## Advantages of cultivating cotton organically

<table>
<thead>
<tr>
<th></th>
<th>Conventional Cotton</th>
<th>Organic Cotton</th>
</tr>
</thead>
</table>
| **Environment**     | • Pesticides kill beneficial insects  
                      • Pollution of soil and water  
                      • Resistance of pests          | • Increased bio-diversity  
                      • Eco-balance between pests and beneficial insects  
                      • No pollution                  |
| **Health**          | • Accidents with pesticides  
                      • Chronic diseases (cancer, infertility, weakness)                                                   | • No health risks from pesticides  
                      • Healthy organic food crops                                                         |
| **Soil fertility**  | • Risk of declining soil fertility due to use of chemical fertilizers and poor crop rotation | • Soil fertility is maintained or improved by organic manures and crop rotation                         |
| **Market**          | • Open market with no loyalty of the buyer to the farmer  
                      • Dependency on general market rates  
                      • Usually individual farmers                                                      | • Closer relationship with the market partner.  
                      • Option to sell products as ‘organic’ at higher price  
                      • Farmers usually organized in groups                                               |
| **Economy**         | • High production costs  
                      • High financial risk  
                      • High yields only in good years                                                     | • Lower costs for inputs  
                      • Lower financial risk  
                      • Satisfying yields once soil fertility has improved                                   |
Successful organic cotton farming with a system approach

- Capacity building and experimenting
- Improving soil fertility
- Crop rotation & crop diversity
- Selecting the right cotton varieties
- Organic manures
- Appropriate irrigation
- Appropriate pest management
- Timely weeding and intercult. operations
- Monitoring of pests
- Timely and proper picking
- Documentation and inspection

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Organic Cotton Training Manual
Organic standards in cotton farming

- No application of any synthetic fertilizers such as urea, NPK, DAP etc.
- No application of synthetic pesticides (including herbicides, insecticides, fungicides) or growth promoters.
- No use of genetically modified organisms (GMO) such as Bt-cotton varieties.
- Crop rotation (no cotton after cotton in the same field in two subsequent years) and/or intercropping.
- Prevent spray drift from neighbouring conventional fields, e.g. by growing border crops.
- Maintain records and documents for inspection and certification.
Internal control and external certification – building trust

External Certifier

- Consumers
- Retail
- Processing & Trade

Internal Control System (ICS)

Trust

(adapted from IFOAM)
Requirements of the cotton crop

Ideal climatic conditions
- High temperature (ideally 30°C)
- Long vegetation period
- Ample sunshine
- Dry climate
- Min. 500 mm rainfall or irrigation

Ideal soil conditions
- Deep soils
- Heavy clay soils, ideally black cotton soils (vertisols)
- No water logging

Crop development
- Strong root growth in first two weeks
- Natural bud shedding (only approx. 1/3 of flowers develop bolls)
- Plant compensates for damage through increased growth
Selecting the right cotton varieties

**American Upland cotton (G. hirsutum)**

- **Advantages:**
  - High yields
  - Longer staple (higher price)
- **Disadvantages:**
  - Needs more water
  - Needs more manure
  - More prone to pests

**Indian ‘desi’ varieties (G. arboreum, G. herbaceum)**

- **Advantages:**
  - Better drought resistance
  - More pest tolerant
- **Disadvantages:**
  - Smaller yields
  - Mostly shorter staple (lower price)

**Suitable for:**
- Deep soils
- Heavy soils
- Good irrigation

<table>
<thead>
<tr>
<th>Suitable for:</th>
<th>Suitable for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep soils</td>
<td>Shallow soils</td>
</tr>
<tr>
<td>Heavy soils</td>
<td>Sandy soils</td>
</tr>
<tr>
<td>Good irrigation</td>
<td>Little/no irrigation</td>
</tr>
</tbody>
</table>
### Soil types and their management

