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CONTOUR FARMING IN INDIA

This summary document provides an overview of the state of contour farming in India. And also covers a literature review of impact studies conducted on contour farming in India. **It is a part of the larger CEEW study,** *Sustainable Agriculture in India 2021: What We Know and How to Scale Up.*

Sustainable Agriculture in India 2021: What We Know and How to Scale Up, is a handbook on the prevalence, practices and state of affairs of the 16 most promising sustainable agriculture practices in the country. It presents the economic, social and environmental impacts of these practices with recommendations on their potential to scale-up sustainable agriculture in India.

The study is available at: https://www.ceew.in/publications/sustainable-agriculture-india-2021

Image: Pixabay

Contour farming or ploughing is the practice of ploughing and/or planting along a contour, i.e., across the slope (horizontal) rather than up and down (vertical). Furrows are ploughed perpendicular rather than parallel to the slope. Contour farming tends to be treated as synonymous with terrace farming; however, contour farming follows the natural shape of the slope without altering it, whereas terrace farming builds walls and alters the shape of the slope to produce flat areas that provide a catchment for water and to check erosion (Stakeholders consulted at DoA, Himachal Pradesh).

In geographical terms, contour is an imaginary line joining the same elevation. In the hills farming is generally done by constructing terraces across the slope by providing a gentle gradient so that moistures and soil conservation is maintain and excess runoff water is safely disposed of. While contour bunding is a soil conservation structure created along the contours to control soil erosion.

Image: Pexels

Contour farming's linkages to FAO's agroecological elements

In principle, contour farming adheres to and promotes many agroecological elements as defined by the FAO

Elements	Description of agroecological linkages
Diversity	Contour farming reduces soil erosion and leads to an increase in vegetation, thus supporting biological diversity and wildlife habitat.
Co-creation and sharing of knowledge	In the hills where contour farming has been practised for hundreds of years, people have been dependent on sharing knowledge passed on between generations. As this is a labour-intensive practice it is often the result of communities co-operating and co-creating the possibility to farm.
Efficiency	Farming across slopes perpendicular to the water flow acts as a barrier and helps to slow water runoff, making it more available for seepage into the soil. The practice thus utilises water efficiently and also avoids the runoff of nutrients, reducing the need for external fertilisers.
Resilience	With climate change leading to irregular rainfall, contour farming prevents soil erosion, increases water infiltration and productivity of the land, leading to greater resilience among farmers and their lands.
Human and social values	By preserving soil and moisture content, contour farming is known to increase crop yields, improving rural livelihoods. It can also lead to crop diversification, which can multiply its benefits.
Culture and food traditions	Contour farming is a traditional practice rooted in the culture of the people, particularly in the hills. It has been supporting healthy and diversified diets for generations.

A brief context in India

Contour farming, a traditional farming technique followed in India, is the simplest and easiest strategy for conserving rainwater. It is mainly practised in the hilly, mid-hilly and sub-tropical areas at variable altitudes where a considerable degree of slope exists. But contour farming/bunding activities are also undertaken as a soil and water conservation (SWC) measure in the plains at lower altitudes. This involves creating bunds or ridges (made of soil and/or stones) to check soil erosion and enhance soil moisture in fields.

Contour farming is practised under various agroecological conditions; in the hills across all climatic zones or regions with <5° slope receiving <500 mm annual rainfall, bunding or contour cultivation are used, with conservative furrows used in <500-700 mm annual rainfall.[1] Contour farming/bunds and contour vegetative cover are recommended as a potential SWC interventions in watershed and resource management programs and policy documents, journals, etc. The practice was recognised and promoted as early as the 1930s, though it has been done traditionally, particularly in the hilly regions. Nonetheless, the effectiveness of the practice depends upon the area's rainfall intensity, topography and soil type.[2]

Contour farming is suggested as one of the important mitigation techniques for reversing land degradation in major ACZs such as hilly areas; Indo-Gangetic plains; dryland and desert areas; southern peninsular India; central India and coastal areas.[3] Contour bunds was an important component implemented under the Programmes of Natural Resource Management Division that includes the *National Watershed*

