5.5** (–0.4%)∞	**8.3** (+0.9%)∞
Hectare per farmer	0.67 (+0.9%)*	1.11 (+1.7%) ∞	0.83 (+0.7% p.a.) ∞
Gross Value Added (10^{12} INR)□	6.1 (+5.8%)*	**36.9** (+6.0%)∞	**42.7** (+6.5%)∞
- Farm sector	1.9 (+4%)*	5.4 (+3.5%)∞	11.2 (+6%)∞
- Nonfarm sector	4.2 (+7.3%)*	31.5 (+6.7%)∞	31.4 (+6.7%)∞
Productivity (INR/day)□	**741** (+5.3%)*	**4 080** (+5.7%)∞	**3 545** (+5.2%)∞
- Cropland (per ha)	815 (+4.0%)*	2 670 (+3.9%)∞	3 719 (+5.0%)∞
- Farmer (per worker)	544 (+5.0%)*	2 967 (+5.6%)∞	3 080 (+5.8%)∞
- Nonfarmer (per worker)	880 (+4.8%)*	4 359 (+5.3%)∞	3 748 (+4.8%)∞
Plant food production (Gkcal/day)	**193** (+2.4%)*	**241** (+0.7%)∞	**298** (+1.4%)∞
- Per hectare (kcal/day)	31,095 (+2.4%)*	43,854 (+1.1%)∞	36,000 (+0.5%)∞
- Per farmer (kcal/day)	20,740 (+3.3%)*	48,729 (+2.8%)∞	29,808 (+1.2%)∞
- Per capita (kcal/day)	3669 (+1.1%)*	4 054 (+0.3%)∞	5 008 (+1.0%)∞
Structural Path (Dorin et al., 2013)	Farmer Excluding	Farmer Excluding	Farmer Developing
Income gap between farmers and nonfarmers (INR/day)□	336 (62%)μ	1 392 (47%) μ	668 (22%)μ

Structural path: as defined by Dorin et al. (2013)

Ha: hectare; INR: Indian National Rupee; Gkcal: giga kilocalories

* Growth rate per annum 1980-2019 (39 years)

∞ Growth rate per annum 2019-2050 (31 years)

□ Constant/Real Indian rupees of 2011-12

^ Category share for the concerned year

μ Share in average farmer income representing the gap nonfarmer income less farmers income

The Natural Farming vision can provide a transformative pathway towards sustainable food systems in Andhra Pradesh by 2050.

HIGHER AND BETTER FOOD PRODUCTION AND AVAILABILITY

In 2050 Natural Farming would produce more and better plant food per capita *(5008 kcal/day) than in Industrial Agriculture (4054 kcal/day), despite slightly lower yields per hectare, but with more land under production.*

Healthy, chemical-free, adequate, and highly nutritious food.

MORE LAND AVAILABLE FOR PRODUCTION THANKS TO REGENERATIVE AND AGROECOLOGICAL PRACTICES.

Natural farming would enable to reverse land use constraints and desertification trends, by regenerating and putting into production degraded soils, ecosystems and fallows.

Total cultivated area with Natural Farming would be 8.3 million hectares in 2050 *(against 5.5 million ha with Industrial Agriculture).*

FARMERS PROVIDE ENVIRONMENTAL SERVICES TO PRESERVE THE PRODUCTIVE BASE.

Natural Farming would ensure safe water, biodiversity conservation, soil health, clean air, nutrient recycling, pollination, natural pest control, drought resistance.

It would mitigate climate change impacts by greening landscapes and reducing greenhouse gas emissions; and supporting farmers' adaptation and resilience.

MORE FARMERS EMPLOYED THROUGH PROFITABLE FARMING APPROACHES

Natural Farming would employ twice the number of farmers than Industrial Agriculture (*10 million farmers vs. 5 million farmers*) and would be profitable for farmers due to less production costs (seeds, chemicals, irrigations, credit, machineries...) and better market value remunerating high-quality produce.

In addition, farming would be more attractive as it would be more resilient and less risky. Farming as a profession would gain a better reputation in society for providing health, decent employment and safeguarding the natural environment.

REDUCED INEQUALITIES BETWEEN FARMERS AND NONFARMERS.

