Economic Benefits and Costs of Technologies for Sustainable Land Management (SLM): A Preliminary Analysis of Global WOCAT Data

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ABSTRACT:

The WOCAT network has collected, documented, and assessed more than 350 case studies on promising and good practices of SLM. Information on on- and off-site benefits of different SLM types, as well as on investment and maintenance costs is available, sometimes in quantitative and often in qualitative form. The objective of the present paper is to analyse what kind of economic benefits accrue to local stakeholders, and to better understand how these benefits compare to investment and maintenance costs. The large majority of the technologies contained in the database are perceived by land users as having positive benefits that outweigh costs in the long term. About three quarters of them also have positive or at least neutral benefits in the short term. The analysis shows that many SLM measures exist which can generate important benefits to land users, but also to other stakeholders. However, methodological issues need to be tackled and further quantitative and qualitative data are needed to better understand and support the adoption of SLM measures.

Keywords: Sustainable Land Management, Costs, Benefits, Technologies

1. INTRODUCTION

Costs and benefits of Sustainable Land Management (SLM) play a crucial role in the adoption and spreading of practices. But economic information on SLM practices is often very difficult to collect and usually not quantifiable – neither by local actors nor by project experts. Despite extensive experience with collecting field data, the WOCAT (World Overview on Conservation Approaches and Technologies[1]) network has also been confronted with this information gap – e.g. in the recently completed TerrAfrica[2] and DESIRE[3] projects. Moreover, the costs and benefits of often well-known technologies vary significantly depending on the economic, social, and bio-physical context. Nevertheless, donors inquire about the benefits and costs of land management investment programmes.

The objective of this paper is to better understand what kind of economic benefits of SLM accrue to local stakeholders, and how these benefits compare to investment and maintenance costs, based on an analysis of over 350 case studies of promising and good practices of SLM collected, documented, and assessed by the WOCAT network. Information on on- and off-site benefits of different SLM types, characterized mostly in non-monetary terms, and on investment and maintenance costs are available in the dataset, sometimes in quantitative and but often only in qualitative form. Acknowledging that the uptake of SLM also depends on non-economic factors, results may help to indicate whether such practices can be expected to spread by themselves (wherever the benefits outweigh the costs from the point of view of the individual land user) or whether such practices require external support to compensate for benefits that accrue to neighbours (e.g. downstream land users) or to a broader public.

2. METHODOLOGY

The paper provides a preliminary overview of information about the costs and benefits of technologies described in the WOCAT database. Systematic quantified cost-benefit analysis was not possible, as many of the datasets do not include quantitative data.

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[1] WOCAT is a consortium of national and international institutions, led by a core Management Group of CDE (Centre for Development and Environment, University of Bern), FAO (Food and Agricultural Organization) and ISRIC (World Soil Information, Wageningen). www.wocat.net

[2] TerrAfrica: http://www.terrafrica.org/

[3] Desertification mitigation and remediation of land, EU FP6 2007-2012, www.desire-project.eu

The WOCAT network collects perceived benefits of the technologies based on expert assessments and stakeholder information. The following information is collected through the standard WOCAT questionnaire and can be used for assessing the costs and benefits of SLM technologies:

- Investment costs and investment period
- Maintenance costs
- Information on the types and strengths / degree of benefits accruing from the technologies
- Perceived overall benefits of SLM technologies in comparison to investment and maintenance costs
- Information on the motivation of land user to implement the technologies.

We provide information on investment and maintenance costs per hectare of land conserved, taking into account different land use systems and regional differences. Information on the nature of the benefits of the technologies and on land users' motivation to implement these technologies is also reported and analysed, and an analysis of methodological issues is provided, with a view to improving ways and means of assessing costs and benefits of SLM.

3. DATA ANALYSIS

1.1 Overview

The data set consists of 363 SLM case studies collected over the last 15 years. The lion's share of case studies is located in Africa (167 case studies) and Asia (149), while Europe, Latin America, and Australia make up a relatively small share (27, 17, and 3). A comparatively large amount of data comes from the sub-regions of Central Asia and East Africa, followed by West Africa and South Asia.

