Identification and valuation of suitable technology options for sustainable land use in hilly areas

Department for International Agriculture

Diploma Thesis: Strub Christian

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Zollikofen, 13th May 2002
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Topic for Diploma Thesis

Identification and valuation of suitable technology options for sustainable land use in hilly areas

Introduction
Numerous technologies to achieve sustainable production in hillside agriculture have been developed and tested in various environments. There is also a whole range of different approaches that have been used to implement and disseminate such technologies on the ground. Efforts to compile both technologies and approaches have led to the development of WOCAT (World Overview of Conservation Technologies and Approaches), a tool assisting soil and water conservation specialists in searching for and deciding on appropriate measures and ways to achieve sustainable and productive land use.

Rationale
During his practical training, the student has developed a model for a system of eco-bonus payments to farmers in the south of the Dominican Republic. The project "Cuenca río Macasías" (Helvetas) aims at developing such a system as a pilot project to test the feasibility and efficiency of this approach in disseminating sustainable land-use practices in the project area. However, the identification and valuation of appropriate technologies has been based on a rather simple assessment so far, and there is a need to improve the system developed. WOCAT could assist in the identification of further potentially suitable technologies and their valuation for appropriateness in the project area.

Objectives
To identify and valuate appropriate technology options and approaches for sustainable land use practices in hilly areas, considering in particular the environment in the south of the Dominican Republic, in order to lay a broadened and sound basis for a system of eco-bonus payments to farmers. Further it shall be evaluated, to what extent WOCAT can facilitate the selection and valuation of suitable technologies (and approaches) in a concrete development project.

Mandate
The student is to identify in a desk study potentially suitable technology options for sustainable and productive land use on sloping land. The development of an analytical framework for assessing these options with regard to the local context shall allow the identification and valuation of best-bet options. The system for eco-bonus payments to farmers in the San Juan und Elias Piña provinces in the Dominican Republic may thus be based on a broadened identification of potentially suitable technologies and a sound analysis of their appropriateness in the area. WOCAT shall be used to identify and valuate appropriate technologies, and its value in facilitating this task shall be assessed.

Means
The identification of suitable technologies shall be based on an in-depth literature and internet search on the topic, including approaches like SALT (Sloping Agricultural Land Technology) and the experiences of CIAT (Centro de Investigación Agricola Tropical) in similar environments. WOCAT is supposed to play a major role in this process; contacting relevant resource persons may facilitate and speed-up the use of WOCAT.

Responsible Professor: Christoph Studer
Zollikofen, 29.11.01
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the Macasías Watershed Project
Summary

The objective of this thesis was to develop a methodology facilitating the identification and valuation of appropriate soil and water conservation technology options and approaches for sustainable land use practices in hilly areas. To this end a "framework for thought in technology finding" was developed, a tool that describes and guides the process of identifying and valuating appropriate soil and water conservation technologies and approaches in the form of a flow chart. The main characteristics of the “framework for thought in technology finding” are the reflections about the need and the feasibility of a soil and water conservation intervention, the strong integration of the farmer in the whole process, and a final development and improvement cycle.

As main source of information and decision-support tool, the World Overview of Conservation Approaches and Technologies (WOCAT) databases were utilised, a compilation of experiences made all over the world in soil and water conservation projects. The WOCAT databases and the WOCAT network are presented, and some suggestions formulated to improve the database for the purposes of the “framework for thought in technology finding”.

As a further result, a list of suitable technologies and approaches for the Macasías Watershed Project are presented. The Macasías Watershed Project is located in the Southwest of the Dominican Republic, and is mainly focusing on natural resource management. The presented list of soil and water conservation technologies and approaches for this project was compiled using the “framework for thought in technology finding”.

Keywords: soil and water conservation (SWC), soil fertility, conservation measures, World Overview of Conservation Approaches and Technologies (WOCAT), participatory technology development, sustainable land management

Zusammenfassung


Als hauptsächliche Informationsquelle und Hilfsmittel wurden die Datenbanken des World Overview of Conservation Approaches and Technologies (WOCAT) in die Methode einbezogen. Diese Datenbanken stellen eine Sammlung von Erfahrungen im Bodenschutz dar, wie sie um den ganzen Erdball gemacht
wurden. Die WOCAT Datenbanken und das WOCAT Netzwerk sind in dieser Arbeit beschrieben, und zudem werden einige Vorschläge gemacht, wie die Datenbanken an die Bedürfnisse des Flussdiagramms „framework for thought in technology finding“ angepasst werden könnten.

1 Introduction

Every minute, an estimated 10 hectares of agricultural land is lost to erosion throughout the world (Kuyper et al. 1999). In some areas, very little erosion occurs, in others, more than 200 tons of soil disappears from one hectare every year. On average about 50 tons of soil per hectare are lost each year. The soil generally loses its top layer, which is the most fertile part of the soil.

Since several years, the World community is fighting against erosion, soil mining, water pollution and other aspects of degradation of natural resources. In these years a lot of technologies and approaches have been developed and used. A lot of experiences have been made and are still being made. Unfortunately, these experiences are not widely exchanged.

To allow a project-planer in Latin America to profit from the experiences made in Asia, all the experiences made throughout the world should somehow be collected. Therefore the World Overview of Conservation Approaches and Technologies (WOCAT) program has been formed. WOCAT is a network of Soil and Water Conservation (SWC) specialists who are collecting data from SWC projects and share their experiences. Still a SWC specialist working in a project faces a big challenge having to decide on appropriate SWC technologies and approaches that suit the site and situation-specific conditions. A tool allowing for sound decision-making and selection could facilitate this task to a great extent.

1.1 Context - The practical training

During the practical training in the Dominican Republic in summer 2001 we elaborated a system of eco-bonus payments to farmers in the Macasías Watershed Project. One part of this work consisted of developing an evaluation system for implemented SWC technologies. Considering biophysical parameters such as slope, position, soil and precipitation, scores were assigned according to the type of SWC measures implemented. Eco-bonus payments to farmers were then calculated depending on the reached score (Strub 2001).

However this point Matrix has been developed using rather vague assumptions. Therefore the results of this approach to an eco-bonus payment may be questionable. It is hoped that using the WOCAT database could provide a possible reference to get the information needed.

Further it was observed that most of the extension workers in the Macasías Watershed Project just promote one or two SWC technologies to the farmers. Therefore the farmers do not have a big choice on what technologies they could or should implement. The main objective of the work presented here is to develop a framework for the identification of a selection of suitable SWC technologies. Within this framework the WOCAT database plays an important role.
The general objective of the practical training in the Macasías Watershed Project was formulated as: Development and evaluation of a model of ecological incentives in a pragmatic way of working, for conservation and protection of the environment and the water sources by the farmers. The main task was to develop and present the so-called “Matrix” for the calculation of eco-bonus payments to farmers.

**The Macasías Watershed Project**
*(HELVETAS 1998)*

**Geographic Position**

The Macasías watershed is situated in the Southeast of the Dominican Republic beside the Haitian border, on the northern slope of the Sierra de Neyba. The project area holds 1’759.9 km². This area includes six municipalities, which are Las Matas de Farfán, El Cercado, Vallejuelo, Comedor, El Llano, and Hondo Valle.

