Use of WOCAT tools and network to prepare for SLM adaptation to climate change – identification of conservation technologies suitable for climate change

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About WOCAT

The main objective of Sustainable Land Management (SLM) is to promote human coexistence with nature with a long-term perspective so that the provisioning, regulating, cultural and supporting services of ecosystems are ensured. Within SLM, WOCAT focuses mainly on efforts to prevent and reduce land degradation through conservation technologies and their implementation approaches. The use and sharing of information and experiences, i.e. knowledge management, related to these efforts is a key asset of WOCAT.

According to the WOCAT strategy (2008-2012), four dimensions of knowledge are offered:

1. Knowledge related to SWC / SLM: innovative methods and an extensive network of both land users and soil and water conservation specialists have enabled WOCAT to accumulate a wide base of know-how;

2. Knowledge related to documentation and evaluation tools and methods: through the process of refining its methodology and tools, WOCAT has developed substantial experience and know-how on documentation and evaluation procedures;

3. Knowledge related to information sharing and networking: the establishment of an intellectual environment conducive to sharing and networking simplifies the dissemination of acquired knowledge to others working in the same areas and seeking to accomplish similar tasks;

4. Knowledge related to research, training and education: Due to requests to use the WOCAT methods and tools, WOCAT has conducted a large number of training workshops throughout the world. Due to emerging knowledge gaps, WOCAT has become more and more involved in research. These experiences have enabled WOCAT to gather a wealth of knowledge related to research, training and education methods.

These different dimensions of knowledge can be used to prepare for SLM adaptation to climate change which is further elaborated below.

The aim of WOCAT, as a network, is to increase the awareness and motivation of planners and decision makers as well as land users and agricultural advisors and to provide knowledge support concerning the advantages and disadvantages of available alternatives, based on a wide range of experience in the field.

WOCAT’s view on adaptation to climate change

SLM is crucial for sustainable development, building on enhancing agricultural productivity and the long-term productive potential of natural resources and the maintenance of their environmental functions and as an entry point for improving land resources resilience and productivity. SLM practices need to account for prevalent and changing climate conditions

WOCAT recognizes and acknowledges the challenge and importance to adapt to climate change. Thus, standardized documentation and evaluation of approved as well as innovative SLM technologies and approaches, also taking into consideration their adaptation potentials and tolerance towards possible scenarios of climate change, builds the basis to get prepared for the future.

- The focus for WOCAT is on existing sustainable land use practices under a changing natural and human environment. Of main concern are the semi-arid und sub-humid zones due to their susceptibility to climate change as well as areas that are affected by extreme events (floods, land slides, wind storms, natural disasters, etc.).

- The aim of WOCAT is to identify well-proven and successful land use systems and innovations as well as their potential to adapt to climate change, which include:

    good (best) practices/ green spots under the current climate and other natural and human conditions.

    SLM practices that show tolerance and potential to adapt to change (SLM is dynamic!).

    already ongoing adaptations and innovations to climate change

- Adaptation depends on both a suitable SLM technology and an approach. Key questions that need t to be addressed are: how fast do/can people respond to changes in their environment, and what are their possibilities and limits (limitations, readiness, and potentials).
- Climate change affects local and global society as a whole which again has implications on land use (e.g. in- and out- migration)

How to assess tolerance / adaptability of land use to climate change:

(1) For a specific region, climate change scenarios at a global level need to be broken down to the regional / local level. These scenarios can change with time as knowledge about climate change is growing. Here the input of climate change experts and groups is needed (eg. NCCR climate). Once the climate scenario is determined, land use systems that have proven successful under similar conditions present a basket of options for adaptations to the “new” climate.

In order to prepare for future climate change, it is necessary to capitalize on the wealth of already documented experiences. Major efforts to compile further current SLM experiences, which are well adapted to different climate ranges and extremes, are needed. SLM includes soil, water and vegetation.

(2) Through the comprehensive appraisal of different land use practices and SLM technologies and approaches as well as the considerable experience of local SLM specialists, the tolerance / sensitivity of an implemented practice towards a changing natural and human environment can be assessed: what is its climate range, where does it occur? Suitable (and easy) indicators to show the sensitivity of a current land use (SLM measure) towards possible climate change are:

- Change in temperature (increase / decrease)
- Change in distribution and amounts of rain (will affect the length of growing season which in turn will affect the choice of plant species and ‘construction/technology’ material as well as the design of the technology).
- Occurrence of extreme events: floods, heavy rains
drought, dry spells
strong winds, dust storms

Contribution to diminish causes of climate change:

For climate change the effect, positive as well as negative, of the technology on green house gas emissions and carbon accounting can be of importance (CO2 sequestration: organic matter content of the soil as an indicator for below ground carbon and CO2 emissions).