For some of the data analyses we present here, the case studies were categorized according to their SLM measures, of which four types are proposed in the questionnaire (respondents can also combine these categories):

- *Agronomic measures*: measures that improve soil cover (e.g. green cover, mulch); measures that enhance organic matter/soil fertility (e.g. manuring); soil surface treatment (e.g. conservation tillage); subsurface treatment (e.g. deep ripping).
- *Structural measures*: terraces (bench, forward/backward sloping); bunds, banks (level, graded); dams, pans; ditches (level, graded); walls, barriers, palisades.
- *Vegetative measures*: plantation/reseeding of tree and shrub species (e.g. live fences; tree crows), grasses and perennial herbaceous plants (e.g. grass strips).
- *Management measures*: change of land use type (e.g. area enclosure); change of management/intensity level (e.g. from grazing to cut-and-carry); major change in timing of activities; control/change of species composition.

The combination of 'vegetative with structural' and 'vegetative with management' measures occurred very frequently and were therefore considered as individual categories in the analysis. All other combinations, including combinations of three types or of all measure types, were pooled in a residual category. The technologies were found to be implemented mainly in cropland (221), followed by grazing land (73), and mixed land use systems (63); 21 technologies related to forest land. Depending on what stage of land degradation has been reached, respondents could choose between three types of SLM intervention: (i) prevention of expected land degradation; (ii) mitigation of on-going land degradation; or (iii) rehabilitation of already degraded land.

1.2 Costs

In compiling the costs of a technology it is often difficult to separate the costs of normal agricultural inputs from additional expenses. In some cases, e.g. reduced or no tillage, the costs are actually less than for the normal or conventional practice. Thus it is relatively difficult to determine the incremental (or alternative) costs (and benefits) of SLM (Liniger and Critchley, 2007; Schwilch et al., 2012)

Establishment costs are defined as those specific one-off, initial costs that are incurred during the setting up of an SLM technology (Liniger and Critchley, 2007). These investments are made over a period of time that can last anything from a few weeks to two or three years. These costs typically include extra labour, purchase or hire of machinery and equipment, and purchase of seedlings. In general, there is no establishment phase involved in agronomic measures, but investments into specialised machinery such as direct-seeding tractors can be considerable.

Maintenance costs are those that relate to maintaining a functioning system. They are regularly incurred and are accounted for on an annual basis (Liniger and Critchley, 2007). In general, these costs consist of labour, equipment, and agricultural inputs.

The median establishment cost for the 363 SLM case studies is US $ 470 per ha. The establishment costs vary greatly from below 20 to over US $ 4000 per ha. With regard to maintenance costs, the median of the responses was US $ 89 per ha per year, with the majority costing between US $ 22 and US $ 286 per ha per year. There is thus a huge variation in the cost of both establishment and maintenance (Figure 1). This is due to the fact that a very high diversity of SLM measures exists. Some of the high-cost technologies involve structural measures such as water-controlling related measures, like the construction of dams, run-off canals, and erosion management.