Development Project for Rainfed Areas and the River Valley Projects (RVP) and Flood Prone Rivers (FPR) Programme to deal with land degradation.[4] Contour bunding /trenching is one of the rainfall management strategies in the Integrated Watershed Management Programme of *PMKSY*. The practice is even recommended in *Report of the Committee on Doubling Farmers' Income Volume XIV "Comprehensive Policy Recommendations*".[5]

Contour farming: acreage, geographies, and cultivation details

How much area in India is under contour farming? Due to the lack of any comprehensive study across India to determine area and farm scales, there is very little information available. However, data provided by stakeholders suggest that in the hilly state of Sikkim, where most of the farming is under contour, it covers an area of approximately 50,000 hectares (stakeholders, Department of Agriculture, Sikkim). In Karnataka the practice varies according to the geographical location in the state; nonetheless rough estimates are that about 5-10 per cent of the cultivated area in the rainfed plain lands and most of the hilly areas are under contour farming (stakeholders at UAS, Bangalore).

At what farm size is contour farming practised? Traditionally, contour farming has been mostly undertaken in the Himalayan region and Western Ghats, largely by subsistence farmers. However, the last few decades have seen it spread to many other parts of the country, with reasonably large farmers adopting it on the plains.

How many farmers in India are practising contour farming? As contour farming is such a common practice, government or other agencies do not include it in agricultural surveys, meaning that data on the numbers of farmers practising it across India are not available. However, stakeholders in the Department of Agriculture, Sikkim estimate that approximately 35,000 farmers are using the practice in the state. In Karnataka, stakeholders consulted from the Dryland Agriculture Project, UAS, Bangalore estimate less than 30 per cent of large-scale farmers and 5-10 per cent of small and marginal farmers follow the practice in the state.

Where in India is contour farming prevalent? Although contour farming is practised more or less across India, some of the prominent states are Himachal Pradesh, Uttarakhand, Jammu and Kashmir, and the north-eastern region that includes eight states. In Himachal, contour farming is practised in 6-7 hilly districts (Shimla, Sirmour, Kangra, parts of Mandi, Solan). In addition, it is also carried out in the southern states of Karnataka, Tamil Nadu, Kerala, dryland regions of Rajasthan as well as some parts of Eastern Ghats. Contour bunding is also carried out, notably in Maharashtra, Gujarat, Tamil Nadu, Karnataka and Andhra Pradesh (Figure 1).

Which are the major crops cultivated under contour farming in India? All types of crops can be grown using contour farming; the topography, climate and locational factors determine which crops are grown. Stakeholders consulted affirm that in the hill state of Sikkim, maize, rice and vegetables tend to be cultivated and pea, potato, maize, pulses, millets, tomato, capsicum, garlic and ginger in Himachal Pradesh. Particularly, in Sirmour in Himachal, during the rainy season farmers are able to grow peas because of the sloped land; this would otherwise be difficult on flat land (Stakeholder consultation).

Figure 1. Geographical coverage of contour farming

Source: Authors compilation from literature and stakeholders consultations

Impact of contour farming

This section considers the economic, social, and environmental impacts of contour farming.

ECONOMIC IMPACT

1.Yields

The short-term studies on natural farming conducted over one or two cropping seasons indicate both increases and reductions in yields for different crops (see below). However, there is a need to generate rigorous longitudinal evidence across different agro-climatic zones and cropping systems. This is also one reason for the polarised views in India's food security discussion on the impact of natural farming. Natural farming is based on poly cropping. New methodologies should be developed to include all the hidden costs in both chemical-based and natural practices to compare the overall productivity in both systems.

Out of 97 farmers surveyed in 2012 in one study in Karnataka, 78.7 per cent stated that their yields had increased, 85.7 per cent reported improvements to income, and 90.9 per cent reported that production costs had decreased.[6] Crop cutting experiments and field surveys in Andhra Pradesh conducted by the Centre for Economic and Social Studies (CESS) in Rabi season 2018-19 reported no statistically significant difference in banana yields bengal-gram, black-gram, green-gram, and groundnut when compared to chemical-based farming. An increase of between 2-38 per cent was reported for these crops. Maize, sorghum, and cashew-nut showed reduced yields (between 1 and 7 per cent).[7]Research by ICAR-IIFSR, Modipuram on Subhash Palekar natural farming in the rice-wheat system in north India shows a 40 per cent yield reduction compared to chemical-based methods.[8]

Another study, not based on any field data, reported that while natural farming could yield benefits for low-input farmers, it could result in yield penalties for crops where higher inputs are needed. The study stated that "even with maximum potential nitrogen fixation and release, only 52–80 per cent of the national average nitrogen applied as fertiliser is expected to be supplied."[9] The study, however, compared the impact on yields against the national average fertiliser rates. In India, the actual application rate is much higher than the reported official figures.

