Plastic film technology

Nepal: प्लास्टिक प्रयोग गरी खेति गर्ने प्रबिधि

Left: Method #1 The ridge is covered by a plastic film and broad leaf mustard seedlings are planted into the ground through regular holes punched into the plastic. (KM Sthapit)
Right: Method #2 Chilli seeds are planted directly in the ground, when the seedlings are a few centimetres high the entire ridge is covered by a plastic film and holes are punched into the plastic allowing the seedlings to emerge. Unwanted weeds are left under the film. (KM Sthapit)

Plastic film technology, sometimes called plastic mulching, is an important breakthrough that can transform traditional agriculture into modern agriculture by helping to circumvent many of the limitations of temperature and moisture. Plastic film is used to cover the surface of the soil in order to increase the temperature, to retain moisture, and to promote the germination of seeds.

Agricultural production by traditional methods is constrained by extremes in temperature and by extremes in the availability of water; freezing temperatures as well as droughts and waterlogging have long daunted farmers. When plastic film is used on the soil, the solar energy absorbed by the soil during the day is retained at night since the plastic film prevents water from evaporating. Higher night time temperatures and higher levels of moisture in the ground promote active micro-organisms, which diminish the need for fertilizer and improve the physical properties of the soil.

Plastic film can be used in one of two ways. In the first method, the plastic film is spread on ridges of soil, the plastic is perforated at regular intervals, and the seedlings are planted through these openings. In the other method, seeds are planted on the ridges as in the traditional method, and when the seedlings have grown to a reasonable size, the ridge is covered by a plastic film and holes are cut at the position of the seedlings to allow them to pass through the film. Depending on the condition of the film after the crops are harvested, the covered ridges can be used to grow another crop.

Experiments at ICIMOD show that the use of plastic film can, on average, double the crop yield as compared to traditional methods. Previous studies by Lu Rongsen (1994) showed that the plastic film method can increase chilli production by 74%, tomato production by 52%, and the production of garden peas by 31%.

WOCAT database reference: QT NEP 37
Location: ICIMOD Knowledge Park at Godavari, Lalitpur District, Nepal.
Technology area: Demonstration plot
Conservation measure(s): Agronomic
Land Use: Cropland
Stage of intervention: Mitigation
Origin: Experiment and research
Climate: Subhumid/temperate
Related approach: Not described
Compiled by: Samden Sherpa, ICIMOD
Date: June 2011, updated March 2013

The technology was documented using the WOCAT (www.wocat.org) tool.

ICIMOD WOCAT

Classification

Land use problems

Farmers have traditionally used mulching to retain moisture in the soil and to help plants withstand ground frost. Mulching is useful but has many limitations. Recently, plastic film technology has been successfully introduced to help retain moisture in the soil and to promote seed germination. Since moisture is retained, the temperature of the soil does not drop as low as it would otherwise; this accelerates the growth and the development of both the roots and the whole plant, resulting in good crops and high yields.

Land use

Annual crop

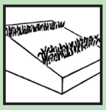
Climate

Subhumid/ temperate

Degradation

Water degradation: aridification/ soil moisture problems

Conservation measures



Management: Conservation of soil moisture and weed control

Stage of intervention

- Prevention
- **Mitigation/reduction** (selected)
- Rehabilitation

Origin

- Land users' initiative
- **Research: demonstration** (selected)
- Externally introduced
- Other (specify)

Level of technical knowledge

- Low
- **Medium: farmers** (selected)
- High

Technical function/impact

Main:
- Increases the temperature of the soil
- Retains soil moisture
- Reduces soil erosion
- Promotes seed germination and emergence

Secondary:
- Accelerates the growth and development of roots and plants in areas where the temperature is low during winter
- Hastens maturation of crops
- Increases yield and promotes good quality crops

Environment

Natural environment

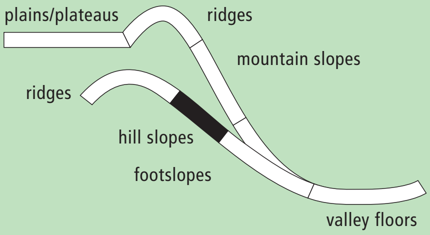
Average annual rainfall (mm)

- >4000
- 3000–4000
- 2000–3000
- **1500–2000** (selected)
- 1000–1500
- 750–1000
- 500–750
- 250–500
- <250