**Altitude, Climate and Precipitation**

Within the Macasías watershed we can define three zones, according to altitude and the topography. These three zones are:

- The lowland zone of the San Juan valley, corresponding to the municipalities of Matas de Farfán, El Llano and Comendador. This area is on average 400m above sea level. The soils in this zone are flat and are the most intensively used in the project zone. Often, irrigation and modern mechanisation is used.

- In the midlevel zone are the little valleys along the Sierra de Neyba. A big part of this area is situated between Vallejelo and El Cercado on the south slope. On the north side, the mini valley of Catana Matias lies between the hills of Catana Matias and Yacahueque in the Cordillera Central. The altitude in this zone is between 400 and 650 meters above sea level. There is some irrigation but systems without irrigation are dominant. The mechanisation level is reaching from tractor and plough to hoe.

- The high zone includes the areas that are steep and of high altitude in the Macasías watershed zone. Here, most of the rivers have their source. All the land higher than 650 meters above sea level is counted to that area.

During the past twenty years the midlevel and the highlevel zone were affected by serious deforestation. In the 70s and 80s, small farm holders migrated in this zone looking for more and more fertile soils to increase their production.
The climate of the Macasías watershed is tropical. The mean temperature all over the year is 23.4°C. The annual mean precipitation for the area is 1'279 mm/year. The rainfall and the temperature can differ considerably between the different zones as can be seen in table 1.

Table 1: Annual temperature and precipitation means in the Macasías watershed (after meteorological stations in the zone).

<table>
<thead>
<tr>
<th>Station</th>
<th>Altitude (masl)</th>
<th>Temperature, annual mean (°C)</th>
<th>Precipitation, annual mean (mm/rain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Juan de La Maguana</td>
<td>415</td>
<td>24.7</td>
<td>956</td>
</tr>
<tr>
<td>Matayaya</td>
<td>430</td>
<td>23.7</td>
<td>1'075</td>
</tr>
<tr>
<td>Las Matas de Farfán</td>
<td>430</td>
<td>25.9</td>
<td>1'070</td>
</tr>
<tr>
<td>El Cercado</td>
<td>720</td>
<td>23.1</td>
<td>1'240</td>
</tr>
<tr>
<td>Comendador</td>
<td>384</td>
<td>27.0</td>
<td>1'618</td>
</tr>
<tr>
<td>Hondo Valle</td>
<td>-</td>
<td>21.3</td>
<td>1'717</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>23.4</td>
<td>1'279</td>
</tr>
</tbody>
</table>

Source: GTZ-ONAPLAN-INDESUR 1995
Note: El Llano does not have a meteorological station

Population

The region is one of the poorest of the country and with a density of 84 habitants per km² it one of the least densely populated. In 1992, 143'214 people were living in the watershed. Between 1981 and 1993, the relative increase of the population was only 1%. From this small percentage it can be concluded that the amount of migration from this region to other parts of the country and to foreign countries is high.

Agriculture

In the area of the Macasías watershed the agricultural sector is the fundamental economic support. From 100 employed persons, 63 earn their income in the agricultural sector.

Within the agricultural sector the most important sub sector is field farming with a percentage of 91.6% of the agricultural area. The principal crops cultivated are maize, rice, beans, pigeonpea, cassava and sweet potatoes. Further, onion, bananas and plantains, tomato, tobacco, potato, groundnut, carrot, chilli pepper and pumpkins are cultivated. With regard to perennial crops coffee and avocado are dominant but, among others, also mangoes, oranges, lemons and passion fruit are cultivated.
In the lower part of the watershed, the production is more intensive than in the higher zones, 72% of the production is done with irrigation, and the farmers use tractors. In the upper and mid part of the watershed, rainfed production is predominant and oxen are used as drought power. In general, the production in the watershed is extensive and traditional.

The proposed “Matrix”
(Strub 2001)

A principal output of the practical training was the so-called “matrix”, a framework allowing for the assessment of the SWC situation on individual farms in order to calculate incentives to be provided. To assess the situation, each farm has to be visited and fully described. Points are distributed as follows (see figure 1):

For every tarea ¹ with an SWC technique implemented, or every dispersed tree, or every 10 meters of terraces or living and dead bunds, the farm gets the points noted in the matrix. Because the effect of a SWC measure depends especially on the particular circumstances of the plot it is used on, the points per tarea vary depending on the grade of the slope, the soil type, annual average rate of precipitation and, eventually on a special situation of the field.

Fig 1: The "matrix" of the eco-bonus proposal is a point scheme for calculation of incentives according to the SWC situation on individual farms.

<table>
<thead>
<tr>
<th>Measure Area</th>
<th>Wood</th>
<th>Agroforest system</th>
<th>Perennial crops</th>
<th>Pasture</th>
<th>Fallow</th>
<th>Minimum tillage</th>
<th>Fruit trees</th>
<th>Terraces</th>
<th>Tana without plants</th>
<th>Tana with plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4%</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4-8%</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8-16%</td>
<td>10</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>16-32%</td>
<td>40</td>
<td>15</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>32-40%</td>
<td>50</td>
<td>20</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 40%</td>
<td>60</td>
<td>25</td>
<td>15</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

| Neiba national park | 30 | 5 | 3 | 1 | 2 | 1 | 3 | 2 | 2 | 2 |
| near water source | 30 | 5 | 3 | 1 | 2 | 2 | 5 | 3 | 3 | 3 |

| Position soil: | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 1 | 1 |
| sandy a | 3 | 3 | 3 | 3 | 3 | 3 | 0 | 2 | 2 |
| clay or stony | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |

| Precipitation | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| (<1,000mm) | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 1 | 1 |
| (1,000-1,500mm) | 3 | 3 | 3 | 3 | 3 | 3 | 0 | 2 | 2 | 2 |

Source: Strub 2001

¹ one tarea is a unit of square measure and equals ~1/16 ha
After assigning each tarea a certain score according to the Matrix, additional points can be added concerning the type of the production system of the whole farm, e.g. for integrated pest management (figure 2).

Fig. 2: Extrapoints for production measures or education of the farmer

<table>
<thead>
<tr>
<th>integrated pest management</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>participation in POSTCOSECHA</td>
<td>200</td>
</tr>
<tr>
<td>participation in FORJA</td>
<td>500</td>
</tr>
<tr>
<td>no &quot;slash and burn&quot;</td>
<td>500</td>
</tr>
<tr>
<td>participation in PROMESA</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: STRUB 2001

Finally to adjust the payment socially, we multiply the points with factors depending, e.g., on the total area of the farm, the family size, etc. (figure 3).

Fig. 3: Social adjustment with multiplication factors

<table>
<thead>
<tr>
<th>production system</th>
<th>production zone</th>
<th>share of the non farm income</th>
<th>family size</th>
<th>total farm land</th>
<th>factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>&gt;30%</td>
<td>1-4 p</td>
<td>&gt; 100 ta</td>
<td>X 0.9</td>
<td></td>
</tr>
<tr>
<td>not organic</td>
<td>medium</td>
<td>10 - 30%</td>
<td>5-7 p</td>
<td>50 - 100 ta</td>
<td>X 1</td>
</tr>
<tr>
<td>organic</td>
<td>high</td>
<td>-10%</td>
<td>8-12 P</td>
<td>15 - 50 ta</td>
<td>X 1.1</td>
</tr>
</tbody>
</table>

Source: STRUB 2001

The evaluation of the points is done every year for each farm, in order to see whether the situation gets better or worse. We can presuppose that as long as the farmer receives an incentive he probably will maintain the SWC structures.