(3) The vulnerability or resilience of a technology to climate change will not only depend on changing natural factors but also on social and economic factors.

What can WOCAT offer:

WOCAT offers a standard method for documenting, evaluating, comparing and analyzing the performance of technologies and approaches under existing natural and human environment. It is based on the knowledge and the assessment of land users and experts and does not rely on wishful thinking.

WOCAT can offer a basket of SLM options (technologies and approaches) that work under specific or under a range of conditions; they are documented in the database. If a climate change scenario for a specific region is known then the database can be queried for technology options that are likely to work under the ‘new’ natural and human environment. If sufficient case studies are described then the range under which the technology is working and its tolerance/resilience or sensitivity/risk factor towards climate change scenarios can be assessed. Through a query of the database a selection of good practices can be made.

The current land use of a specific region will also determine how quickly an adaptation can be realized. If the technology is applied on annual crops the change to more ‘adapted or resistant’ species will be ‘easier’ than with perennial crops such as forests or windbreaks. A change in the design of windbreaks (eg tree shelterbelts) as compared to grass strips will be much slower. Climate change scenarios may not only imply modifications in a technology but a change in the choice of the technology altogether.

WOCAT has an established network of SLM specialists and organizations / institutions, which allows the sharing and exchange of experience, the joint development of the methodology, tools and data to the broad and changing needs of the various stakeholders actively involved in WOCAT and that at a local, national as well as international / global level. The annual Workshops and Steering Meetings provide a forum for discussion, exchange and adaptations of WOCAT towards the changing needs.

One of these needs was to contribute to the discussion on the adaptations to climate change. Based on the knowledge of the specialists of the network and their profound experience of land use and its adaptation to an ever changing environment as well as further developments of the WOCAT tools, the database will provide information of how a specific technology performs under extreme natural events, change of temperature and rainfall.

A recent development is to present WOCAT in GoogleEarth, showing locations and a summary of the case studies. This has created great interest among various stakeholders and shows potential.

Apart from case studies on SLM, a comprehensive WOCAT mapping method assessing land use, degradation and conservation (SLM measures) for defined areas from village, to basin, national level has been developed which can be used to assess current practices as well as their impact on ecosystem services and human-wellbeing. This could be used to assess climate change impacts on land use, degradation and conservation.

What WOCAT cannot provide, is to give the ultimate solution, it always depends on the specific situation and the priorities of those implementing it. But what it provides is a more informed decision making and the use of the wealth of untapped knowledge.

What is needed?

A **well populated database on SLM technologies and approaches** (full and ‘complete’ basket of options) covering the wide variety of geographic areas, land forms, climate zones etc... WOCAT has already around 250 SLM technologies and 140 SLM approaches in the global database. However, more case studies need to be documented and evaluated and made available covering different types, variations and adaptations of SLM options. In order to do so, a major global effort is needed involving projects, government and NGOs involved in SLM to document and evaluate their experiences and provide their knowledge to a common database and to provide easy access to this wealth of knowledge(in the internet, as well as in fact sheets, books, CD-ROMs). Currently efforts are made to include the use of the WOCAT tools in major UN, GEF as well as development and national projects. The aim is that the tools and the database become a standard for the documentation and monitoring of SLM. Thus projects should include right from the beginning sufficient resources for proper SLM knowledge management, i.e. dedicate a certain percent of time and financial resources for it.

Additionally, analysis and **decision support tools** are needed to assist in the use of this knowledge: data analysis, selection and evaluation of ‘viable’ options, selection of criteria for improved decision making. Special attention needs to be given to the sensitivity towards climate change and to ongoing adaptations/innovations to climate change.

In the following Annex a technology and an approach documented using WOCAT tools and standard format are presented. Sections that relate to adaptation to climate change are highlighted.

left: A bird's-eye view of the rectangular grid pattern of shelterbelts which were established over wide expanses of cropland in order to reduce wind erosion and enhance moisture conservation. (Liingqin Meng)

right: Detailed view of a shelterbelt established in the early 1960s. A road and an irrigation channel run in between the tree rows. (Anonymous)

Shelterbelts

China – 农田防护林

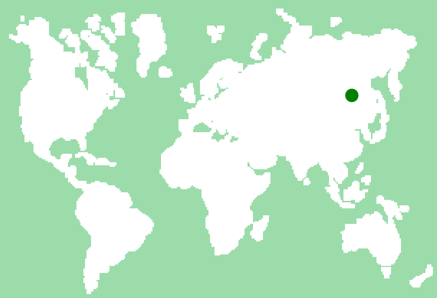
Belts of trees, planted in a rectangular grid pattern within areas of farmland, to act as windbreaks.

