**Orchard-based agroforestry (Tajikistan)**

**DESCRIPTION**

An agroforestry system where legumes and cereals are planted in fruit orchards, giving simultaneous production and conservation benefits.

In the Faizabad region, Tajikistan, an area which is characterised by hilly topography, and deep but highly erodible loess soils, farmers traditionally cultivate beans and wheat in combination with fruit trees. This was a rather unsystematic agroforestry system, and during Soviet times (in the 1980s) fruit production was intensified. Pure-stand orchards were established: the land was levelled and on slopes exceeding 20%, terraces were constructed mechanically. The density of trees was increased, and the little space remaining between was used for hay production. Annual cropping was stopped.

Purpose of the Technology: After the Soviet era, farmers reduced the number of trees, allowing room for inter-cropping. They also established new orchards according to this same pattern. Those who farm rented land merely inter-crop wheat, whereas the few farmers who own their land, rotate crops with two years of wheat, followed by one of legumes (beans or lucern). Crops are grown both for home consumption and sale.

Establishment / maintenance activities and inputs: The density of apples was reduced by expanding the spacing from approx 5 m to 10 m between rows, and from 2 m to 4 m within rows. Along each row of trees a 2-3 m strip of grass was left to grow. The layout of fruit trees in lines is a compromise between being along the contour, and against the prevailing wind. After harvesting of the fruit, between August and October, farmers sow their annual crops.

Natural / human environment: This agroforestry system provides protection against strong winds, heavy rains and flooding. Soil erosion (by water) has been reduced due to improved soil cover by the inter cropping, and through leaf litter, which is left to decompose on the ground. Furthermore, after harvesting, about three quarters of the crop residues are left on the field as mulch. The remainder is used as fodder. Soil organic matter within the current agroforestry system is considerably higher than in the surrounding grazing areas. Soil fertility has improved also: beans can fix 60-80 kg/ha/year of nitrogen. Compared with other crops, wheat provides the best erosion protection. Since the lateral rooting system of the apple trees reaches only 1-1.5 m from the trunk, competition for nutrients is not a major problem. Neither is there a problem with shade, since during the crop establishment period the trees have lose their leaves. In order to increase production, farmers plan to apply supplementary irrigation where possible.

**LOCATION**

Location: Faizabad, Tajikistan, Faizabad, Tajikistan

No. of Technology sites analysed: 

Geo-reference of selected sites: 69.1931, 38.5282

Spread of the Technology:

In a permanently protected area?:

Date of implementation: 10-50 years ago

Type of introduction:

- through land users' innovation
  - as part of a traditional system (> 50 years)
  - during experiments/ research
  - through projects/ external interventions
Typical examples of apple trees intercropped with wheat. Alignment of the trees is often a compromise between wind direction, slope and shape of plot. (Hanspeter Liniger (Centre for Development and Environment (CDE) University of Bern.))

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- improve production
- ✓ reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- create beneficial economic impact
- create beneficial social impact

Land use
- Land use mixed within the same land unit: ✓ - Agroforestry

Cropland
- Annual cropping: legumes and pulses - beans, cereals - wheat (spring), lucerne
- ✓ Tree and shrub cropping: pome fruits (apples, pears, quinces, etc.)

Water supply
- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Purpose related to land degradation
- ✓ prevent land degradation
- ✓ restore/ rehabilitate severely degraded land
- ✓ adapt to land degradation
- not applicable

Degradation addressed
- ✓ soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying
- ✓ soil erosion by wind - Et: loss of topsoil
- ✓ chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

SLM group
- ✓ agroforestry
- ✓ windbreak/ shelterbelt
- ✓ improved ground/ vegetation cover

SLM measures
- ✓ agronomic measures - A2: Organic matter/ soil fertility, A7: Others
- ✓ vegetative measures - V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants
- ✓ structural measures - S1: Terraces

TECHNICAL DRAWING

Technical specifications
Fruit trees intercropped with wheat (or beans): note the fruit trees are aligned in a 'compromise' position between the direction of the prevailing wind and the slope.