Advantages of this approach are that it is the farmer who takes the decisions on which technique he wants to implement and through what measures he wants to get points. To make appropriate decisions, the farmer has to learn what options might be suited. Thus, the farmer has to get informed, and the technicians have to go to all the farms and make a plan of each farm, which is an additional advantage of this approach.

Disadvantages of the approach include the susceptibility to corruption, the relatively complicated calculation of the eco-bonus payments, some insecurity about definitions and the fact that most of the farmers not really know how much land they have. Another major disadvantage of the whole eco-bonus approach is the dependability on external payments.
1.2 Rationale

During the practical training in the Macasías Watershed Project in the southwest of the Dominican Republic we were confronted with the problem on how to estimate the value of a SWC measure for a given area. A framework allowing for the identification and valuation of suited SWC options would have helped a lot in scoring SWC measures for the calculation of incentives. WOCAT could provide solutions for the difficulties encountered. It could assist in evaluating the value and effect of a specific SWC measure in a given situation, and in defining a menu of measures, which are practicable under the given circumstances.

The objective of the thesis presented here is to develop and describe an analytical framework for assessing options of SWC measures. This framework for thought shall allow the identification and valuation of best-bet options with regard to the local context. The system for eco-bonus payments to farmers in the San Juan und Elias Piña provinces in the Dominican Republic may thus be based on a broadened identification of potentially suitable technologies and a sound analysis of their appropriateness in the area. Further, WOCAT shall be used to identify and valuate appropriate technologies, and its value in facilitating this task shall be assessed.

Both, the identification of SWC technologies for specific conditions as well as their valuation with regard to a given environment, will not only benefit the Macasías Watershed Project but also other projects dealing with Soil and Water Conservation.

1.3 WOCAT

(LINIGER et al. 2002, WOCAT 2000)

In this report the WOCAT databases serve as one of the main data sources, and play an important role in the “framework for thought in technology finding” elaborated and presented in this study for SWC technology identification and valuation. For this, the WOCAT network is now presented.

The WOCAT network

In 1992 during the ISCO Conference in Sidney the “World Overview of Conservation Approaches and Technologies” (WOCAT) was initiated. It is a network of Soil and Water Conservation specialists with the aim to share experience. Since then several workshops, meetings and reports have allowed to develop and build the WOCAT network and tools (WOCAT 2002a). The WOCAT network is based on the principle of open sharing of information. It is organised as a consortium of national and international institutions and operates in a decentralised manner. This means that it is carried out through initiatives at
regional and national levels, with backstopping from experienced members of the consortium.

Fig. 4: The WOCAT process and tools

![The WOCAT process and tools](image)

**Source:** WOCAT 2000

WOCAT offers services to different target groups, which include SWC specialists, national and regional SWC institutions, planers and decision-makers, and the donors of SWC projects.

**Benefits of WOCAT for the different stakeholders:**

- What does WOCAT offer to SWC specialist, extension workers and technicians:
  - a method for documenting, evaluating and monitoring their own experience in SWC
  - information on SWC approaches and technologies world-wide in books, maps and digital format
  - comprehensive information about the biophysical and socio-economic context of SWC
  - SWC options, including their potentials and limitations
  - contacts and information exchange around the globe
What does WOCAT offer to national and regional SWC institutions, planners and decision-makers:
Tools that can be used to learn from existing experiences and avoid mistakes and duplication through:
- an information management system containing a database to document, store, analyse and disseminate SWC activities
- an instrument for evaluating and monitoring on-going activities
- a decision support system for making appropriate plans
- a network enabling the sharing of experiences at national and international levels
- educational tools (extension, training, instruction).

What does WOCAT offer to donors:
Tools and outputs that assist in:
- decision-making for investments
- monitoring the efficiency and effectiveness of investments in SWC (impacts and better returns)
- capacity building of national and regional SWC expertise
- evaluating the contribution of SWC towards overall goals, such as poverty alleviation and sustainable development.

WOCAT is now running about for ten years, the network and the databases have been developed, and quite some experiences have been gathered. WOCAT has been evaluated internally and by external experts. LINICER et al. (2002) summarise the experience with WOCAT during the last ten years as follows:

For the WOCAT Network:

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>- a decentralised structure</td>
<td>- individuals leave institutions, which requires re-establishing a personal link to the institution</td>
</tr>
<tr>
<td>- personal and institutional commitment</td>
<td>- limited funding for global (core) activities</td>
</tr>
<tr>
<td>- free/open access to tools, data and outputs</td>
<td>- national/regional programmes need additional funding</td>
</tr>
<tr>
<td>- sharing resources</td>
<td>- low capacity to run WOCAT at national/ regional level</td>
</tr>
<tr>
<td>- no competitive but complementary</td>
<td></td>
</tr>
<tr>
<td>- non political</td>
<td></td>
</tr>
<tr>
<td>- annual workshops and steering meetings</td>
<td></td>
</tr>
</tbody>
</table>
For the WOCAT methods, tools and outputs:

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>- work at field level, national level and global level</td>
<td>- demanding data collection (case studies and maps) for practitioners (use for self-evaluation, training)</td>
</tr>
<tr>
<td>- considers both socio-economic and ecological aspects</td>
<td>- low quality of some data</td>
</tr>
<tr>
<td>- fills a gap (national and global) in documentation and exchange</td>
<td>- problems in using the tools (need for training)</td>
</tr>
<tr>
<td>- sets global standards: methods, tools, outputs</td>
<td>- challenge still ahead: use in the field and at planning level</td>
</tr>
<tr>
<td>- brings practitioners, researchers and planners together</td>
<td>- provide tools and a platform</td>
</tr>
</tbody>
</table>

The WOCAT Database

The main output of WOCAT is a Microsoft Access 97 based database. This database consists of three main databases. The first one describes various SWC technologies, the second includes approaches and the third maps. Additionally an address database of resource persons and institutions and an image database with photos and drawings were set up.

Structure and use of the database are well documented in the brochure “How to use WOCAT”, also available on the WOCAT homepage [http://www.wocat.net](http://www.wocat.net) (WOCAT 2002a).

The WOCAT tools

The framework provided by WOCAT to analyse and evaluate SWC measures consists of three questionnaires.

1. Questionnaire on SWC Technologies
2. Questionnaire on SWC Approaches
3. Questionnaire on SWC Map

These three questionnaires complement each other. The questionnaire on SWC Technologies addresses the questions: what are the specifications of a specific technology and where is it used (natural and human environment)? It has got three main parts:

1. General information
2. Specification of SWC Technology
3. Analysis of the SWC Technology
For each completed Technology questionnaire there is a corresponding Approach questionnaire to fill out. The questionnaire on SWC Approaches addresses the questions: how was implementation achieved and who achieved it. It has three main parts:
1. General information
2. Specification of SWC Approach
3. Analysis of the SWC Approach
For each major SWC Technology that was used under the SWC Approach, you need to fill out a SWC Technology questionnaire.