Altitude (masl)

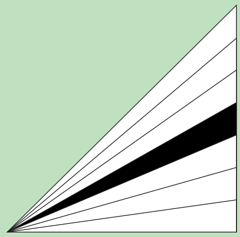
- >4000
- **3000–4000** (selected)
- 2500–3000
- 2000–2500
- 1500–2000
- 1000–1500
- 500–1000
- 100–500
- <100

Landform



Selected: hill slopes

Slope (%)



Selected: rolling (8–16)

Soil depth (cm)

- **0–20** (selected)
- 20–50
- 50–80
- 80–120
- >20

Growing season(s): two
Soil texture: medium loam
Soil fertility: medium
Topsoil organic matter: high (>3%)
Soil water storage capacity: medium
Ground water table: <5 m
Availability of surface water: good

Water quality: good for drinking and agricultural use
Tolerant of climatic extremes: plants grown using plastic film technology can tolerate long spells of low temperature in winter, as well as frost and snowfall
If sensitive, what modifications were made/are possible: none

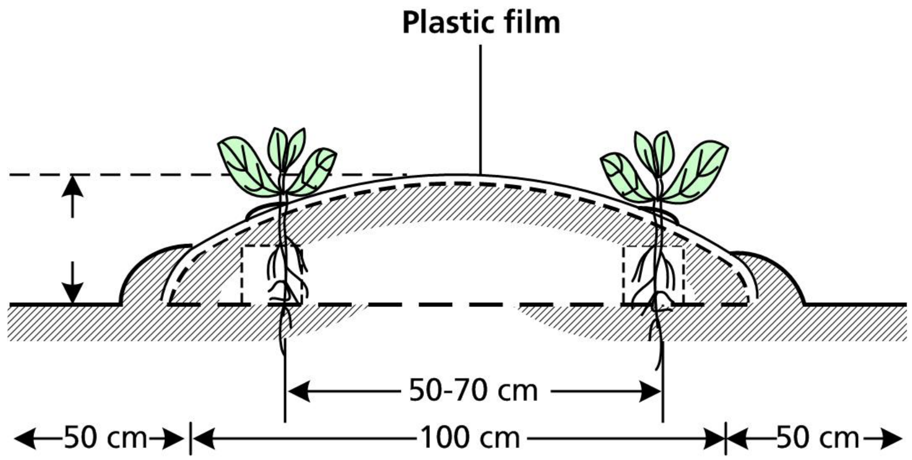
Human environment

Crop land per household (ha)

- **<0.5** (selected)
- 0.5–1
- 1–2
- 2–5
- 5–15
- 15–50
- 50–100
- 100–500
- 500–1000
- 1000–10000
- >10000

Land user: for demonstration and experiment
Population density: >2 persons per km^2
Land ownership: government
Land/water use rights: community/individual
Relative level of wealth: neighbouring communities are poor
Importance of off-farm income: >50% of all households around the demonstration site have off-farm income
Access to services and infrastructure: labour available; road access used to transport crops

Market orientation: mixed subsistence and commercial in the vicinity of the demonstration site
Mechanization: manual and animal traction
Number of livestock: in the vicinity of the demonstration site poor households may have a few goats whereas wealthier farmers often own several cattle
Purpose of forest/woodland use: fodder, fuelwood
Types of other land: scrubland
Level of technical knowledge required: medium, some training required



Technical drawing
The diagram shows a cross-section of a ridge planted using plastic film technology. The plants grow through holes punched in the plastic. The plastic helps to retain moisture in the soil and, in so doing, also helps to increase the soil temperature. Weeds trapped below the plastic are inhibited from interfering with the crop.
The ridges (or beds) are typically 20 m long, 1 m wide and spaced 1 m apart (for access); they are usually 10–20 cm high. The distances shown in the diagram are averages for crops such as chillies where the row-to-row distance is 50–70 cm and the plant-to plant distance is 40–50 cm. These distances vary according to the crop.
(AK Thaku)