<table>
<thead>
<tr>
<th>Light soils</th>
<th>Heavy soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow; roots do not penetrate very deeply</td>
<td>Deep; roots penetrate deeply</td>
</tr>
<tr>
<td>Light colours</td>
<td>Dark colour; cracks when dry</td>
</tr>
<tr>
<td>Sandy; easy to cultivate</td>
<td>Rich in clay; muddy when wet, hard when dry</td>
</tr>
<tr>
<td>Low water retention capacity → affected by drought!</td>
<td>High water retention capacity → less risk of being affected by drought</td>
</tr>
<tr>
<td>Nutrients easily get leached out → need sufficient compost; supply of mineral fertilizers in several doses</td>
<td>Very fertile → need sufficient manures because of high productivity</td>
</tr>
<tr>
<td>Drought-resistant crops: sorghum, maize, pigeon pea (desi varieties), moong, millet, castor; desi cotton varieties</td>
<td>High performance crops: chilli, soya bean, banana, sugarcane, hybrid cotton varieties, pigeon pea (hybrid varieties); wheat</td>
</tr>
<tr>
<td>Intercrop to reduce risk of crop failure</td>
<td>Intensive crop rotation; green manures</td>
</tr>
<tr>
<td>Compost and mulching to improve water holding and nutrient supply</td>
<td>Compost to activate soil life and improve soil structure</td>
</tr>
<tr>
<td>Shallow ploughing, little soil cultivation</td>
<td>Deep ploughing, frequent intercultural operations (shallow soil cultivation)</td>
</tr>
<tr>
<td>Increase infiltration with trenches and bunds</td>
<td>Risk of waterlogging!</td>
</tr>
</tbody>
</table>
Why organic matter is so important

A loose and soft soil structure with a lot of cavities

Good aeration and good infiltration of rain and irrigation water

Non-visible parts of organic matter act like a glue, sticking soil particles together

Visible parts of organic matter act like tiny sponges

Many beneficial soil organisms such as earth worms feed on organic material

Soil organic matter provides a suitable environment for soil organisms
## Crop rotation – rotation crops

<table>
<thead>
<tr>
<th>Rotation Type</th>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulses + cereals</td>
<td>Cotton (winter crop: wheat or pulses)</td>
<td>Pulses (soya, moong beans, cow pea, black gram, pigeon pea), maize or sorghum</td>
<td>Cotton (winter crop: wheat or pulses)</td>
</tr>
<tr>
<td>Vegetable</td>
<td>Cotton (winter crop: wheat or pulses)</td>
<td>Chilli, onion or other intensive vegetable crop</td>
<td>Cotton (winter crop: wheat or pulses)</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>Cotton</td>
<td>Sugar cane</td>
<td>Sugar cane</td>
</tr>
<tr>
<td>Diverse rotation (from Tanzania)</td>
<td>Cotton</td>
<td>Sesame, safflower, sorghum or maize</td>
<td>Pulses (moong, chick pea, cow pea, pigeon pea, groundnut)</td>
</tr>
<tr>
<td>Rotation with herbal plants (from Egypt)</td>
<td>Cotton (winter crop: wheat or pulses)</td>
<td>Herbs (anise, basil, fennel etc.)</td>
<td>Maize with clover intercrop</td>
</tr>
</tbody>
</table>
Green manures and intercrops

**Green manure**

- Sowing the green manure crop
- Mulching the green manure crop

**Intercrop**

- Sowing the intercrop
- Harvesting the intercrop
Timing of nutrient supply in the cotton crop

- **Basal application**
- **Top dressing**
- **First flowering**
- **Boll formation**
- **First picking**
- **Continuous picking**
- **Second flush**
- **Uprooting**

**Nutrient Demand**
- **Demand fully covered**
- **Demand partly covered**

**Nutrient Supply**

- **Maximum demand**

**Time**

**Plant Nutrient Demand and Supply**
Disturbance of nutrient uptake

- Lack of water
- Oversupply of nutrients: Too much N, P, K prevent the uptake of Ca, Mg, Fe, Zn etc.