Strips of tall growing varieties of poplar (Populus spp.) or willow (Salix spp.) were originally planted in a 400 by 400 m rectangular grid pattern within extensive areas of cropland. Strips are of variable width, consisting of 2-5 tree lines (1-2 m apart) with trees planted every 1-2 m within the lines.

Established under collective action through the Forestry Department's 'Three Northern Shelterbelts Project' from 1960 onwards, shelterbelts protect a large area – approximately 22 million hectares – of vulnerable cropland in this part of China. The shelterbelts reduce wind velocity and consequent loss of topsoil during winter and spring when the soils are dry and bare. In early summer, the crop is protected from damaging winds, and soil moisture loss is reduced along with excessive wind-induced transpiration. Where there is irrigation, the shelterbelts protect the infrastructure from silting up with wind-borne sediment.

In the 1960s, all land ownership and land use rights in China were communal and cropland was farmed collectively by village communes. After reform and open policy was put into practice in 1978, land use rights were transferred to the villages, to groups and individuals. Land, itself and the shelterbelts however still belonged to the state. Nowadays the rights to cultivate specific parcels of land, within protected blocks, are generally granted to individual farm households. In some cases, in recent years, the shelterbelts too have been redistributed to individuals to look after. Inevitably maintenance has become an issue. But most of the shelterbelts are managed well.

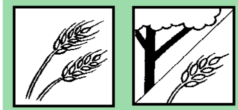
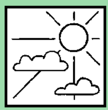
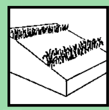
While originally not permitted under Chinese forestry law, the local forestry department now allows some felling of mature trees, on a rotational and selective basis, for timber and fuelwood. Single lines of mature trees are cut. The remaining lines ensure that the effectiveness of the shelterbelts to reduce wind speed is not affected. After felling, lines are replanted through organisations led by the local forestry department. Replanting is increasingly done with pine (Pinus sylvestris, P. mongolica and P. tabulaeformis), which command a higher value for construction. Apart from the windbreak effect of the shelterbelts, the farmers benefit from timber sales, fuelwood, and fodder for their animals. All in all the benefits of the shelterbelts outweigh the loss of cropland occupied by the trees.



Location: Inner Mongolia Autonomous Region, Peoples' Republic of China
Technology area: 500 km²
Conservation measure: vegetative
Stage of intervention: reduction of land degradation
Origin: Externally introduced through projects, under collective action, Since 1960
Land use: cropland (before), mixed: agroforestry (after)
Climate: semi-arid, temperate*
WOCAT database reference: QT CHN48
Related approach: not documented
Compiled by: Hai Chunxing, Hohhot, China
Date: May 2002, updated July 2004

Classification

Land use problems: sandstorms, droughts, wind erosion, frost*

Land use	Climate	Degradation	Conservation measure
 annual crops: maize/wheat, suppl. irrig. (before) agroforestry (after)	 semi-arid temperate*	 wind erosion: loss of topsoil, deflation/ deposition; water: reduced soil moisture	 vegetative: aligned trees (windbreaks)

Stage of intervention
- Prevention
- Mitigation/reduction
- Rehabilitation

Origin
- Land user's initiative:
- Experiments/research:
- Externally introduced: 50 years ago
- Other's (specify):

Level of technical knowledge
- Low: land user*
- Medium: agricultural advisor*
- High:

Main causes of land degradation: wind storms/dust storms, over-exploitation of vegetation for natural use*

Main technical functions: ·
- reduction in wind speed
- protection from wind erosion
- protects crop from mechanical damage
- reduction in evaporation loss
- soil moisture conservation

Secondary technical functions:
- prevention of sand storms
- preventing siltation of irrigation canals
- increase in organic matter

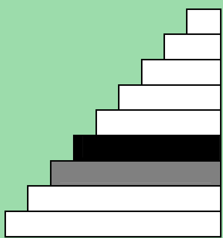
Environment

Natural Environment

Average annual rainfall (mm)

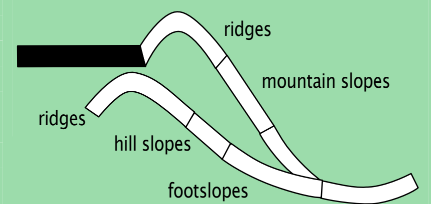
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
<250

Altitude (m a.s.l.)