Location: Faizabad. Faizabad, Tajikistan

Date: 25-07-2004

Technical knowledge required for field staff / advisors: moderate
Technical knowledge required for land users: moderate

Main technical functions: improvement of ground cover, increase in nutrient availability (supply, recycling,...), reduction in wind speed, improvement of soil fertility (with crop rotation inc. Beans+ lucerne)

Secondary technical functions: control of concentrated runoff: retain / trap, reduction of slope angle, improvement of subsoil structure (hardpan), water harvesting / increase water supply, retain/trap concentrated runoff (prevention of gully erosion)

Mulching
Material/species: leaf litter, crop residues

Rotations / fallows
Material/species: wheat, legumes

Aligned: -against wind
Vegetative material: T: trees / shrubs, G: grass
Vertical interval between rows / strips / blocks (m): 2-6
Spacing between rows / strips / blocks (m): 10
Vertical interval within rows / strips / blocks (m): 4
Width within rows / strips / blocks (m): 2-3

Slope (which determines the spacing indicated above): 20-60%

terrace: forward sloping: earth

### ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

**Calculation of inputs and costs**

<table>
<thead>
<tr>
<th>Most important factors affecting the costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>n.a.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Establishment activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planting of fruit orchard (Timing/ frequency: None)</td>
</tr>
<tr>
<td>2. Thinning: doubling the spacing between trees (by farmers, after Soviet period) (Timing/ frequency: None)</td>
</tr>
<tr>
<td>3. Hand planting of fruit tree seedlings (Timing/ frequency: None)</td>
</tr>
<tr>
<td>4. Planting fruit trees (Timing/ frequency: None)</td>
</tr>
<tr>
<td>5. 1. Levelling of steep land into terraces with graders (Timing/ frequency: None)</td>
</tr>
<tr>
<td>6. Planting of fruit orchards (Timing/ frequency: None)</td>
</tr>
</tbody>
</table>

#### Establishment inputs and costs

<table>
<thead>
<tr>
<th>Specify input</th>
<th>Unit</th>
<th>Quantity</th>
<th>Costs per Unit (USD)</th>
<th>Total costs per input (USD)</th>
<th>% of costs borne by land users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Planting of fruit orchard</td>
<td>ha</td>
<td>1,0</td>
<td>60,0</td>
<td>60,0</td>
<td>100,0</td>
</tr>
<tr>
<td>Thinning and hand lanting</td>
<td>ha</td>
<td>2,0</td>
<td>10,0</td>
<td>20,0</td>
<td>100,0</td>
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<tr>
<td>Machine use</td>
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<td></td>
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<tr>
<td>Tools</td>
<td></td>
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<tr>
<td>Plant material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seedlings</td>
<td>ha</td>
<td>1,0</td>
<td>250,0</td>
<td>250,0</td>
<td></td>
</tr>
<tr>
<td>Fertilizers and biocides</td>
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<tr>
<td>Fertilizer</td>
<td>ha</td>
<td>1,0</td>
<td>50,0</td>
<td>50,0</td>
<td>100,0</td>
</tr>
<tr>
<td>Biocides</td>
<td>ha</td>
<td>1,0</td>
<td>30,0</td>
<td>30,0</td>
<td>100,0</td>
</tr>
<tr>
<td>Pesticides</td>
<td>ha</td>
<td>1,0</td>
<td>30,0</td>
<td>30,0</td>
<td>100,0</td>
</tr>
<tr>
<td><strong>Total costs for establishment of the Technology</strong></td>
<td></td>
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<td>570,0</td>
</tr>
<tr>
<td><strong>Total costs for establishment of the Technology in USD</strong></td>
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<td></td>
<td></td>
<td></td>
<td>570,0</td>
</tr>
</tbody>
</table>

#### Maintenance activities

1. Applying organic manure for crops and trees (Timing/ frequency: (November to March))
2. Ploughing to depth of 25–30 cm for annual crops (Timing/ frequency: (November to March))
3. Disc ploughing and harrowing. (Timing/ frequency: (March))
4. Chemical fertiliser application to crops (Timing/ frequency: (once during season).)
5. Pest management with chemicals (Timing/ frequency: (two-three times where possible/affordable))
6. Harvesting: wheat is the only crop, which can be harvested if tractor and petrol is available (Timing/ frequency: None)
7. Mulching trees (humus cover) (Timing/ frequency: None)
8. Cutting trees (Timing/ frequency: None)