2. Income

The income from contour farming, as for any agriculture practice, depends on multiple factors such as location, landholding, crops and seed quality among many.

The few studies undertaken on the impact of contour cultivation on overall income suggest that contour farming tends to be more remunerative than fields which are left in the natural state as soils are likely to be eroded due to the steep slope and have to be replenished continuously with nutrients. A study of contour ploughing in rainfed conditions in the north-east monsoon zone found cowpea and castor to be more profitable, with a cost-benefit ratio of 1.9 and 1.86 respectively.[10] An experiment conducted to estimate income from contour-bunding activities in Kandhamal, Odisha found a higher gross return from contour bunded areas than control plots, and a cost-benefit ratio of 1.85.[11] However, more long-term systematic studies are required to understand and document income enhancement from the practice.

Areas for further research

1. There is a strong need to evaluate the evidence on economic indicators (income, productivity) in different regions of the country, to gain a better perspective on economic gains. Its effect on human health and women also has comparatively little research.
2. More studies are needed on the impact of the practice on below-ground biodiversity, which has synergistic effects that may translate into enhanced crop productivity.

SOCIAL IMPACT

1. Human health

There are no scientific studies on the impact of the practice on human health. However, contour farming is practised in the hilly regions of the country with minimal or almost no use of chemical inputs. This would definitely signify better health outcomes for the implementers.

2. Gender

Though there is a general understanding of the prominent role of contour farming traditionally in crop cultivation and for sustaining women in the hilly regions of the country, there is a general lack of literature on the topic. One study of the north-eastern states found that in Mizoram State, contour farming and terracing allow rice and vegetables to be grown and processed, with the products being sold by women.[12] In Nagaland, about 70 per cent of the female *jhum* (shifting cultivation) farmers introduced contour

bunding to conserve resources within their *jhum* lands. This had led to enhanced soil quality below the contour bunds and improved the size and quality of crops, helping women to earn additional income.[13]

ENVIRONMENTAL IMPACTS

1. Soil and nutrients

Soil conservation is one of the central goals of contour farming and several papers mention the practice as a potential SWC strategy.[14,15,16]On very steep slopes, contour farming alone may not be sufficient to control erosion and needs to be supplemented by bunding[1] and planting vegetative barriers across the slope. Other than these measures, it is most effective when implemented along with alley and cover cropping, residue management and mulching, etc. One contour guideline is said to be enough in smaller fields with uniform slopes, but where slopes are irregular, two to three guidelines are required. Overall, the practice is known to be the most effective on moderate slopes of 2 to 7 per cent, while contour bunding is recommended on up to 6 per cent slopes and where rainfall is up to 600mm.[17]

Conservation furrows with contour cultivation offer a low-cost in-situ soil conservation practice in red (Alfisol) soil regions with 400-900 mm rainfall and slopes up to 4 per cent.[18] Contour farming can reduce soil erosion by as much as 50-60 per cent compared with vertical ploughing.[19,20] It also helps to reduce sediment runoff and increase water infiltration. In one study, the reduction in soil loss was between 20 and 30 tonnes per hectare. However, the incorrect establishment of contour lines can increase the risk of erosion. As for contour bunds, they are recommended for medium to low rainfall areas (<700 mm) and on permeable soils with <6 per cent slope; they are not suitable where soils are shallow (less than 7.5 cm).[21,22] In experimental areas, contour bunds recorded only 0.3 tonnes/hectare soil loss compared with 18.92 tonnes/hectare in control treatment.[23]

Contour farming prevents nutrient-rich top soils from eroding excessively.[24] The increase in soil moisture promotes biological activity which releases additional nutrients to the soil, thus avoiding the need for input costs. Though this is validated by stakeholders consulted (Department of Agriculture, Himachal Pradesh), more in-depth research is required to assess the impact of nutrients from implementing the practice.