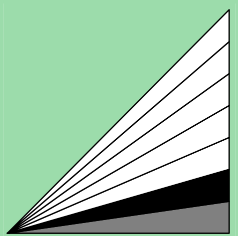


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform



Slope (%)



Soil depth (cm)

0-20
20-50
50-80
80-120
<120

Growing season(s): 150 days (May to September)
Soil texture: coarse (sandy)
Soil fertility: medium to low
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: medium

Soil water storage capacity: medium
Ground water table: 5-50m*
Availability of surface water: medium*
Water quality: good drinking water*
Biodiversity: medium*

Tolerant of climatic extremes: temperature increase, windstorm/dust storms*
Sensitive to climatic extremes: heavy rainfall events, floods, droughts*
If sensitive, what modifications were made / are possible: no data available

Human environment

Mixed land per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1000
1000-10000
>10000

Land user: groups, small-scale, common, mainly men*

Population density: 10-50 persons/km^2

Annual population growth: 1-2%

Land ownership: communal/state

Land/water use rights: individual (for cropland – though not usually the land directly under shelterbelts)

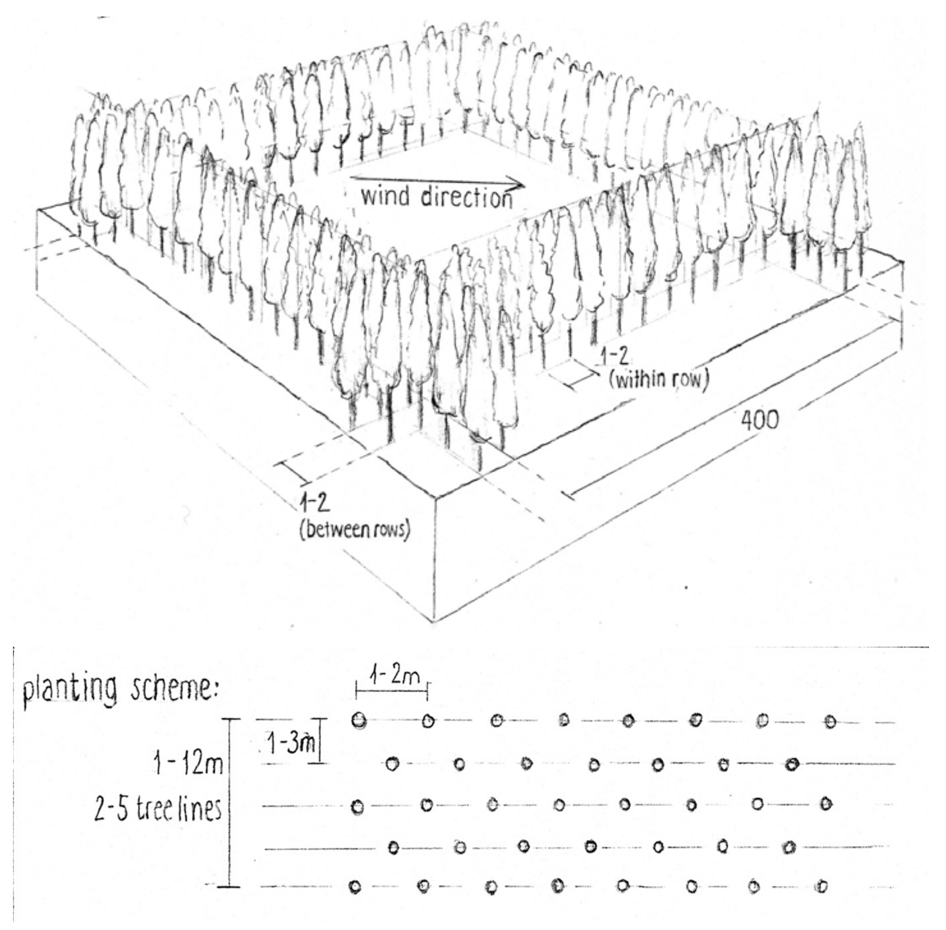
Relative kevel of wealth: average, 80% of land users

Importance of off-farm income: 10-50% of all income: farmers benefit from the shelterbelts as a source of off-farm income, through timber and firewood

Access to service/ infrastructure: low: financial services, market; high: education, health*

Market orientation: mixed (subsistence/ commercial)

Mechanization: land cultivation is performed mechanized



Technical drawing

Structure of a shelter-belt. (Hai Chunxing)

Implementation activities, inputs and costs

Establishment activities

1. Pits for planting the seedlings are dug by hand using shovels and pickaxes in late autumn and spring.
2. Tree seedlings are planted in late spring.
3. After planting each seedling is watered by hand for up to two years using a bowser (bucket irrigation).

Duration of establishment: 2-3 years

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (25 person days)	100	0%
Equipment		
- Tools (shovel, pickaxe, bowser	5	100%
Agricultural		
- Tree seeding (100)	25	0%
TOTAL	130	4%

Maintenance/recurrent activities

1. Loosen the soil and incorporate the straw using the ‘Simba Solo’; soil consolidation, using the ‘Cultipress’ (immediately post-harvest).
2. Spray the stale seedbed to remove all the weeds/volunteer plants o previous crops (mid September).
3. Light surface tillage and sowing into the seedbed; using the ‘Väderstad Rapid Cultivator Drill’ (usually end September, just after spraying).
4. Consolidation of the sown land (using Cambridge rollers).
5. After crop maturity, combine harvesting - with simultaneous chopping of straw.
6. Disperse the chopped straw, using a trash rake.