The questionnaire on the SWC Map addresses the question: where do problems and their treatments occur. It is split up into:
1. General information
2. Land use
3. Soil degradation
4. Soil and water conservation
5. Soil productivity
The information obtained from the three questionnaires will provide an information base/database for the development and evaluation of SWC. The analysis and evaluation process is based on this information and the knowledge provided by core groups of SWC specialists and the world community of SWC implementers at large.

2 Material and Methods

The “framework for thought in technology finding” and the technology menu presented here are the result of an intense process. Frameworks for thought, developed for other purposes where consulted. The issue of finding appropriate technologies was discussed with experienced persons, and literature dealing with this issue was consulted. A mayor difficulty consisted in compiling and prioritising all this information, and in particular in developing the “framework for thought in technology finding”. Many different frameworks were elaborated, problematic ones rejected, and, using a selection process, the present version was born. Discovering the structure and the possibilities of the WOCAT database was another important part of the thesis. Knowing the possibilities of the WOCAT database, a process was defined on how to use the database for the purpose of the “framework for thought in technology finding”.

This work is a synthesis of a literature and an Internet investigation, personal communications, personal experience and knowledge, and the work with the WOCAT database.

The literature was principally found in the Info Agrar library and on the WOCAT homepage: http://www.wocat.net.
Resource persons consulted were:

- Dr. Ch. Studer, professor for tropical crop production on the SCA Swiss College of Agriculture
- Dr. Karl Herweg, lecturer for soil and water conservation at the SCA Swiss College of Agriculture and Collaborator of the Centre for Development and Environment, Geographic institute of the university of Berne.
- Dr. H.P. Liniger ("Mister WOCAT"), collaborator of the Centre for Development and Environment, Geographic institute of the university of Berne.

3 Results

In the following, a manual-like description on how to use and apply the "framework for thought in technology finding" (Fig. 5) is provided. Further, the framework is used to identify a suitable SWC technology menu for the Macasías Watershed Project, hereby demonstrating and testing the approach at a concrete example. The red arrows in figure 5 shell help to follow the explications.

3.1 Framework for thought in technology finding

To define a framework that is able to include all aspects of a complex issue like action for SWC, the framework has to be open. The presented framework is a flow-chart diagram including various "yes" or "no" decisions. It is important to realise that this "black and white" vision in most of the cases is not appropriate; decisions have to be taken in a more qualitative way, e.g. "yes is more appropriate than no". The process of going through the framework, being aware of each step, is as important as the result.
Fig. 5: Framework for thought in technology finding

A participatory problem definition process.

Is there a need for SWC measures?

Is it feasible to implement SWC technologies?

What exactly is the problem? (Narrower definition)

Are there appropriate measures being used in the area?

The corresponding technology menu (Annex 2)

Experts pre-selection using WOCAT

Farmers choice

Participatory: -Adaptation -Improvement -Development

Analysis of the effect of the implemented technology

Implementation in farmers' fields

Comparison with expert knowledge

Choice of an approach (WOCAT)

Eventually, trails

1. Check the indicators of the need for SWC (Table 2)

2. Check the indicators of the feasibility of SWC (Table 3) and/or the WOCAT database.

3. What exactly is the problem? (Narrower definition)

4. Why is it not feasible?

5. Are there appropriate measures being used in the area?

6. The corresponding technology menu (Annex 2)

7. Analysis of the effect of the implemented technology

* Wt = loss of topsoil by water
  Wg = gully erosion
  Wm = mass movements
  Wr = riverbank-/coastal erosion
  Et = loss of topsoil by wind
  Ed = deflation
  Cn = fertility decline/ reduced organic matter content (leaching, soil mining)
Participatory problem definition

(⇐1)

The whole process begins with a participatory problem identification. The local people and the farmer are included in this step. The Soil and Water Conservation (SWC) effort would not be sustainable if problems were addressed which the local people do not recognise as a problem of high priority, i.e. if they have other more urgent problems. In participatory actions the SWC experts have got the chance to learn about the views and perceptions of the local people and the locals might learn something about erosion problems.

The need for a SWC measure

(⇐2)

In search of an appropriate SWC measure it should be evaluated if and to what extent the specific piece of land does really improve through the implementation of erosion control measures. Many SWC projects do not reach their aims, or implement measures that are not sustainable, because they are promoted or implemented where there is no need (HERWEG 2002). This means that we are the most effective when the hot spots are treated first. Indicators of the need for SWC and what they signify are presented in table 2 (HERWEG et al. 1998):

Table 2: Indicators for the need for SWC measures

<table>
<thead>
<tr>
<th>Climatic data</th>
<th>Test plot data, erosion modelling or field estimates</th>
<th>Catchment data or other hydrological off-side information</th>
</tr>
</thead>
<tbody>
<tr>
<td>rainfall</td>
<td>runoff</td>
<td>river discharge</td>
</tr>
<tr>
<td>erosivity</td>
<td>soil loss</td>
<td>off-side sediment concentration</td>
</tr>
<tr>
<td>shortage of rainfall</td>
<td></td>
<td>quality</td>
</tr>
<tr>
<td>variability of rainfall</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

leads to

<table>
<thead>
<tr>
<th>Climatic erosion hazard</th>
<th>On-site erosion hazard</th>
<th>Off-side erosion hazard: possible impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>water erosion hazard</td>
<td>excess of surface water</td>
<td>flash floods, water shortage</td>
</tr>
<tr>
<td>potential of the rain causing soil erosion</td>
<td>quantity of soil transported</td>
<td>sedimentation of dams, water</td>
</tr>
<tr>
<td>moisture deficiency</td>
<td>downslope by water</td>
<td></td>
</tr>
<tr>
<td>moisture deficiency</td>
<td>water quality</td>
<td></td>
</tr>
</tbody>
</table>

Source: HERWEG et al. 1998
The feasibility of a SWC measure

After assessing the necessity for SWC measures, the feasibility of implementation has to be examined. This can be achieved by analysing the limiting factors and the potentials of the area. HERWEG et al. (1998) defined the following indicators:

Table 3: Limiting factors for SWC technologies implementation

<table>
<thead>
<tr>
<th>Limiting factors</th>
<th>expected limitations for biological SWC</th>
<th>expected limitations for mechanical SWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>shortage of rainfall</td>
<td>limited plant growth and variety</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>due to limited water availability</td>
<td></td>
</tr>
<tr>
<td>variability of rainfall</td>
<td>insecure plant grow due to</td>
<td>difficult balance between water</td>
</tr>
<tr>
<td></td>
<td>insecure water availability</td>
<td>conservation and runoff control</td>
</tr>
<tr>
<td>excess rainfall</td>
<td>possibly insufficient runoff control</td>
<td>difficult runoff control</td>
</tr>
<tr>
<td></td>
<td>by biol. SWC</td>
<td></td>
</tr>
<tr>
<td>temperature</td>
<td>limited plant growth and variety</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>due to frost, water deficiency</td>
<td></td>
</tr>
<tr>
<td>topography</td>
<td>steep slopes often indicate</td>
<td>steep slopes indicate high costs</td>
</tr>
<tr>
<td></td>
<td>shallow soils and limited plant</td>
<td>irregular slope shape indicates</td>
</tr>
<tr>
<td></td>
<td>growth</td>
<td>difficult and expensive layout of</td>
</tr>
<tr>
<td></td>
<td>flat slopes often indicate</td>
<td>drainage system</td>
</tr>
<tr>
<td></td>
<td>waterlogging or low soil quality</td>
<td>flat slopes indicate waterlogging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and drainage problems</td>
</tr>
<tr>
<td>soils</td>
<td>shallow soils indicate limited</td>
<td>shallow soils indicate problems</td>
</tr>
<tr>
<td></td>
<td>plant growth</td>
<td>during the establishments of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mechanical SWC and reduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>crop yield below the terrace and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>limited terrace development</td>
</tr>
<tr>
<td>expected yield reduction</td>
<td>competition with crops for light,</td>
<td>loss of productive are due to</td>
</tr>
<tr>
<td></td>
<td>water, nutrients</td>
<td>narrow terrace spacing and side</td>
</tr>
<tr>
<td>negative experience SWC approach</td>
<td>superimposed SWC like closed area</td>
<td>effects (waterlogging)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>superimposed terracing and waterways</td>
</tr>
</tbody>
</table>