Nutrients:
- N
- P
- K
- Mg
- Ca
- S
- Fe
- Zn

Water-logging

Mineral Particles

Soil Organic Matter
Nitrogen immobilisation in soil → retarded growth

Symptoms
- Yellowish leaves
- Stunted growth
- Delayed development

The reason
Decomposable material in the soil (half rotten compost or manure, straw, crop residues)

The decomposition of carbon-rich organic material requires nitrogen

Little organic material with high nitrogen content (e.g. oil cake)

Preventive measures
- Remove sturdy crop residues (stalks) from the field and compost them
- Ensure that the compost is well decomposed
- Apply compost at least two weeks before sowing
- Apply sufficient nitrogen-rich organic manures (e.g. de-oiled cakes)
- Note: Organic manures need 1-3 weeks until they release nitrogen
- Shallow soil cultivation helps to accelerate decomposition of organic matter
## Organic manures and natural mineral fertilizers for cotton

<table>
<thead>
<tr>
<th>Manure/Fertilizer</th>
<th>Comment</th>
<th>Nitrogen (total N)</th>
<th>Phosphate ($P_2O_5$)</th>
<th>Potash ($K_2O$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td>Soil improvement</td>
<td>0.6 - 1.5 %</td>
<td>0.5 - 1.0 %</td>
<td>0.5 - 2.0 %</td>
</tr>
<tr>
<td>Farmyard manure</td>
<td>Less stable humus</td>
<td>0.7 - 1.5 %</td>
<td>0.5 - 0.9 %</td>
<td>0.4 - 1.5 %</td>
</tr>
<tr>
<td>Vermi-compost</td>
<td>Very stable humus</td>
<td>0.6 - 1.5 %</td>
<td>0.4 - 0.9 %</td>
<td>0.5 - 1.0 %</td>
</tr>
<tr>
<td>De-oiled Castor</td>
<td>N- and P-supply</td>
<td>4.5 - 6.0 %</td>
<td>0.8 - 1.8 %</td>
<td>1.3 - 1.5 %</td>
</tr>
<tr>
<td>Cane press mud</td>
<td>Soil improvement</td>
<td>1.4 - 1.8 %</td>
<td>0.1 - 1.0 %</td>
<td>0.4 - 0.6 %</td>
</tr>
<tr>
<td>Rock phosphate</td>
<td>P-supply, in compost heap</td>
<td>0</td>
<td>15 - 30 %</td>
<td>0</td>
</tr>
<tr>
<td>Muriate of potash</td>
<td>Natural potassium fertilizer</td>
<td>0</td>
<td>0</td>
<td>ca. 60 %</td>
</tr>
<tr>
<td>Wood ash</td>
<td>K, Mg, Ca, Mg etc.</td>
<td>0</td>
<td>1 - 3 %</td>
<td>1 – 8 %</td>
</tr>
</tbody>
</table>

*Note: Figures are given in percent of dry matter. The nutrient contents vary from source to source.*
Compost and farmyard manure – proper handling pays off!

Nutrient contents of different compost and dung heaps collected in the Nimar region, India

<table>
<thead>
<tr>
<th>Manure / Compost type</th>
<th>Nitrogen (total N)</th>
<th>Phosphate (P$_2$O$_5$)</th>
<th>Potash (K$_2$O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow dung heap, well maintained</td>
<td>1.5%</td>
<td>0.7%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Cow dung heap, poorly maintained (too wet)</td>
<td>0.9%</td>
<td>0.5%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Compost in good condition (with heat process and turning)</td>
<td>1.3%</td>
<td>0.9%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Compost, poorly maintained (too dry)</td>
<td>0.8%</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Vermi-compost in good condition</td>
<td>1.5%</td>
<td>0.9%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Vermi-compost, poorly maintained</td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>
Setting up a compost heap

Collect the composting material.

• Choose a shady location
• Collect plenty of plant material
• Pile it up separately
• Chop coarse material

Set up the heap from bottom:
• N-rich material
• Coarse C-rich material
• Twigs and branches

• Humidify the materials
• Pile them up loosely in layers
• Cover with earth or straw

Turn the heap
• after 2–3 weeks
• after 1-2 months

• When temperature declines.
• Outside material goes inside.