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Equipment		
-various machines	180	100%
TOTAL	180	100%

Remarks: The costs are calculated as though planting was taking place currently (in the 1960s labour was much cheaper). The original planting was paid for by the state: re-planting (maintenance/recurrent) is the responsibility of the land user. If pines are the species of choice for re-planting, the cost will be much more than those shown above (which are for poplar and willow).

Assessment

Impacts of the technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	wood production increase	– –	loss of land /width of the shelterbelt)
++	crop yield increase		
++	farm income increase		

Socio-cultural benefits		Socio-cultural disadvantages	
++	community institution strengthening	– –	shelterbelts (trees) are not a direct source of food – this leads to a negative attitude amongst some farmers
+	improved knowledge SWC/erosion		

Ecological benefits		Ecological disadvantages	
+++	soil cover improvement		
+++	increase in soil moisture		
+++	soil loss reduction		
+++	reduction of wind velocity		
++	increase in soil fertility		

Off-site benefits		Off-site disadvantages	
+++	reduced downstream flooding		

Contribution to human well-being/livelihoods

++ Comments: decreased workload, better health*

Benefits/costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment*	not specified	not specified
Maintenance/recurrent	Slightly positive*	very positive*

If farmer cuts mature timber (for example a 40 years old poplar), he/she can sell it for US$ 20-25 per tree. With maturity of shelterbelts, the timber production increases, which brings increasing economic benefits; meanwhile, the effect of protection from wind erosion also improves.

Acceptance/adoption: As noted, the shelterbelts and irrigation canals were laid out as part of a government project in which all costs were met by the state, therefore 'adoption' or 'acceptance' of windbreaks by land users was not a relevant concept. The technology has not spontaneously spread beyond the areas developed through government intervention.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Reduced wind speed and trapped wind-blown sand particles → Plant combinations of deciduous and evergreen trees to maintain shelterbelt's protective function throughout the year.	Loss of land due to width of the shelterbelts → In this windy area of Inner Mongolia the extra benefits of the protected area (eg topsoil conserved through decreased wind erosion) outweigh the production losses incurred due to reduced cropped area. This may not always be the case when windbreaks are planted in areas where wind erosion is less: therefore windbreaks should not be planted indiscriminately.
Increased crop yield → Extend shelterbelt technology to unprotected croplands.	Farmers lost the right to crop the strip of land which was converted to shelterbelts (since the shelterbelts belonged to the state). Originally, farmers were not allowed to fell trees. → Nowadays the local forestry department permits farmers to occasionally cut trees, which is a source of income. If land users were allowed to cut trees on a more systematic basis, it would help them to better appreciate the benefits.
Increased cash income → Develop rotational felling regimes that maximise quantity and quality of tree products without reducing the shelterbelt's protective function.	High cost (labour and money) for establishment → Government support required.

* New questions, no information available from this case study. Possible answers are invented.

Key reference(s): Compilation Committee of Inner Mongolia Forest (1989) Inner Mongolia Forest, Beijing: *China Forestry Publishing House*, 1989, 299-319

Contact person(s): Hai Chunxing, College of Geographical Sciences, Inner Mongolia Normal University, No.295 Zhaowuda Road Hohhot Inner Mongolia 010022, Peoples' Republic of China. hcxjs@imnu.edu.cn

left: Mass mobilisation showing people from several villages helping each other. Initially, farmers were not paid but from the 1980s onwards farmers received cash and other support for their work. (Photo: from 'Terraces in China' Ministry of Agriculture)

right: Construction of terrace risers following instructions given by a specialist.(Photo: from 'Terraces in China' Ministry of Agriculture)

Terrace approach

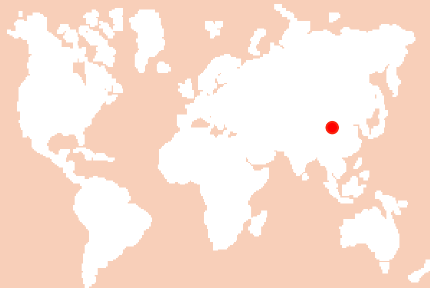
China -庄浪梯田

Highly organised strategic campaign to assist land users in creating terraces: support and planning from national down to local level.