General socio-economic limitations

<table>
<thead>
<tr>
<th>Limitation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>farm size</td>
<td>labour requirement, economic/ uneconomic conditions</td>
</tr>
<tr>
<td>land security</td>
<td>helpful condition for on-farm investment</td>
</tr>
<tr>
<td>access to market</td>
<td>availability of agricultural inputs, acceptance to produce more or different goods on farm</td>
</tr>
<tr>
<td>off-farm options</td>
<td>economic security, possible acceptance of further on-farm investment</td>
</tr>
</tbody>
</table>

Potentials

<table>
<thead>
<tr>
<th>Potential</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>expected economic return</td>
<td>return on investment in SWC and acceptance of a SWC</td>
</tr>
<tr>
<td>soil loss reduction</td>
<td>basic desirable impact of SWC</td>
</tr>
<tr>
<td>runoff control</td>
<td>basic desirable impact of SWC in sub-humid areas</td>
</tr>
<tr>
<td>moisture conservation</td>
<td>basic desirable impact of SWC in semi-arid areas</td>
</tr>
</tbody>
</table>

Source: HERWEG et al. 1998
In many cases, limiting factors are difficult to assess. Especially the analysis of socio-economic limitations may cause difficulties. It is, however, important that possible limiting factors are considered in the selection of technologies. Browsing the WOCAT databases for experiences with particular SWC technologies in other projects and environments allows the identification and consideration of potential limitations and effects of the SWC technologies envisaged.

It may occur that the need for implementing SWC measures is identified and recognised, but the feasibility of their implementation is uncertain. In that case, the problem(s) with regard to feasibility should be solved prior to continuing the process.

**Narrower definition of the SWC hazard**

(⇐4)

Once a SWC problem is identified and recognised by the farmer, the SWC specialist and (eventually) a sponsor or donor, and if a solution seems feasible, then the problem has to be defined more in depth in order to identify the appropriate measures for SWC under the prevailing conditions. Further it has to be checked if there are already measures to solve the identified problem applied in the area. If there is a problem, the farmers are often aware of it, and indigenous solutions may have been developed (HERWEG 2002). Such indigenous measures can be used directly or may be developed further and adapted according to expert knowledge.

**The technology menu**

(⇐5)

If no indigenous solution to the identified problem can be found or the existing ones seem not appropriate, a menu of possible solutions has to be developed. To identify SWC technologies with a high probability to solve specific problems, a classification of such measures according to their nature (or type) and the specific hazard they prevent is necessary. A SWC technology consists of one or more measures belonging to the following categories:
- agronomic (e.g. intercropping, contour cultivation, mulching),
- vegetative (e.g. tree planting, hedge barriers, grass strips),
- structural (e.g. graded banks or bunds, level bench terrace),
- management (e.g. land use change, area closure, rotational grazing).

Combinations of the above measures, if they are complementary and thus enhance each other, may improve the value of a SWC technology (WOCAT 2002c). The four main categories of conservation measures include the following sub-categories (after WOCAT 2002b):
- **Agronomic measures**
  - Vegetation / soil cover / alignment
  - Organic matter / soil fertility
  - Soil surface / subsurface
  - Subsurface treatment

- **Vegetative measures**
  - Trees and shrubs cover
  - Grasses and perennial herbaceous plants

- **Structural measures**
  - bench terraces
  - channel terraces
  - bunds / banks
  - graded ditches, waterways
  - level ditches, pits
  - level ditches, pits
  - reshaping surface (reducing slope, …) / top soil retention (e.g. in mining storing top soil and re-spreading)
  - Walls, barriers, palisades
  - others

- **Management measures**
  - Land use systems change
  - Change of management / input level
  - Land use plan and layout according to natural and human environment
  - Major change in timing of inputs
  - Control / change species composition

For the complete classification system used in WOCAT see Annex 1.

In the “framework for thought in technology finding”, the technologies have to be categorized according to the damage they prevent. Seven categories are distinguished:

- Wt = loss of topsoil by water
- Wg = gully erosion
- Wm = mass movements
- Wr = riverbank-/coastal erosion
- Et = loss of topsoil by wind
- Ed = deflation
- Cn = fertility decline/ reduced organic matter content (leaching, soil mining)

Annex 2 lists SWC technologies classified this way. The technologies are still described very generally, since it is a large list of technologies. From this list, the SWC expert can make a pre-selection of SWC technologies that have a high probability to solve the identified problems. The SWC expert should also start defining the selected technologies more in detail. For this process the WOCAT database is helpful: Technologies may be selected and described best performed under similar conditions.
After the selection process, still a handful of options should be left, preferably technologies of different nature or type, i.e. agronomic, vegetative, structural and management measures. The farmer should not be confronted with only one single recommendation, but should be able to choose from a menu of a few possible SWC measures according to his preferences and capacities.

Thus, the further choice is at farmer’s level. The farmer decides which technology he is willing to use, and he can also design on his own the details of the measure he is going to implement. The SWC experts should be present to give advice.

If a handful of possibilities are chosen by the SWC expert, he has to consider that every farmer’s situation is unique and may vary a lot from one farmer to another. Important factors influencing the suitability of a measure of technology for specific farmers include:
- land tenure
- wealth
- motivation of the farmer
- personal view and preferences of the farmer
- situation of his/her land (fertility, slope,...)
- education
- . . .

A farmer who does not own land will usually prefer agronomic measures; these measures do not need a high investment. A landowner may prefer structural measures that raise the value of his land, he will more invest more in the land that he owns. Every farmer will implement or deal with measures that seem to be the best solution for the given circumstances. The farmers will also adapt measures to their own needs (HERWEG 2002). Even within the same area, the needs and possibilities of individual farmers and their preferences may vary considerably.

Choice of an approach

The success or the failure of a technology may also depend on the approach that is used to implement and promote the technology. A SWC approach defines the way and the means that are used to realise and support a SWC technology in achieving more sustainable soil and water use (WOCAT 2002c), i.e. how was implementation achieved and who achieved it. Elements of a SWC Approach include: all stakeholders (policymakers, administrators, experts, technicians and users, i.e. actors at all levels), inputs and means (financial, material, legislative, etc.), and know-how (technical, scientific, practical). An approach may include different levels of intervention, from the individual farm, through the community level, the extension system, the regional or national administration, or the policy level to the international framework.

