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Targeting food self-sufficiency : Economic and Social Impact of Soil and Water Conservation in Western Africa

KIRSCH-JUNG, Karl P.
(karl-peter.kirsch-jung@gtz.de)

Summary

Soil and water conservation has become a major instrument of sustainable land use in the Sudano-Sahelian zone of West Africa. This work summarizes factors which enabled the large scale implementation and adoption as well as the impact on food security in a region where land degradation endangers rural livelihoods.

Today, stone and rock structures consisting of lines placed across the land contour are the most popular Soil and Water Conservation (SWC) measures used in the Sahel. Mulching and the spread of dry manure has become a common practice in most of the villages. Compost preparation in basins constructed from mud bricks instead of in pits seems to become the promising technique to maintain soil fertility.

Large scale dissemination of SWC was favoured by collaborating with all development agents in the area, applying a farmer-to-farmer extension approach and supporting the transport of stone and rock material. In Bam province / Burkina Faso, 95 % of the communities participate in SWC. All farms have implemented SWC measures in at least one field, the approximately 14,000 households have meliorated an average of 1.5 ha each. Thus, benefits are widespread among farm-households and they consider the SWC measures as being the most important activities for social development.

A long-term strategy, based on a farm model of sustained food production, proposes to reverse the structural grain deficit in the region.

Key Words: soil and water conservation – soil fertility - economic and social impact – food self-sufficiency - Burkina Faso

Introduction

At the 6th ISCO conference held in Addis Ababa 1989, the concept of a land management project fighting land degradation and erosion on the Central Plateau of Burkina Faso was presented (Eger / Bado 1992). Since then, soil and water conservation has become a major instrument of sustainable land use in the Sudano-Sahelian zone. This work summarizes experiences of the PATECORE (*Projet d'Aménagement des Terroirs et Conservation des Ressources dans le Plateau*

Central) project in Bam Province / Burkina Faso over the period from 1988 to today with regard to techniques and support offered, extension methods applied and results of project impact assessment as well as research studies.

Project area

Bam Province (latitude 13° to 14° N, longitude 3° W to 1° E) is characterized by low hills with laterite caps and shallow, stony soils (lithosoils), the sandy or sandy loam 'glacis' and valley bottoms, made up of heavy clays (vertisols). Annual rainfall of 400 – 700 mm is concentrated in five months, from May to September, but rainfall events can be extremely localized and seasonal distribution is highly erratic with frequent dry spells up to 15 days. Most of the rain falls in intensive showers (55 to 80 mm/h within 30 minutes), surpassing infiltration capacity and leading to sheet and gully erosion. The mean minimum and maximum temperatures are 14.5° and 40°C respectively and potential evapotranspiration is high all year round.

The project zone covers 2.700 km², with a population of approx. 160.000 inhabitants, a density of around 60 persons / km² or up to 200 persons per km² of cultivated area are reached. The Mossi, with 80 % of the population the dominant ethic group, live in around 190 nucleated villages. The Mossi depend for their livelihood on the cultivation of the grains sorghum *(Sorghum bicolor*) and millet (*Pennisetum americanum*) and own mostly small livestock. Most of the Fulani herdsmen in the area have become sedenterized, but animal husbandry remains their main undertaking.

High population growth has led to decline of natural vegetation, reduced or abandoned fallow and extension of cultivation on marginal land. Land degradation is widespread and do occur as water erosion, wind erosion, physical degradation (surface crusting) and chemical degradation (soil mining). Soil erosion was estimated to amount to up to 100 t/ha soil loss per year (Raymond / Lindskog 1994). Average grain yields have decreased from 900 to 400 kg/ha in the first half of this century and might have come down today to only 200 – 300 kg/ha. But the local economy is based on subsistence agriculture and self-sufficient food supply on household level, the later no more guaranteed in most of the years.