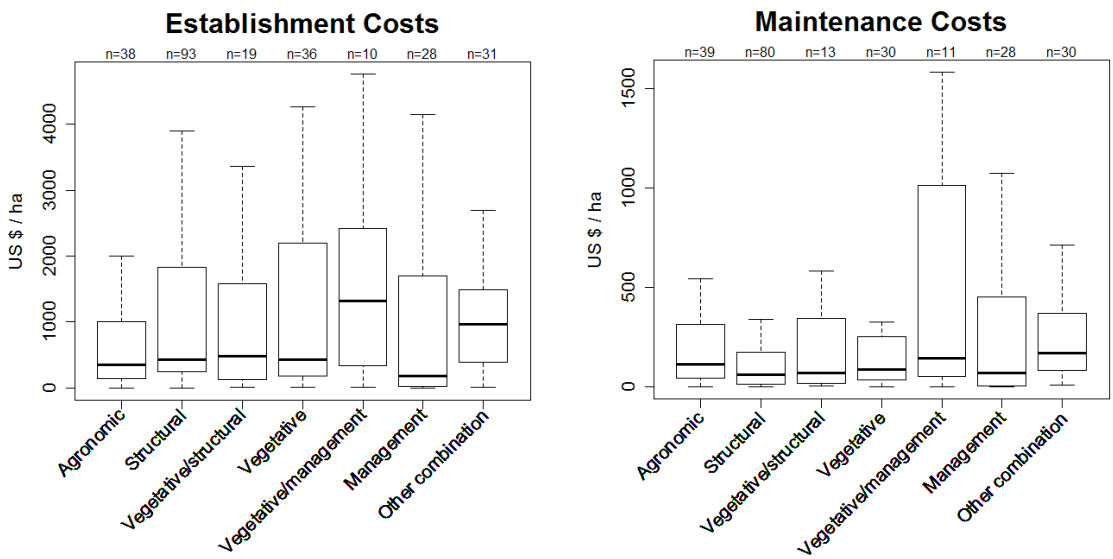

Figure 1: Boxplot of establishment and maintenance costs by measure category. Empty values were ignored.

Note 1: The thick horizontal lines in the box-and-whisker-plots (Figure 3) show the median value. The box around the median embraces the medium 50% of the sample values. The whiskers extend to the extreme data points, however, whiskers extend to a maximum of 1.5 times the interquartile range (which corresponds to the length of the box) from the box, while the remaining data points are considered as outliers.

Note 2: Establishment costs refer to a period of a few weeks to up to 3 years, maintenance costs to annual costs beyond the establishment period

In 50% of the cases, the cost of maintenance is below US $ 89/ha, showing a great potential for relatively low-cost SLM practices.

A preliminary analysis was also conducted into regional differences. In the regions with a relatively large sample (Africa, Asia, and Europe), we found comparatively little difference between the median maintenance costs. Europe showed higher investment costs compared to Asia and Africa, probably mainly due to higher labour costs. The small samples in Latin America and Australia do not really allow for such a comparison.

1.3 Cost-benefit ratio

The WOCAT network collects information on the perceived overall benefits of the reported technologies and how these benefits relate to the cost of investment and maintenance. Both benefits and costs include non-economic valuation, as mentioned in section 2. The perception of benefits was found to be generally positive.

Establishment costs: Regarding how short-term benefits relate to establishment costs, around three quarters of the technologies were rated as positive or at least neutral – implying that SLM measures are worth the investment and efforts after 1-3 years already. In the remaining quarter of the cases, the impact was rated as slightly negative to very negative. Looking at the individual categories of measures, we found that for the short term, management measures are rated slightly more positively than the other measures. Only 8% rated short-term establishment costs below neutral. This can be explained by the fact that

management measures often do not involve investments, but mainly a change in practice, and therefore the benefits can quickly balance the initial cost of change in SLM practice. The long-term benefits regarding establishment costs are even more positive; 82% perceived the measures as positive or very positive. In less than 1% of the case studies the impact was rated between very negative and slightly negative.

Maintenance costs: For the relation between benefits and maintenance costs, a similar picture can be drawn. More than 90% of the case studies found that benefits were higher than, or at least neutral, with regard to the cost of maintenance. In the short term, around 9% found that the impact was slightly negative to very negative. Interestingly, the categories vegetative/management and vegetative seem to be affected more negatively, with 28% and 15% of the cases, respectively, rating benefits against costs as negative. This might be due to the costs of replacing plants and seeds and maintaining productive and healthy plants. For the long term, in analogy to the establishment costs, the impact was perceived as even more positive. A staggering 82% of the ratings are positive or very positive, and only about 1% of the ratings are below neutral and negative.

Overall, it can be concluded that the SLM technologies assessed in the WOCAT database are perceived by land users as having benefits that justify the necessary investments. These technologies are successful because they provide land-users with benefits and therefore have a potential to be up-scaled and replicated.

The above analysis also implies that many (about a quarter of the cases) implementations of SLM technologies can be expected to give negative returns on investment in the first 1-3 years, even when they are successful. This raises a number of questions. Why and how have land users been able to afford these investments, for example? One explanation is that land users often implement such systems incrementally, gradually enlarging the area under SLM every year, or building terraces through continuous efforts over many years or even generations. Other technologies described in the WOCAT database have been supported by subsidies, even though this does not appear to be the major motivation of land users (see section 1.4: Motivation).