Difficulties may arise with regard to the interpretation of the term “approach”. Not all the stakeholders of a project interpret the term in the same way. Often the “approach” is roughly defined by the philosophy of the organisation that
implements SWC measures, and is influenced by the way of thinking and by current trends. In this work and in the “framework for thought in technology finding” the term “approach” is used in a narrower sense: i.e. it defines by whom and by what means a SWC technology is promoted and implemented, and may include:

- Food for work
- eco-bonus
- cascade approach (BRANDENBERGER 2001)
- distribution of seedlings
- etc.

Different approaches may be combined; this can further complicate the understanding of the term “approach”. Two main categories of approaches may be distinguished: approaches that use incentives and the ones that don’t. In spite of the fact that incentives in general do not yield sustainable results they are still widely used (GiGER 1999).

In selecting an appropriate approach, the WOCAT database may provide ideas on what kind of approaches exist, and information on success and performance of different approaches as well as reasons for that.

**The participatory monitoring, adaptation and development cycle**

At the end of the “framework for thought in technology finding” stands the monitoring, adaptation and development cycle. The process of identifying suitable SWC technologies does not end with the implementation of a SWC measure in the field but enters at this point a cycle of improvement, adjustment and further development. Within this cycle after the implementation, the impact of a SWC technology is monitored, its effect analysed and the technology is adapted, improved and further developed. The chosen technologies should enter the same process of monitoring, development and evolution like an indigenous technology would.

By filling out the WOCAT questionnaires, a project can use standardised tools to analyse and document the experiences made, and to share them with the world community. The process of assessment and improvement has to be done together with the land user.
3.2 Applying the framework to the Macasíás Watershed Project

The “framework for thought in technology finding” was applied to the Macasíás Watershed Project to check if the framework and the WOCAT database are ready to use. Although the project is already running, an extended list of adequate SWC technologies might add additional benefit to it.

The whole area of the Macasíás Watershed Project is large and heterogeneous. In this study, the “framework for thought in technology finding” is therefore only applied to a restricted part of the Macasíás Watershed Project zone, the upper zone. This is the zone where the project is the most active and the problems are the most urgent. Helvetas started the Macasíás Watershed Project together with local people. The project was designed and the problems where identified in a participatory way in a workshop (⇒1).

In the Macasíás watershed the need to implement SWC measures is given by the climatic conditions and the steep slopes that trigger soil erosion. The soil loss and off-side effects are evident, and drying up of water sources becomes a bigger problem every year. The fact that the Macasíás river is so important for Haiti accentuates need to save the water of this river and to keep it clean. A further reason to implement SWC in the Macasíás watershed is the existence of the Neyba national park and the need to stop the expansion of farmland into the national park territories (⇒2).

Analysing at the feasibility of implementing SWC measures, we found the following constraints (⇒3):

- variability of rainfall: might difficult implementation of agronomic SWC measures, makes more difficult the growth of vegetative SWC measures
- topography: steep slopes: might difficult the implementation of structural SWC measures
- expected yield reduction: reduces the acceptance of a SWC measure by the farmer
- land security: untitled land, illegally used land of the Neyba national park: Farmers wont invest in land they do not own
- negative experience: that some farmers might have made with the actual project or with others projects

On the other hand, we also identified potentials:

- expected economic return: some SWC measures are promising high economic returns (BRANDENBERGER, 2001)
- soil loss reduction: it can be expected that the implemented SWC technologies reduce the soil loss by erosion
- run-off control: the SWC measures implemented in fields reduce the run-off problems

Assuming that feasibility is given, the SWC problem is defined in more detail (⇒4).

After HELVETAS (1998), the main SWC problems are:

- loss of top soil by water
- deforestation, dry out of water sources
- fertility decline and reduced organic matter content
The Macasías Watershed Project is working on these problems, on the fertility decline with the promotion of good agricultural practices (earthworm cultures, alternatives to burning,...), on the deforestation with communal woodland plots and distribution of tree seedlings. In this report the main emphasis shall be put on the loss of topsoil by water.

If a serious feasibility problem was identified, the WOCAT database could be used to search for examples with the similar constraints. WOCAT can thus assist in identifying possibilities to overcome the problem of feasibility. In the case of the Macasías Watershed Project this was not necessary; none of the identified constraints should seriously restrict the feasibility of implementing SWC measures.

A selection of potential SWC measures from Annex 2 according to the experiences made in the Macasías Watershed Project yielded the following list:

Table 4: A list of SWC measures selected using the “framework for thought in technology finding” for the Macasías Watershed Project

<table>
<thead>
<tr>
<th>agronomic measures</th>
<th>vegetative measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Better soil cover by vegetation</td>
<td>- Dispersed trees/ shrubs</td>
</tr>
<tr>
<td>- Contour planting</td>
<td>- Aligned trees (live fences, hedges, hedgerows, alley cropping)</td>
</tr>
<tr>
<td>- Cover cropping</td>
<td>- Trees/ shrubs in blocks</td>
</tr>
<tr>
<td>- Retaining more vegetation cover</td>
<td>- Dispersed grass</td>
</tr>
<tr>
<td>- Temporary trashlines</td>
<td>- Aligned grass strips (on contour, graded, along perimeter, linear)</td>
</tr>
<tr>
<td>- Green manure</td>
<td>- Grass in blocks</td>
</tr>
<tr>
<td>- Applying organic fertiliser</td>
<td></td>
</tr>
<tr>
<td>- Conservation tillage</td>
<td></td>
</tr>
<tr>
<td>- Contour ridging</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>structural measures</th>
<th>management measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Bench terraces on level</td>
<td>- From crop to grazing land</td>
</tr>
<tr>
<td>- Forward sloping bench terraces</td>
<td>- Exclusion of natural waterways and hazardous areas</td>
</tr>
<tr>
<td>- Backward sloping bench terraces</td>
<td>- Land preparation timing change</td>
</tr>
<tr>
<td>- Levelled channel terraces</td>
<td>- Planting-time change</td>
</tr>
<tr>
<td>- Graded channel terraces</td>
<td></td>
</tr>
<tr>
<td>- Levelled bunds/ banks</td>
<td></td>
</tr>
<tr>
<td>- Graded bunds/ banks</td>
<td></td>
</tr>
<tr>
<td>- V-shaped bunds/ banks</td>
<td></td>
</tr>
<tr>
<td>- Trapezoidal bunds/ banks</td>
<td></td>
</tr>
</tbody>
</table>

In this step of the “framework for thought in technology finding”, WOCAT can be used to search for potentially suitable technologies. The WOCAT database includes a search frame (Fig. 4) allowing for the choice of relevant criteria from a list.
In order to check good and bad experiences with potentially suited technologies, data files from projects in comparable conditions were searched and consulted. The search criteria that were used are listed in Annex 3.

These database searches yielded 56 results. To narrow down the number of potentially suitable technologies, two key factors available on the database were analysed in a further step:

1. The economic benefits/disadvantages (questions 3.4.1 to 3.2.8 in the technology questionnaire (WOCAT 1998), referring to changes in production value and benefits versus investment and maintenance costs).

2. The acceptance or adoption of the SWC measures (questions 3.4.1 to 3.4.3 in the technology questionnaire (WOCAT 1998), referring to adoption with and without incentives, adoption trends, and maintenance).