Before 1964, the slopes on China's Loess Plateau were cultivated up and down by machinery. Consequently soil and water were lost at high rates, and fertility and yields declined. Accessibility to cultivated land became more and more difficult due to dissection by gullies. The first terraces were established by self-mobilisation of the local land users. However there was no standard design. Furthermore, as the individual plots were very small and scattered all over the village land, terracing needed better coordination. Between 1964 and 1978, the local government at the county level took the initiative of organising farmers and planning terrace implementation according to specific technical design on a larger scale. At that time the land was still communally managed by production brigades. Through mass mobilisation campaigns people from several villages were organised to collectively terrace the land – village by village – covering around 2,000 hectares each year. Labour was unpaid.

The Yellow River Conservancy Commission (YRCC) came into being in 1948 – and the Upper and Middle Yellow River Bureau in 1977. This gave greater impetus to the implementation of SWC in the Loess Plateau. After 1978, land use rights were allocated to individuals (though official ownership was still vested in the state). SWC specialists and county level SWC bureaus started to work with groups of farmers who had land use rights within a given area. Survey and design were carried out. The farmers organised themselves, consolidated the parcels of land, and then after the conservation work was done they redistributed the terraced fields.

In the 1980s the government started to financially support land users involved in SWC projects. Subsidies ranged from (approx) US$* 20 / ha in projects at county level, to US$* 55 / ha for national projects (eg through the Yellow River Commission), and up to US$* 935 / ha when World Bank projects were involved – as in the recent past. Implements were provided by the farmers themselves. Then, in 1988 a nationwide project in SWC – which originally was proposed at county level – was approved by the national government. Furthermore, in 1991 a national law on SWC came into force. Protection of the Yellow River and associated dams became a priority at regional and national levels. In total, within Zhuanglang County, 60 SWC specialists /extensionists cover an area of 1,550 km², and most of the terraces were built with low levels of subsidies. Annual plans about implementation of new SWC measures were made during summer. Small areas were planned at village or township level, whereas bigger areas (> 7 hectares) were designed at county level. Implementation then took place during winter. Terracing was implemented first where access was easiest and closest to settlements, and only later, further away.



Location: Zhuanlang County, Gansu Province, Loess Plateau Region, Northern China, Peoples' Republic of China
Approach area: 1,555 km²
Land use: cropland
Type: programme*
Focus: mainly on conservation*
Climate: semi-arid
WOCAT database reference: QT CHN45
Related technology: Loess Plateau Terraces
Compiled by: Wang Yaolin, Gansu GEF/OP12 Project Office, Lanzhou, Gansu, China; Wen Meili, Department of Resources and Environmental Sciences, Beijing Normal University, China; Bai Zhanguo, World Soil Information, Wageningen, Netherlands
Date: May 2002, updated March 2006

Problem, objectives and constraints

Problems
- Lack of organisation, capital and technical knowledge in farmer communities to counter the underlying problems of water loss, soil loss, fertility decline and downstream effects on the Yellow River (floods and sediment) at catchment level.
- Absence or poor maintenance of erosion control measures.

Aims/Objectives
- Water conservation (this is a semi-arid area)
- Soil conservation: reduce soil loss on the sloping and erosion-prone land of loess plateau
- Enhancing soil fertility, and consequently production
- Improve people's living conditions

These primary objectives were to be achieved by building level bench terraces on a large scale through a structured and organised campaign. Finally at the national level, a fourth aim was added: the protection of the Yellow river (avoiding floods and reducing the sediment load).

Constraints addressed

	Constraints	Treatments
Legal	Land users leased the land from the state and land users' rights were insecure in the long term. Investments in SWC were not encouraged.	National government persuaded land users to implement terraces by 'selling' the benefits (increased yield and easier workability of the land). After 1978, individual user rights motivated farmers to invest in SWC.
Technical	Poor knowledge of how to reduce water loss, soil loss and fertility loss. Technical solutions were needed at the catchment level, involving the whole population.	Enhanced guidance by SWC specialists.
financial	Initially farmers were not paid and as they had no immediate benefit from, or security over, the use of the land. The investment in construction was a heavy burden on poor farmers.	After 1988, labour inputs by farmers started to be partly covered by subsidies provided by local and national government.

Participation and decision making

Stakeholders / target groups

Approach costs met by:

	%
	%
TOTAL	100%

Annual budget for SLM component:

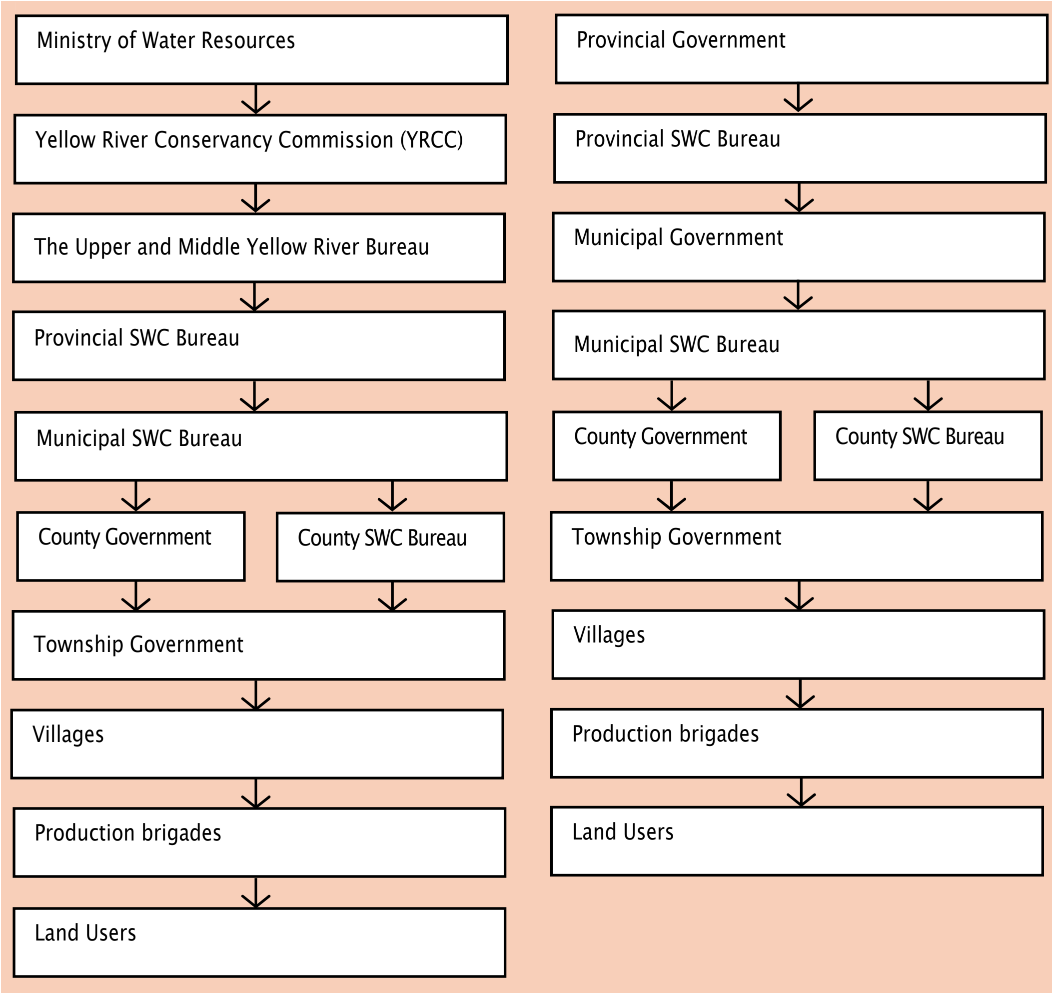
Decisions on choice of the technology (ies): Mainly made by SWC specialists with consultation of land users,
Decisions on method of implementing the technology (ies): Decisions are made by politicians / SWC specialists; land users are consulted in the planning phase (experienced farmers may be involved initially).
Approach designed by: County level and national specialists.
Implementing bodies: government*

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Self-mobilisation/interactive.	Land users started implementing terraces but SWC specialists at the country level assisted in designing standards for terrace construction and township governments and production brigades organised whole villages and watersheds
Planning	passive	Being consulted in the planning phase. Experienced peasants may be involved in introducing the local situation.
Implementation	Interactive	Major organisation done through the SWC bureau specialists with the village organisation including land users. Land users were actively involved in implementation.
Monitoring/evaluation	none	Reporting. No participation of land users
Research	none	On-station research. No participation of land users

Differences between participation of men and women: For manual labour, men can do more work and they have greater technical knowledge and skills related to terrace construction than women*.

Involvement of disadvantaged groups: Yes, moderate*



Organogram
Terrace construction supported by projects from MWR, YRCC and international organizations (left) and terrace construction supported by provincial funds (right)

Technical support

Training / awareness raising: Until 1978 the 'pyramid system' was used: the county level trained the township level, which trained the village level, which in turn trained the production brigades/farmers, who then trained other production brigades and farmers.
Training was on-the-job, focusing on design and construction of terraces on sloping land (provided by the county level specialists and by land users from villages where implementation was already carried out; at a later stage national trainers were involved as well). With respect to courses, demonstration areas, and farm visits – these were effective for all target groups.
Advisory service: The pyramid system is also used for extension. At each government level (at the county, district and provincial levels) there is a SWC division which is in charge of SWC activities including extension (demonstration, farm visits, etc). Effectiveness with respect to land users has been good. With rural economic development, more and more land users plan to invest in the SWC activities, including terrace making. The extension system is quite adequate to ensure continuation of activities.
Research: Mostly on-station research; carried out at the provincial and national levels, mostly by technical staff. Land users have not been involved. Topics covered include economics/marketing, ecology, technology. Terrace building is based on scientific design, according to local conditions.