Land users therefore need to have a long planning horizon, made possible through stable economic and social conditions, and secure tenure rights, amongst other things. If additional investment support can be delivered, then the chances for rapid uptake and replications may be improved – if the potential negative side-effects of such programmes can be minimized. In practice, this is not easy (Giger, 1999; Giger et al., 1999).

1.4 Motivation

Additional information that sheds some light on the reasons for adoption of the SLM technologies is reported in responses to a question that investigates land users' motivation for adopting these practices (Figure 2). This information is contained in a different WOCAT dataset – the one which reports about approaches. According to WOCAT, an SLM approach constitutes "the ways and means of support that help introduce, implement, adapt, and apply SLM technologies on the ground" (Liniger & Critchley, 2007; Schwilch et al. 2012).

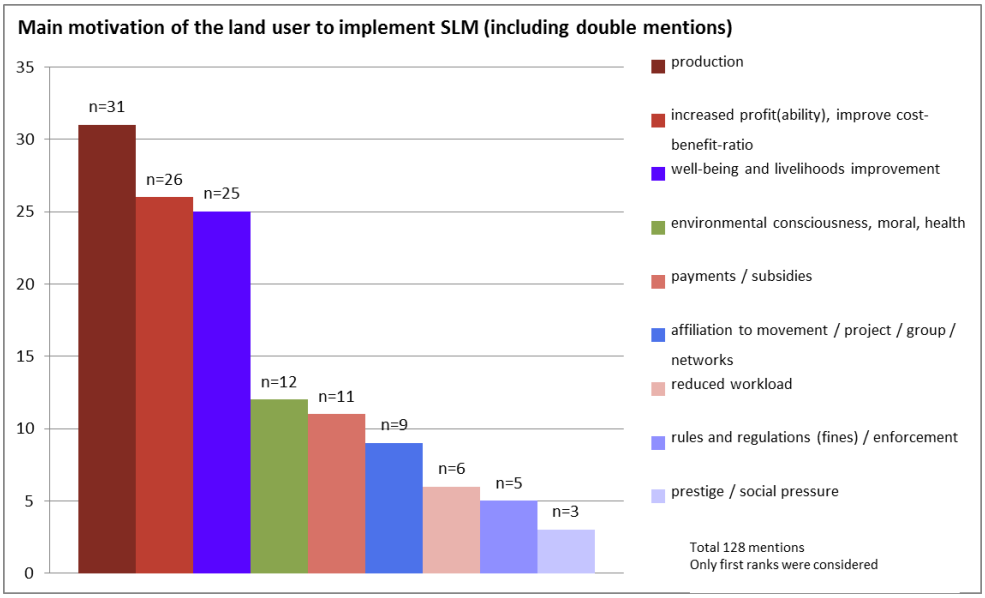

Figure 2: Main motivations for implementing SLM.

Amongst the motivations for adopting an SLM technology mentioned most often are production (24%), and well-being and increased profitability (20%). Livelihoods generate 20% and environmental consciousness 9% of responses. It is obvious that some of these possible answers are linked (e.g. production, livelihood, and profitability) and relate to different kinds of benefits, all of which have some kind of economic significance. Thus increasing productivity and economic benefits are the primary motivation for land users for implementing SLM, followed by environmental benefits and a number of social and cultural values such as affiliation to a project or a group, reduced work load, rules and regulations and prestige and social pressure.

1.5 Methodological problems and limitations

The methodology and the questionnaire for collection of information have been developed in several key languages by the WOCAT network. This questionnaire has been field tested and revised a number of times and is now relatively easy to understand and use. Of course, there is still scope for individual interpretation of questions and subjective bias.

Many of the respondents were directly involved in projects implementing SLM, but the datasets also include technologies that were developed by land users without external support. In these cases, they therefore know the technologies well; but this position could also entail a subjective bias. Furthermore, some of the questionnaires may still contain some gaps and inconsistencies, despite best quality control efforts by the WOCAT network. Moreover, the dataset used is not a randomized sample of successful SLM practices but has been collected following opportunities and linkages provided by the manifold networks of WOCAT and its partners. Therefore the regional distribution of the case studies does not yet represent the global spread of successful SLM practices; it also reflects also strengths and weaknesses in WOCAT's network and database.