The analysis of these two key indicators was rather difficult, particularly because there are a lot of data missing in the database, probably because the questionnaires where not completed for these indicators. To select potential technologies for the Macasías Watershed Project, the ones which showed promising notations in both indicators where retained, yielding a list of eight promising technologies:
COL1: Manejo ecologico de laderas  
COL2: Silvoagricultura  
MAL3: Trash lines  
tha15: Rice terraces  
tha17: Integrated conservation system  
UGA1: Contour Vetiver planting  
ZIM2: Infiltration pits  
RSA3: Stone Bunds/ Stone terrace walls

Detailed information on these technologies is provided in Annex 5 or may be found on the WOCAT CD-ROM.

In these eight cases of described SWC technologies, the following SWC measures are used:

**Agronomic:**  - Crop rotation  
**Vegetative:**  - Agroforestry  - Alley cropping  - Contour planting of grass stripes

**Structural:**  - Stone bunds  - Infiltration Pits  - Trash lines  - (Rice) terraces  - Terraces

**Management:**  - none

The combination of these results from the search within the database and the list developed in step 5 according to the “framework for thought in technology finding” (Tab. 4) allows designing a final menu of proposed SWC measures for the selected area in the Macasías Watershed Project. Both results and the knowledge of the SWC expert are combined. This yields the following possible menu of SWC technologies for the Macasías Watershed Project (the SWC measures written in bold are the ones that occur in both lists):

**Agronomic:**  -Better soil cover by vegetation  -Contour planting  -Cover cropping  -Retaining more vegetation cover  **Temporary trashlines**  -Green manure  -Applying organic fertiliser  -Conservation tillage  -Contour ridging

**Vegetative:**  -Dispersed trees/ shrubs  -Aligned trees (live fences, hedges, hedgerows, alley cropping)  -Trees/ shrubs in blocks  -Dispersed grass  -Aligned grass strips (on contour, graded, along perimeter, linear)  -Grass in blocks

**Structural:**  -Bench terraces  -Channel terraces  -**Bunds/ banks**
Management

- from crop to grazing land
- Exclusion of natural waterways and hazardous areas
- land preparation timing change
- Planting-time change

Identification of promising approaches

To get a selection of approaches for defined purposes, indicators can be selected in the search frame of the WOCAT approach database. The search result is a list of files that fulfil the criteria. The files on this list can be checked for advantages and disadvantages, for constraints and threats related to the described approach (⇐ 6).

Using the search criteria listed in Annex 4, the following ten approaches were found potentially suitable for the Macasías Watershed Project:

CHN11: Comprehensive adminiser in Songxi watershed of Pucheng County
CHN12: Comprehensive development and management of small watershed, interplant intercrop
COL01: Desarrollo a escala humana
COL02: Desarrollo Rural Integral Comunitario
KEN06: Catchment approach - for grass strips in Kiambu
NIC03: Enfoque comunitario participativo
PHI4: LANDCARE
RSA34: Clearing of invasive alien plants
RSA5: Pilot government incentive
THA01: Vegetative erosion control and conservation cropping system

More information about these ten datasheets can be found in Annex 6. However, not all of these datasheets describe an approach in the sense the term is used in the “framework for thought in technology finding”.

Different approaches can be combined if they do not compete with each other. Presently, the Macasías Watershed Project is working in the SWC part with an eco-bonus approach and a farmer-to-farmer extension approach combined. Based on the list of the ten WOCAT data sheets and additional information (BRANDENBERGER 2001, STRUB 2001), the following list of approaches can be recommended for the Macasías Watershed Project:

- Provision of inputs (fertiliser, advice, etc.) upon implementation of SWC technologies (COL02)
- Catchment approach (KEN06), i.e. concentrating the efforts in a focal area for one year.
- Landcare approach (PHI4): an association of farmers (Landcare) enhancing camaraderie and encouraging group decisions on matters relating to SWC
- “Pilot government incentive” approach (RSA5): working with a group of 14 volunteer farmers. Advice, training, provision of material by the project
- “Vegetative erosion control and conservation cropping system” approach (THA01): farmers get farm inputs and wage for doing SWC work. At the same time extension workers provide farmers with training
- Cascade approach (BRANDENBERGER 2001): one initial farmer out of a community gets the money to implement SWC technologies on his plots. Then he has to work for the value of the money received for another farmer implementing SWC technologies.

**New punctuation of the Matrix**

The intensive work with the WOCAT database and consultation of relevant literature did not yield any reasons for changing the punctuation of the matrix for calculation of eco-bonus payments to farmers as proposed by STRUB (2001). With an improved, extended WOCAT database it may however become possible to find reasons to adapt the punctuation.

However it is recommended to drop the criteria related to soil type and precipitation in the matrix. Both, soil type and precipitation did not exert significant influence on the final punctuation. Further, it is difficult to estimate the soil type and the rainfall for a specific field. In order to make the procedure less complicated it is suggested to delete this part from the matrix.

Fig 6: The new matrix for calculation of incentives according to the SWC situation on individual farms

<table>
<thead>
<tr>
<th>technic</th>
<th>per area</th>
<th>per tree</th>
<th>per 10 meters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>forest</td>
<td>agroforesta</td>
<td>perennial</td>
</tr>
<tr>
<td>0-4%</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4-8%</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>8-16%</td>
<td>10</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>16-32%</td>
<td>40</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>32-40%</td>
<td>50</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>&gt; 40%</td>
<td>60</td>
<td>25</td>
<td>15</td>
</tr>
</tbody>
</table>

Neiba national park

<table>
<thead>
<tr>
<th>field</th>
<th>per tarea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neiba national park</td>
<td>30</td>
</tr>
<tr>
<td>spring zone</td>
<td>30</td>
</tr>
</tbody>
</table>

With regard to the additional points, some changes are suggested, considering recent recommendations (CECCHINI 2001).

Fig 7: New extrapoints for production measures or education of the farmer

| integrated pest management | 300 |
| participation in other projects or courses (farmer's will for education) | 300 |
| no "slash and burn" | 500 |
| agronomic SWC measures | 300 |
Helvetas projects are no longer preferred to other projects, i.e. POSTCOSECHA, FORJA and PROMESA are now included in “participation in other projects or courses (farmers will for education)”. Further, agronomic SWC measures are now considered as well in the procedure.

For the last element of the Matrix system (social adjustment with multiplication factors), it was proposed to change the multiplication factors (LININGER 2002, CECHIN 2001): Instead of multiplying the final score by 1.1, 1.0, and 0.9, it was suggested to use the factors 1.5, 1 and 0.5, respectively (see fig 8).