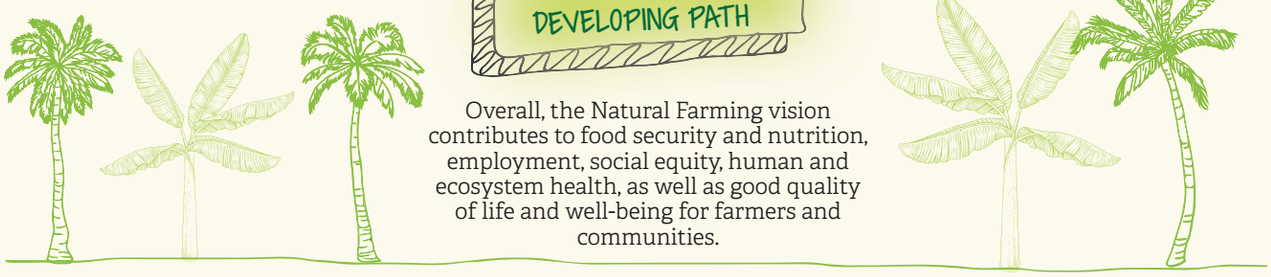
The 2019 income gap between farmers and nonfarmers (62%) will be significantly narrowed under Natural Farming (22%, *i.e. almost half of the income gap in Industrial Agriculture at 47%*).

COST-EFFECTIVE POLICIES

Because there would be less unemployment in Natural Farming, the policies to reduce income inequality would only cost 7.6% of the total economy in 2050. With Industrial Agriculture, those policies would cost at least 18.2%.

PROMOTE A FARMER DEVELOPING PATH

Overall, the Natural Farming vision contributes to food security and nutrition, employment, social equity, human and ecosystem health, as well as good quality of life and well-being for farmers and communities.



Complex challenges call for systemic solutions! Agroecology enables the sustainable transformation of food systems.

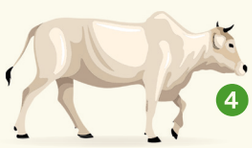
Agroecology is an integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of food and agricultural systems. It seeks to optimize interactions between plants, animals, humans and the environment, while taking into account the social aspects that need to be addressed for a sustainable and equitable food system. Natural Farming is a regenerative form of agroecology implemented in India, in particular in Andhra Pradesh through the 'Andhra Pradesh Community-managed Natural Farming' (APCNF) programme'.

The 9 Universal Principles of Natural Farming

1. **Soil to be covered with crops 365 days of the year (living roots).**

2. **Diverse crops, including trees (15-20 species)**

3. **Minimize tillage, Minimal disturbance of soil**



4. **Integrate animals into farming**

5. **Bio-stimulants as catalysts to trigger soil biology**

6. **Keep soil covered with crop residues, whenever living plants are not there.**

7. **Farmers' own seeds to be used, indigenous seeds preferred**

8. **Pest management through better agronomical practices and botanical pesticides**

9. **No synthetic fertilizers or pesticides.**

Andhra Pradesh Community-managed Natural Farming at a glance.

Andhra Pradesh Community-managed Natural Farming (APCNF) is a state-wide programme, implemented by Rythu Sadhikara Samstha (RySS), aiming to transition 6 million farmers from conventional chemical farming towards natural farming by 2031, impacting 8 million hectares.

APCNF is all about farming in harmony with nature, and firmly believes that nature has solutions to all kinds of human-induced problems in agriculture and food sector. As an alternative to the current agriculture practices, APCNF has emerged as a transformational approach. As of 2023, APCNF is operational in 3 730 villages and has enrolled 850 000 farmers across the 26 districts covering an area of 3.78 lakh Ha. In addition, 90% of these farmers are small and marginal farmers.

A recent study measured major economic, social and health impacts of APCNF farms against conventional farming, from 2020 to 2022.

It showed that:

- the net incomes of APCNF farmers rose by 49%, usage of chemical inputs was reduced by 56%-73%, while average yields were 11% higher.
- crop diversity in APCNF farms increased from 2.1 crops to 4 crops.
- APCNF farms demonstrate 88% higher dietary diversity.
- Led by women farmers, APCNF builds social capital for long term sustenance.

Seeing the inspiring work in Andhra Pradesh, many States have approached RySS for technical support. Accordingly, RySS is supporting Madhya Pradesh, Rajasthan, Meghalaya and Odisha. RySS has also been declared as the National Support organization to provide support to other states for grounding natural farming. The work of the programme has also crossed borders as other countries and international entities want to adopt the APCNF model in their own areas.

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For more information:

- on the AgroEco2050, please contact bruno.dorin@cirad.fr and annesophie.poisot@fao.org
- on APCNF, please visit https://apcnf.in

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