2. Water

It is well established that contour cultivation, including bunding and terracing, is a common agronomic measure for conserving water in hilly agro-ecosystems and on sloping land. The furrows and ridges built across the slope act as a barrier that reduces the flow of water. In drier areas, it conserves moisture as it increases infiltration rates, while it reduces soil loss in higher areas of rainfall, enhancing the soil moisture in both cases and thus improving crop productivity.[25] It also prevents waterlogging of fields as water runs down the hill gradually, decreasing incidence of root or water-borne diseases. Seasonal runoff from catchments decreased from 54 to below 40 per cent where contour farming was practised.[26]

[1] Contour bunds are narrow base trapezoidal earthen embankments around 1.5 to 2 m wide, constructed across the slope to prevent runoff (Goyal et al. 2013).

In the north-eastern region, contour trenches are built along contours (slope >15 per cent) to trap soil which needs to be removed annually before monsoon. These trapped soils are fertile and as they are lower in the contour trenches infiltration of water is greater. They are used to grow horticultural plants or for silviculture (e.g., pineapple plantations in Mizoram).[27] Rectangular staggered contour trenches designed to trap 75 per cent of runoff are recommended in the ravine and marginal lands of Rajasthan, Gujarat and Uttar Pradesh.[28]

3. Energy and emissions

Contour farming is constructed to counteract or decrease the kinetic energy of water that flows downhill with high intensity on steeper slopes.[29] However, scientific studies relating to such inferences are lacking and need more research.

As a SWC measure, contour farming preserves soil and soil organic matter, including soil carbon, which would otherwise run off on sloping terrain. As soil removed by erosion has 1.5-5 times soil organic matter than the soil left behind, contour farming assists in preserving the soil organic carbon that is mostly concentrated in the topsoil layer.[30]

4. Biodiversity

Without building contours, terracing and bunding the fields it is almost impossible to plough and cultivate crops on sloping lands. Sowing a diversity of crop varieties enhances biodiversity. As a SWC measure contour farming retains soil and soil organic matter, which would otherwise wash away. The soil organic matter affects soil biodiversity and biological activities within it; hence the practice is vital for promoting biodiversity in an agro-ecosystem. Despite such linkages, no systematic studies were found on the impact of the practice on biodiversity in India.

Impact evidence

State of available research discussing the impact of contour farming on various outcomes.

Evidence Type	Yield	Income	Health	Gender	Soil and nutrients	Water	Energy	GHG emissions	Bio-diversity
Journals	3	2	0	1	3	5	1	1	0
Reports	1	0	0	0	2	2	0	0	0
Articles/ case-studies	2	0	0	0	4	1	0	0	0
Others **	8	0	0	0	6	3	0	0	0
Total	**14**	**2**	**0**	**1**	**15**	**11**	**1**	**1**	**0**

*** Thesis, guidelines, conference papers, etc*

Source: Authors' compilation

Note – The evidence is from the first 75 results examined in Google Scholar Advanced search and the first 30 results from Google Advanced Search. Only those papers which clearly established the evidence for different indicators were selected.

Stakeholder mapping

The following institutions are involved in the research and promotion of contour farming; a few were consulted for this research:

Government institutions	Research/implementation institutions	NGOs/Civil society organisations
Department of Agriculture, Cooperation and Farmers' Welfare (DAC&FW)	ICAR-Research Complex for North Eastern Hill Region	Peoples Endeavor for Social Change (PESCH)
Government of Himachal Pradesh – Prakritik Kheti Khushhal Kisaan	Dryland Agriculture Project, University of Agricultural Sciences, Bangalore	
Department of Agriculture, Himachal Pradesh;	International Crops Research Institute for the Semi-arid Tropics (ICRISAT)	
Agriculture Department, Government of Sikkim.	College of Agricultural Engineering and Technology, Odisha (CAET)	

Source: Authors compilation

Note – The stakeholders list is indicative and not exhaustive

Endnotes

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Contact shanal.pradhan@ceew.in/ abhishek.jain@ceew.in for queries

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