Implementation activities, inputs and costs

Establishment activities

The plot of land to be planted is prepared by first fertilizing it with a mixture of soil, compost, and/or farmyard manure. The soil is gathered into parallel ridges, typically 20 m long, 1 m wide, and 10–20 cm high; the distance between two ridges is usually 40–50 cm. For many crops the seedlings are spaced 50–70 cm apart.
Method #1 Plastic film (approx. thickness 0.014–0.003 mm) is used to cover the ridges and anchored into the ground. Round holes are punched in the film at regular intervals. Some soil is excavated through the holes and the seedlings are planted through the holes and thoroughly watered. The holes in the plastic are sealed using soil.
Method#2 Seeds are sown on the ridges and seedlings are allowed to develop. The ridge is covered in plastic film and the film is anchored. Holes are punched into the plastic at the position of the seedlings so that they pass through.
For either method, when the crops are harvested all residue should be removed. Depending on local conditions and on whether the plastic film is still viable, the plastic covered ridges can be reused to grow another crop without replacing the film.

Establishment inputs and costs per ha

Inputs	Cost (USD)	% met by land user
Labour (80 person days)	310	
Equipment		
– Spade, secateurs	10	
Materials		
– Plastic film (48 kg/ha)	48	
Agricultural		
– Seedlings/compost	250	
TOTAL	**668**	0%

Maintenance/recurrent activities

Provide crop support such as staking and removal of excess leaves as required.

Maintenance/recurrent inputs and costs per ha per year

Inputs	Cost (USD)	% met by land user
Labour (30 person days)	110	
Materials		
– Bamboo poles	20	
TOTAL	**130**	**0%**

Remarks:

- All costs and amounts are rough estimates by the technicians and authors. Exchange rate USD 1 = NPR 72 in June 2011.
- This was a demonstration project conducted by ICIMOD.

Assessment

Impacts of the technology

Production and socioeconomic benefits	Production and socioeconomic disadvantages
+ + + Increased crop yield in areas with a long winter season + + + Reduced soil erosion and nutrient loss + + + Greater farm income; less time is spent weeding	none

Socio-cultural benefits	Socio-cultural disadvantages
+ + + Improved understanding of how to maintain soil fertility, how to conserve water, and why soil erodes	none

Ecological benefits	Ecological disadvantages
+ + + Reduced soil erosion + + + Increased moisture in the soil + + + Increased soil temperature + + + Weeds are controlled	– – The discarded plastic is not biodegradable.

Off-site benefit	Off-site disadvantages
+ Downstream farmers benefit because soil is conserved and runoff is reduced.	– If farmers do not dispose of old plastic film responsibly it can become a nuisance even far from where it was originally used.

Contribution to human wellbeing/livelihood

+ + + Improved crops and higher yields benefit the entire community because more food is available and the harvest brings in cash income.

Benefits/costs according to the land user

The above example shows that the establishment and maintenance cost for 1 ha of land is USD 798. Using plastic film technology this 1 ha of land yielded USD 1500 worth of crops.

Benefits compared with costs	short-term	long-term
Establishment	positive	very positive
Maintenance/recurrent	very positive	very positive

Acceptance/adoption:
This demonstration of plastic film technology was used mainly to show that it is viable both in the mid-hills and at higher elevations where temperatures can be very low during the winter season. Plastic film technology can be used to cultivate high-value horticultural crops such as vegetables, strawberries, and melons. In China, it has been successfully used to cultivate more than 80 species (Lu Rongsen 1994).

Driver for adoption:
Improved income for farmers and less time is spent weeding. Greater awareness among farmers is being spread through participatory research and development in rural areas.

Constraints
Plastic film is not always available in rural areas

Concluding statements

Strengths and ➔how to sustain/improve	**Weaknesses** and ➔how to overcome
Plastic film technology can increase the yield of some crops by as much as 100% as compared to conventional farming. ➔ Since this technology is still relatively new, it will be necessary to continue sharing experiences and to promote awareness.	As farmers begin to use plastic film technology more plastic is being discarded in rural areas. ➔Plastic film needs to be retrieved and recycled. In China it has been shown that this is possible.
Plastic film technology can be used to grow crops in hilly areas where the long winter season is usually too cold to support crops. ➔ Need to create greater awareness of the benefits of using plastic film technology in mountain areas.	Discarded plastic film can pollute agricultural lands ➔Farmers need to be made aware of hazards and encouraged to form networks for collection and recycling the used plastic.

Key reference(s): Rongsen, L (1994) *The application of plastic film technology in China: Plastic film technology data collected and analyzed in ICIMOD D&T Centre, Godavari.* Kathmandu, Nepal: ICIMOD
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