### Maintenance inputs and costs

<table>
<thead>
<tr>
<th>Specify input</th>
<th>Unit</th>
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<th>Costs per Unit (USD)</th>
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<tbody>
<tr>
<td>Labour</td>
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<tr>
<td>Applying organic manure for crops and trees</td>
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<tr>
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<td>10.0</td>
<td>20.0</td>
<td>100.0</td>
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<tr>
<td>Equipment</td>
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<td>Labour animal traction</td>
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<td>1.0</td>
<td>10.0</td>
<td>10.0</td>
<td>100.0</td>
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<tr>
<td>Labour harvesting</td>
<td>ha</td>
<td>1.0</td>
<td></td>
<td>100.0</td>
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<tr>
<td>Labour mulching and cutting</td>
<td>ha</td>
<td>1.0</td>
<td>50.0</td>
<td>100.0</td>
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<tr>
<td>Plant material</td>
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<td></td>
</tr>
<tr>
<td>Seeds</td>
<td>ha</td>
<td>1.0</td>
<td>30.0</td>
<td>30.0</td>
<td>100.0</td>
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<tr>
<td>Fertilizers and biocides</td>
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</tr>
<tr>
<td>Fertilizer</td>
<td>ha</td>
<td>1.0</td>
<td>50.0</td>
<td>50.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Compost manure</td>
<td>ha</td>
<td>1.0</td>
<td>10.0</td>
<td>10.0</td>
<td>100.0</td>
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<tr>
<td><strong>Total costs for maintenance of the Technology</strong></td>
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<td></td>
<td><strong>220.0</strong></td>
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<tr>
<td><strong>Total costs for maintenance of the Technology in USD</strong></td>
<td></td>
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<td><strong>220.0</strong></td>
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</tr>
</tbody>
</table>

### NATURAL ENVIRONMENT

#### Average annual rainfall
- Less than 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- More than 4,000 mm

#### Agro-climatic zone
- Humid
- Sub-humid
- Semi-arid
- Arid

#### Specifications on climate
- Thermal climate class: temperate

#### Slope
- Flat (0-2%)
- Gentle (3-5%)
- Moderate (6-10%)
- Rolling (11-15%)
- Hilly (16-30%)
- Very steep (>60%)

#### Landforms
- Plateau/plains
- Ridges
- Mountain slopes
- Hill slopes
- Foot slopes
- Valley floors

#### Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- More than 4,000 m a.s.l.

#### Technology is applied in
- Convex situations
- Concave situations
- Not relevant

#### Soil depth
- Very shallow (0-20 cm)
- Shallow (21-50 cm)
- Moderately deep (51-80 cm)
- Deep (81-120 cm)
- Very deep (>120 cm)

#### Soil texture (topsoil)
- Coarse/ light (sandy)
- Medium (loamy, silty)
- Fine/ heavy (clay)

#### Soil texture (>20 cm below surface)
- Coarse/ light (sandy)
- Medium (loamy, silty)
- Fine/ heavy (clay)

#### Topsoil organic matter content
- High (>3%)
- Medium (1-3%)
- Low (<1%)

#### Groundwater table
- On surface
- Less than 5 m
- 5-50 m
- More than 50 m

#### Availability of surface water
- Excess
- Good
- Medium
- Poor/ none

#### Water quality (untreated)
- Good drinking water
- Poor drinking water (treatment required)
- For agricultural use only (irrigation)
- Unusable

#### Is salinity a problem?
- Yes
- No

#### Occurrence of flooding
- Yes
- No

### CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

#### Species diversity
- High
- Medium
- Low

#### Habitat diversity
- High
- Medium
- Low

#### Market orientation
- Subsistence (self-supply)
- Mixed (subsistence/ commercial)
- Commercial/ market

#### Off-farm income
- Less than 10% of all income
- 10-50% of all income
- More than 50% of all income

#### Relative level of wealth
- Very poor
- Poor
- Average
- Rich
- Very rich

#### Level of mechanization
- Manual work
- Animal traction
- Mechanized/ motorized

#### Sedentary or nomadic
- Individuals or groups
- Gender
- Age
### Area used per household

| < 0.5 ha | ✓ |
| 0.5-1 ha | ✓ |
| 1-2 ha | ✓ |
| 2-5 ha | |
| 5-15 ha | |
| 15-50 ha | |
| 50-100 ha | |
| 100-500 ha | |
| 500-1000 ha | |
| > 10,000 ha | |

### Scale

| small-scale | ✓ |
| medium-scale | |
| large-scale | |

### Land ownership

| state | ✓ |
| company/ communal/ village group | |
| individual, not titled | |
| individual, titled | |

### Land use rights

| open access (unorganized) | |
| communal/ village group | |
| leased | ✓ |
| individual | |

### Access to services and infrastructure

| health | poor | ✓ | good |
| education | poor | ✓ | good |
| technical assistance | poor | ✓ | good |
| energy | poor | ✓ | good |
| roads and transport | poor | ✓ | good |

### IMPACTS

#### Socio-economic impacts

- **Crop production**: decreased, ✓ increased
- **Fodder production**: decreased, ✓ increased
- **Wood production**: decreased, ✓ increased
- **Farm income**: decreased, ✓ increased
- **Trees hinder farm operations**: increased, ✓ decreased

**Note:** Difficult to apply pesticides using machinery and pesticides are very expensive. Pruning is important, but farmers are new to the system and don't always have the skills required.