Fig 8: Social adjustment with new multiplication factors

<table>
<thead>
<tr>
<th>production system</th>
<th>production zone</th>
<th>share of the non farm income</th>
<th>family size</th>
<th>total farm land</th>
<th>factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>&gt;30 %</td>
<td>1-4 p</td>
<td>&gt; 100 ta</td>
<td>X 0.5</td>
<td></td>
</tr>
<tr>
<td>not organic</td>
<td>medium</td>
<td>10 - 30%</td>
<td>5-7 p</td>
<td>50 - 100 ta</td>
<td>X 1</td>
</tr>
<tr>
<td>organic</td>
<td>high</td>
<td>-10%</td>
<td>8-12 P</td>
<td>15 - 50 ta</td>
<td>X 1.5</td>
</tr>
</tbody>
</table>

4 Discussion

4.1 Discussion of the framework

It was a long and hard process to elaborate a framework that is able to cover the whole complexity of identifying SWC technology options that suit specific conditions. Aspects that initially seemed very important, such as land tenure and climatic conditions are no more that prominent in the final product. An important element of the framework is the central role of the farmer in deciding on what technologies best suit him (the “farmers choice”). All too often external specialists attempt to put themselves in the position of “the farmers” in order to approximate potential decisions “the farmers” would make. We have to be aware of the fact, however, that "the farmers" are not a homogeneous group but represent a variety of individuals living under specific framework conditions and having their own philosophy. If farmers are left to make the decisions themselves, all the discussion and insecurity on what the farmer would decide according to his conditions and perceptions can be avoided. The role of the SWC specialists is thus more focusing on sharing his knowledge with the farmers and making them able to take a sound decision. Both, the central role of the farmer in decision-making as well as his empowerment in terms of capacity are prerequisite for really sustainable development.

The aim of the framework is not to recommend one best-suited technology as a solution. The framework rather aims at providing a menu of a few reasonable possibilities (options) that the farmer can choose from and which he can adapt according to his specific needs and capacity. The WOCAT database can help to consider other experiences. The important role of the framework lies in the process of technology identification and not in the result alone.
The technologies and approaches resulting from applying the “framework for thought in technology finding” are usually not specified in much detail. The SWC specialist and the farmer have a lot of possibilities to adapt and improve the technologies and the approaches, e.g. to choose the right plant species or the adequate material to build an SWC structure.

4.2 Discussion of the WOCAT database

We will restrict our discussion to the WOCAT databases we worked with, and not discuss the WOCAT network. We used WOCAT in view of using the databases to find a menu of SWC measures and/or approaches for a given area or project within the “framework for thought in technology finding”.

The WOCAT databases represent all in all a well working and valuable tool, they fill a real gap and correspond to a need. Especially valuable is the database on the resource persons. Because SWC is a very complex issue and it is difficult consider all aspects that might decide upon success or failure of a project, it is important to have access to contact addresses of experienced resource persons. No database can ever replace an experienced person.

Within the “framework for thought in technology finding” it is foreseen to use the WOCAT databases four times: (1) to analyse the feasibility of SWC interventions; (2) to make a pre-selection of promising technologies by a SWC expert; (3) to identify approaches which are promising sustainability; and (4) to monitor the effect and impact of the implemented SWC measures.

For extension agents, the WOCAT databases offer additional benefits, particularly in the process of selecting appropriate SWC technologies, by allowing an evaluation of advantages and disadvantages of specific technologies under different conditions. This may also be useful in the formation of extension workers.

There is already a lot of data collected, and the database gives a lot of information and is a rich pool of experiences. But the bigger the database, the more difficult it is to navigate through it, i.e. appropriate search and query tools need to be provided. For the purpose the database was used in this work, was it sometimes difficult to find the right data.

The quality of some data sheets seems to leave quite some space for improvement. Sometimes we got the impression that the person who filled out the questionnaires was rather directed by wishful thinking than by reality. This was particularly the case in the sections where the financial profitability has to be estimated. Additionally, there are a lot of gaps in some data sheets. Therefore, the pre-selection of suitable technologies has therefor to be based to a great extent on the SWC expert’s knowledge and experience, whereby the search of the database using indicators may help in decision-making.
In the section on approaches, a classification of approaches according to certain criteria (e.g. with/without incentives) would be helpful. For the purpose of searching for different options of approaches, the tools are useful; particularly the possibility to search for good or bad examples seems very valuable, a feature which is somehow lacking in the search frame of the technology database.

**Potentials of the WOCAT databases**

While using WOCAT for the “framework for thought in technology finding”, some suggestions for improvement of the WOCAT database came up, highlighting certain not used potentials of the database:

- **More Key words**
  More and more general keywords could help to find a more refined selection of SWC technologies. It is difficult to see a consistency with regard to the limited list of keywords available.

- **To put a common name in French, Spanish and English into the field “Name of the technology” according to the SWC classification system.**
  The option to use any name for any SWC technology results in the problem that, in some cases, equal technologies are registered under different names. Using the same terminology in all cases would allow to compare better equal or similar technologies under different conditions. Further it would be useful if the sheets could be ordered according to the SWC classification system. This would allow an easy comparison of different designs of equal/similar technologies and of their characteristics under different conditions.

- **In the search frame of the technology database, sections “Problems/Means”, “Measures”, “Category” and “Main means”, it might be useful to only allow keyword entries according to the WOCAT SWC technologies classification system (Annex 1).**

- **For the purpose of this work (to check the punctuation of the “Matrix”), it had been very useful to have the possibility to combine a technology with natural environmental conditions.**
  The result of such a comparison might produce a print with the average effectiveness of the technology under the chosen conditions. We assume that the needed data for this purpose are already available in the WOCAT database, and therefor the needed tools could easily be developed.

- **It may also be useful to get as search result not just a list of relevant data sheets but also, if wanted, a sort of summary of these.**
  An easy comparison of key indicators, especially the ones used as search criteria, would be particularly helpful. Further, the list of keywords describing the technologies could be expanded. This would allow selecting further if many sheets are found in a search a problem, which increases as the databank is expanding.
- It would be useful to develop a classification system for the approaches, in order to be able to put them in order. This would allow to get an overview and to make it easier to take a choice.

- Communicating well with the persons who fill out the questionnaires will allow guaranteeing the quality of the data. Improving data sheets of low quality information content may make the databases trustworthier.

### 4.3 Discussion of the approaches and the technologies for the Macasías Watershed Project

Applying the “framework for thought in technology finding” on the Macasías Watershed Project showed that it that this methodology represents a useful and functioning tool. However, the application of the framework should preferably take place in the area of concern (and not from a remote place), and should ideally be done at the beginning of a project.

The technology menu obtained by using the “framework for thought in technology finding” seems to be useful. The technologies already used in the project are all included. This means on one hand that the right technologies are propagated, and on the other hand that the framework leads to reasonable results. The menu of technologies developed in this study should encourage the project to enlarge the number of options of SWC technologies suggested to participating farmers. Further it is important to let the farmer take the decision which technology he implements. This needs a certain flexibility of the project crew and the acceptance of farmer’s decisions. The knowledge on the technologies is available in the project crew.

The list of approaches developed in this study is useful in my eyes. However, not all of the approaches included in the list can be used at the same time. Some, however, could be combined with the ones actually used, e.g. the cascade approach with the eco-bonus approach.

### 4.4 Conclusions

The “framework for thought in technology finding” presented in this thesis is a valuable tool, guiding the process of finding a menu of appropriate technology options and approaches for SWC projects. The WOCAT database represents a useful source of information that can be used within the “framework for thought in technology finding”, allowing for more success in the fight against soil degradation. However, neither the “framework for thought in technology finding” nor WOCAT can replace an experienced SWC specialist whose knowledge will still be of major importance to achieve sustainable land use practices in hilly areas.
5 References


HERWEG K., 2002. Personal communication.


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