The information presented here relies on land users' perceived benefits of SLM measures. Based on our knowledge of the field reality and our experience with collecting data together with specialists and land users, this is an approach that can deliver useful information on the attractiveness of the technologies for the land users themselves.

It is very difficult to provide verified quantitative figures on the impact of SLM on long-term trends in yields and production. Despite explicit questions regarding additional production under each SLM technology, only about 5% of the datasets contain information about production quantities.

From the methodological point of view, the shortage of additional economic data on benefits (on- and off-site) of these technologies is an important drawback. This limitation of information can be explained by the persistent difficulties faced by both experts and land-users in quantifying the benefits of SLM technologies. Despite substantial efforts to improve the questionnaire and make questions relevant and understandable at the same time, these economic data have proven the most difficult data to collect.

Therefore, looking more deeply at all the aspects of costs and benefits of SLM will require a detailed review of the case studies and additional research. In the context of future research programmes, WOCAT intends to give greater attention to these aspects in a sub-set of its case studies and to complement existing case studies with new ones where the economic aspect will be given more space, while maintaining the holistic assessment made possible through the WOCAT questionnaire. To this purpose WOCAT intends to build bridges to other research initiatives interested in the subject.

4. POLICY-ORIENTED RECOMMENDATIONS

Our analysis shows that a wide range of SLM technologies exist that generate positive benefits for land users. These good practices can be used as a basis for replication and adaptation in the implementation of investment projects for SLM.

Often, SLM technologies imply additional costs, especially during the establishment phase. This barrier against adoption of SLM needs to be overcome. Stable economic conditions and land tenure security are some of the important frame conditions. Innovative mechanisms to support the adoption of SLM technologies may also be needed.

Land users give great importance to production-related benefits; but social and environmental benefits are also important and can ultimately offer society additional economic benefits (such as water and biodiversity conservation, food security, etc.). Policy-makers for SLM should make use of holistic assessments of SLM technologies to account for these synergies.

While it is both necessary and desirable to generate more data and analysis on quantifiable economic and monetary benefits of SLM, other (qualitative) methodologies to identify economic benefits are also important and need to be used in analysis of options and planning.

The methodology proposed by WOCAT to assess SLM technologies with perceived benefits helps to identify successes and failures of SLM. The further use and refinement of this methodology needs to be supported.

Knowledge management networks can contribute greatly to disseminate good practices, and the UNCCD process can benefit from the information basis generated through WOCAT.

5. CONCLUSIONS

The following general conclusions can be made:

The large majority of the technologies contained in the database are perceived as having positive benefits that outweigh the costs in the long term from the point of view of the land users. About three quarters of these technologies also have positive or at least neutral benefits in the short term.

The analysis shows that many SLM measures exist which can generate important benefits to land users, but also to other stakeholders.

Land users are implementing SLM technologies as they are convinced of their benefits, even though the exact importance often cannot be expressed in monetary terms. Benefits, however, are not only monetary benefits but include other dimensions. Well-being and livelihood and environmental considerations have been cited as often as profitability and increased production.

Many technologies have rather high investment costs, but nevertheless are still able to generate benefits that are perceived as positive or even very positive – this is also an interesting finding.

A significant percentage (about one quarter) of the SLM technologies must be considered not beneficial from the land users' point of view in the short term, as they imply considerable costs. An investment period with reduced net benefits therefore needs to be overcome. Many of these technologies have been adopted without external support. In 43% of the cases the establishment costs were covered fully by farmers. But such investments require stable economic conditions and secure land and tenure rights, to allow for gradual adoption. Nevertheless, support for investments by land users may be needed in many cases, and this support could be justified by the significant off-site benefits that SLM measures can generate.

In general, the SLM specialists who contributed the information have considerable difficulties in providing data on the costs and benefits of SLM. This reflects weak monitoring systems and research support, and it indicates the need for further investigations into the economics of SLM.

6. ACKNOWLEDGEMENTS

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