#### Socio-cultural impacts

- **Community institutions**: weakened, ✓ strengthened
- **Conflict mitigation**: worsened, ✓ improved

#### Ecological impacts

- **Excess water drainage**: reduced, ✓ improved
- **Soil moisture**: reduced, ✓ increased
- **Soil cover**: reduced, ✓ improved
- **Soil loss**: increased, ✓ decreased
- **Soil organic matter/ below ground C**: decreased, ✓ increased
- **Wind velocity**: increased, ✓ decreased
- **Nutrient use efficiency**: decreased, ✓ increased
- **Water use efficiency**: decreased, ✓ increased
- **Soil fertility**: decreased, ✓ increased

**Also biodiversity enhancement is medium (20-50%)**

#### Off-site impacts

- **Reliable and stable stream flows in dry season (incl. low flows)**: reduced, ✓ increased
- **Downstream flooding (undesired)**: increased, ✓ decreased
- **Groundwater/ river pollution**: increased, ✓ reduced
- **Wind transported sediments**: increased, ✓ reduced

#### COST-BENEFIT ANALYSIS

### Benefits compared with establishment costs

- **Short-term returns**: very negative, ✓ very positive
- **Long-term returns**: very negative, ✓ very positive

### Benefits compared with maintenance costs

- **Short-term returns**: very negative, ✓ very positive
- **Long-term returns**: very negative, ✓ very positive
CLIMATE CHANGE

ADOPTION AND ADAPTATION

<table>
<thead>
<tr>
<th>Percentage of land users in the area who have adopted the Technology</th>
<th>Of all those who have adopted the Technology, how many have done so without receiving material incentives?</th>
</tr>
</thead>
<tbody>
<tr>
<td>single cases/ experimental</td>
<td>0-10%</td>
</tr>
<tr>
<td>1-10%</td>
<td>11-50%</td>
</tr>
<tr>
<td>✓ 11-50%</td>
<td>51-90%</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>91-100%</td>
</tr>
<tr>
<td>✓ &gt; 50%</td>
<td></td>
</tr>
</tbody>
</table>

Number of households and/or area covered

3500 land user families have adopted the Technology without any external material support in an area of 45 km²

Has the Technology been modified recently to adapt to changing conditions?

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user’s view

- Easy to convert orchards
- How can they be sustained / enhanced? Land reform from state to private ownership would assist the process and strengthen farmers' associations.
- Helps provide employment (mainly self-employment, partial employment of additional labourers) and increased self-sufficiency. With the cultivation of wheat, some farmers can solve their food problems and do not need an off-farm income.
- Improvement of soil fertility and soil organic matter content

Strengths: compiler’s or other key resource person’s view

- How can they be sustained / enhanced? Use all the crop residue and leaves of trees as cover (mulch).
- Considerable reduction of soil erosion
- How can they be sustained / enhanced? Adopt cover crop and rotate with other legumes and minimum tillage system.
- Wider spacing between the rows of trees (to 10 m) is best for the agroforestry
- How can they be sustained / enhanced? Remaining orchards with the original Soviet spacing of 5m between the rows should be thinned.

Weaknesses/ disadvantages/ risks: land user’s view → how to overcome

- The irrigation system established during Soviet times required high maintenance inputs due to siltation of the canals. During the period of the civil war systems ceased to function, the canals filled up with sediments and finally overflowed during rain storms causing gully formation → Control of water flow within the orchard using cutoff drains and drainage ditches.
- Lines of trees which are planted up and down the slope to provide wind. → Compromise in layout design (see description).
- Orchards managed by state farms are often not well looked after. → Leasing of land and awarding landholder certificates leads to improved orchard management.

REFERENCES

Compiler
Loes Masselink

Reviewer
Deborah Niggli
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David Streiff
Lisa Soloveva
Olga Andreeva
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Last update: 14 أغسطس 2019

Resource persons
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Bettina Wolfgramm - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/ar/wocat/technologies/view/technologies_1017/

Linked SLM data
Approaches: Transition from a centralised regime to a local initiative
https://qcat.wocat.net/ar/wocat/approaches/view/approaches_2660/

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Wocat SLM Technologies
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