External material support / subsidies

Contribution per area (state/private sector): no
Labour: In the 1960s and 1970s farmers were not paid for their labour inputs. From the 1980s onwards the government started to reward the community for establishment of terraces with cash: projects paid on the basis of area treated, and at different rates.
Input: Shovels and carts were provided by land users.
Credit: Credit was available at interest rates (0.5–1% per year) lower than the market rates
Support to local institutions: Financial support to local institutions was made available through SWC Bureaus.

Monitoring and evaluation

Monitored aspects	Methods and indicators
Bio-physical	regular measurements of runoff loss, sediment load, soil moisture
Technical	regular measurements of structure of terraced areas, slope of risers, levelness of terrace surface
Socio-cultural	ad hoc observations of land users' perceptions of terraces
Economic/production	regular measurements of yield, income of land users.
Arera treated	regular measurements of terraced area
No. of land users involved	ad hoc measurements of the numbers of farmers directly involved in terracing and farmers benefited directly
Management of approach	ad hoc observations of number of small watersheds terraced

Changes as result of monitoring and evaluation: The approach changed fundamentally from self-mobilisation to organised mass movements guided by the government

Impacts of the approach

Improved sustainable land management: Soil and water management have improved a lot: easier workability, intensified land use, in-situ water retention, top soil and fertilizer/manure are not washed away, etc.
Adoption of the approach by other land users / projects: As the Zhuanglang area was one of the pioneering areas for the Loess Plateau other regions were able to profit from the approach. But likewise, experiences gained in other counties helped improve the approach, and a basically similar approach has been applied over the whole Loess Plateau – though the level of subsidies for construction is much higher under World Bank projects.
Improved livelihoods / human well-being: Yes, little*
Improved situation of disadvantaged groups: Yes, little*
Poverty alleviation: Yes little*
Training, advisory service and research: Many people from different levels are trained, training effective.*
Land/water use rights: The ownership of the land and its resources belongs to state and communities: land users can only lease the land for a period of time. Due to uncertainty over future user rights and possible reallocation of the land every few years (5, 10 or 20) by the village in response to changes in population and household needs, additional investments into land/SWC measures may be hindered. 1978 a first major change took place by allocating some individual land use rights.
Long-term impact of subsidies: As more and more payment is currently being made to land users on the basis of the area treated, land users rely more and more on being paid for investments into SWC. The willingness to invest in SWC measures without receiving financial support has decreased. Thus the use of incentives in the current approach is considered to have a negative long-term impact.

Concluding statements

Main motivation of land users to implement SLM: well-being and livelihood improvement*
Sustainability of activities: Given the recent escalation in payments made to land users for implementation under certain projects it seems that the costs will be too high to sustain. Currently the Ministry of Finance is demanding that in-depth cost-benefit analyses are carried out involving environmental, social as well as economic assessments.

Strengths and → how to sustain/improve*	Weaknesses and → how to overcome
Efficient organisation, planning to cover a large area, which is very susceptible to land degradation.	High costs: farmers depend on external support from the government, they are not willing to invest their labour without payments (as it used to be in communist times) → new approach: give farmers loans for construction as now they use machines to do the work. In addition, search for cheaper SWC technologies and for improving the benefits.
Heavy investment made by the land users and local as well as national government to reduce land degradation	The steeper slopes which are also further away from the village, are now often not cultivated and maintained as they are too far and marginal in production. → solutions need to be found for these areas, eg afforestation.
Many people involved and trained at different levels (pyramid system; see training/extension); commitment by all stakeholders.	
The collective activities / organisation strengthens the community and enhances social stability and coherence within villages; collective activities are expanded to other sectors, such as road construction, supply of agrochemical inputs, etc.	
Farmers are getting direct benefits: marked increase in productivity, improved workability of the land, etc.	

* no recommendations provided on how to sustain/improve the strengths in this case study

* New questions, no information available from this case study. Possible answers are invented.

Key reference(s): Water and Soil Conservation Department of Yellow River Water Resources Committee of Ministry of Water Resources and Electric Power 1987: Corpus of economic benefits of water and soil measures, p77~102, 510~514 ■ Suide Water and Soil Conservation examination station of Yellow River Water Resources Committee, 1981. Corpus of Test Research of Water and Soil Conservation, p130~185 (the second volume) ■ Jiangdingsheng, ACTA CONSERVATIONIS SOLI ET AQUAE SINICA, 1987. Discussion on section design of the terrace on the Loess Plateau; Vol.1,No.2, p28~35

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