Let it rest to mature for up to 3 months.

soil layer
Nitrogen fixation through leguminous plants

- There is plenty of nitrogen in the air (78% nitrogen gas)
- Leguminous plants fix nitrogen from the air and make it available to the plant
- Examples: pigeon pea, soya bean, moong, cow pea, chick pea, daal etc.
- The fixation is done by bacteria living in root nodules (*Rhizobium* species)
- The nitrogen fixed by the leguminous crop gets available to the associated or following crop (e.g. cotton)
- If a lot of fertilizer is available in the soil, legumes fix less nitrogen
Keeping your cotton crop healthy

- Select a variety suitable for the location
- Diverse crop rotation
- Intercropping, green manure
- Not too much manure (tender leaves attract pests; vegetative growth instead of bolls)
- Encourage soil aeration (e.g. shallow hoeing)
- Balanced nutrition (compost, organic manures)
- Promote natural enemies of pests through diverse cropping patterns
- Enrich the soil with organic matter
- Avoid water shortage
- Avoid waterlogging (boll shedding, less yield)
- Diverse crop rotation

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## Important cotton pests

<table>
<thead>
<tr>
<th>Bollworms and other caterpillars</th>
<th>Sucking pests and other pests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>American bollworm</strong> (&lt;i&gt;Heliothis armigera&lt;/i&gt;)</td>
<td><strong>Cotton aphid</strong> (&lt;i&gt;Aphis gossypii&lt;/i&gt;)</td>
</tr>
<tr>
<td><strong>Cutworm</strong> (&lt;i&gt;Agrotis spp.&lt;/i&gt;)</td>
<td><strong>Spider mites</strong> (&lt;i&gt;Tetranychus spp.&lt;/i&gt;)</td>
</tr>
<tr>
<td><strong>Pink bollworm</strong> (&lt;i&gt;Pectinophora gos.&lt;/i&gt;)</td>
<td><strong>Grasshoppers</strong> (&lt;i&gt;Locusta spp.&lt;/i&gt;)</td>
</tr>
<tr>
<td><strong>Armyworm</strong> (&lt;i&gt;Spodoptera spp.&lt;/i&gt;)</td>
<td><strong>Whitefly</strong> (&lt;i&gt;Bemisia tabaci&lt;/i&gt;)</td>
</tr>
<tr>
<td><strong>Spiny Bollworm</strong> (&lt;i&gt;Earias spp.&lt;/i&gt;)</td>
<td><strong>Cotton jassids</strong> (&lt;i&gt;Amrasca devestans&lt;/i&gt;)</td>
</tr>
<tr>
<td><strong>Cotton leafworm</strong> (&lt;i&gt;Alabama argillacea&lt;/i&gt;)</td>
<td><strong>Thrips</strong> (&lt;i&gt;Thripidae&lt;/i&gt;)</td>
</tr>
<tr>
<td><strong>Cotton stainer</strong> (&lt;i&gt;Dysdercus spp.&lt;/i&gt;)</td>
<td><strong>Root knot nematodes</strong> (&lt;i&gt;Meloidogyne spp.&lt;/i&gt;)</td>
</tr>
</tbody>
</table>

Photos (top left to bottom right): Paolo Mazzei, Clemson University, Roland Smith, Mississippi State University, James Smith, Winfield Sterling, Douglas Ferguson, Insectcorner, P. Room, Scott Bauer, Cotton SA, University of Georgia, Frank Eyhorn, Insectcorner, Clemson University
## Pest management in cotton

<table>
<thead>
<tr>
<th>Pest</th>
<th>Preventive measures</th>
<th>Direct control measures</th>
</tr>
</thead>
</table>
| **Bollworms (Helicoverpa and others)** | - Trap crops: sunflower, okra, castor  
- Hand-pick damaged capsules  
- Encourage natural enemies  
- Remove cotton stalks  
- Cattle grazing after picking is over | - Bt-spray, NPV spray  
- Neem, botanical preparations  
- Buttermilk spray  
- Pheromone traps, light traps  
- Trichogramma cards |
| **Aphids, jassids, thrips, whitefly (Bemisia)** | - Intercrop of moong, cow pea etc.  
- Avoid high manure application  
- Avoid waterlogging and water shortage  
- Promote natural enemies by growing flowering plants | - Neem, botanical preparations (chilli, sweet flag, turmeric etc.)  
- Soft soap spray  
- Cow urine spray  
- Potato starch spray  
- Yellow sticky traps |
| **Cotton stainers (Dysdercus)** | - Frequent soil cultivation to destroy the eggs (also along field borders)  
- Encourage birds (turmeric-coloured rice, bird perches, trees)  
- Avoid stand-over of cotton | - Pyrethrum spray  
- Botanical sprays (neem, custard apple, garlic bulb, sweet flag, sweet basil, Derris species)  
- Grazing of chickens |
| **Cutworms (Agrotis and other species)** | - Early soil cultivation  
- Remove weeds in and around fields  
- Encourage birds, spiders etc. (bird perches, trees, hedges) | - Apply neem cake into the soil  
- Pyrethrum, Derris or thyme spray  
- Cutworm baits  
- Hand picking or Bt-spray at night |
Natural enemies of major cotton pests

- **Parasitoids** (e.g. parasitic wasps)
- **Green lacewing** (*Chrysoperla spp.*)
- **Damsel bug** (*Nabis spp.*)
- **Ladybird beetle** (*Harmonia spp.*)
- **Hoverfly** (*Eristalis spp.*, *Volucella spp.*)
- **Bollworms**
- **Aphids**
- **Cutworms**
- **Assassin bugs** (*Prithesancus spp.*)
- **Ants**
- **Big-eyed bugs** (*Geocoris spp.*)
- **Spiders**
- **Birds**

Photos: left: WURL, Insectcorner (3), J.K. Lindsey; middle: Paolo Mazzei, Roland Smith, Clemson University; right: Joseph Berger, Bradley Higbee, University of Tennessee (2), Olivier Olgiati
Direct pest management methods

Biological control
- Trichogramma cards (parasitic wasp)
- Bt-spray (Bacillus thuringensis)
- NPV (Nuclear polyhedrosis virus)
- Beauvaria bassiana (fungus)

Natural pesticides
- Neem
- Botanical mixtures
- Buttermilk spray
- Soft soap spray

Mass trapping
- Light traps
- Sticky traps
- Pheromone traps
Monitoring pests - Economic threshold

Scouting for pests with the pegboard

Pest control only if pest populations are beyond the economic threshold

(Graphics: gtz-IPM Project Shinyanga, Tanzania)
Soil cultivation and weed management

Preparing the field
- Early ploughing to expose pests to the sun
- Earthing up ridges
- Soil cultivation speeds up the decomposition of organic matter

Sowing
- Appropriate spacing
- 2-4 seeds per spot
- Gap filling with trap crops
- Timely thinning

Weed management
- Crop rotation prevents weeds
- Weeds can also be beneficial
- Timely intercultural operations
Low-cost drip irrigation in cotton

- Normal drip system (approx. 1100 US$ per ha)
- “Easy Drip” system (approx. 400 US$ per ha)
- “Pepsee” drip system (approx. 220 US$ per ha)
The cotton processing chain

- Picking
- Storing
- Selling
- Ginning
- Cleaning
- Collecting
- Baling
- Spinning
- Fabric formation
- Retail
- Stitching
- Dying/Finishing

Photos: Remei AG
Strategies in organic cotton farming

**Strategy I: Intensive organic**
- High yields, but relatively high production costs
- High loss in case crop fails

**Strategy II: Low input, low risk**
- Smaller yields, but also lower production costs, thus still good income
- Lower loss in case crop fails
Farming intensities in conventional and organic cotton production

- **High input conventional**
- **Low input conventional**
- **Traditional, not certifiable**
- **High input organic**
- **Low input organic**
- **Traditional, certifiable**
- **“Organic by default”**

Conversion paths:
- **usual conversion path**
- **minor conversion path**

Intensities of production:
- **Conventional Agriculture**
- **Organic Agriculture**
Success factors in the conversion to organic cotton farming

Getting ready

- Adequate training in organic agriculture and organic cotton production
- Involve the family in decision making
- Develop strategies to cope with initial drop in yields and higher labour requirement
- Competent and timely advice on organic crop management
- Regular exchanges with experienced organic farmers

Adapting the production system

- Try out organic technologies on small plots to gain experience
- Identify suitable crop rotation, green manures and intercrops
- Ensure sufficient input of organic matter (if necessary from outside the farm)
The role of women in organic cotton farming

Impact on women
- Work load
- New activities
- Food crops

Support to women
- Training on organic farming
- Learning new skills

Involvement of women
- Decision making
- Role sharing
- Experience sharing
- Forming of women’s groups