Measures to fight land degradation

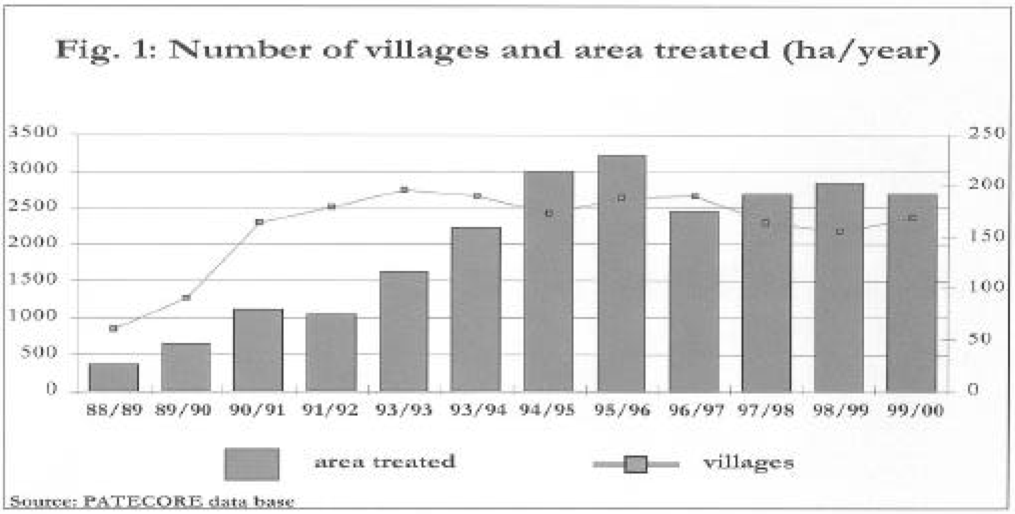
Traditional techniques of **erosion control and water harvesting** were all line interventions such as: wooden barriers, grass strips, earth ridges and stone lines. All those measures are meant to reduce soil and nutrient losses and to decrease run-off speed, thus increasing infiltration and sedimentation. Earlier proposed intensification based on the large-scale construction of earthen ridges did not meet approval among farmers of the Central Plateau (Marchal 1986, cit. in Kunze 1997). They cause yield depressions in high rainfall years due to water-logging as well as high annual maintenance costs. Based on the availability of the construction material, the more permanent option of using stones and rocks was further developed. Today, **stone and rock structures** consisting of lines placed across the land contour are the most popular Soil and Water Conservation (SWC) measures used in the Burkinbè Sahel. Depending on soil type and slope, there are three different structures proposed: stone rows (*cordons pierreux*), rock bunds (*diguettes*) and permeable rock dams (*digues filtrantes)*, varying in base width and height.

To provide biological stability, perennial grasses (especially *Andropogon gayanus*) are planted or sown at short intervals along the stone structures. More than 35% of the structures have now been stabilised in this manner, which is equivalent to a total length of more than 3,500 km. The stalks of the Andropogon grass are a highly sought-after raw material for the manufacture of mats, or are used as fodder.

In the same line, traditional measures to **maintain soil fertility** are hardly feasible today. The present population density and the need for food production no longer allow for fallow periods. Former *grazing contracts* between Mossi farmers and Fulani herdsmen, whereby cattle of the later graze on the stubble of the fields of the Mossi, have decreased as sedenterized Fulani herdsmen engage partly in cultivation on their own. Maintaining soil fertility with manure alone is no more possible on a large scale as the pressure on crop land and cultivation of marginal lands have reduced grazing grounds (and total number of cattle) in the region over the years. About 15 – 20 ha of grazing land would be necessary to fertilize one ha of crop land (van Keulen / Breman 1990). On the other hand, **mulching** and the spread of dry manure – as available - has become a common practice in most of the villages. The preparation of **compost** in pits filled with ashes, straw and leaves, manure and household residues, a long standing extension recommendation to improve soil fertility, was hardly accepted by farmers. A major break-through in adoption rates came across when compost preparation in basins constructed from mud bricks instead of in pits was introduced. The basins are laid out to produce about 5 t of compost, the recommended amount for one hectare each second year. Trials with compost enriched with Burkina rock phosphate (400 kg/5 t) are underway, but so far results do not yet allow for recommendations.

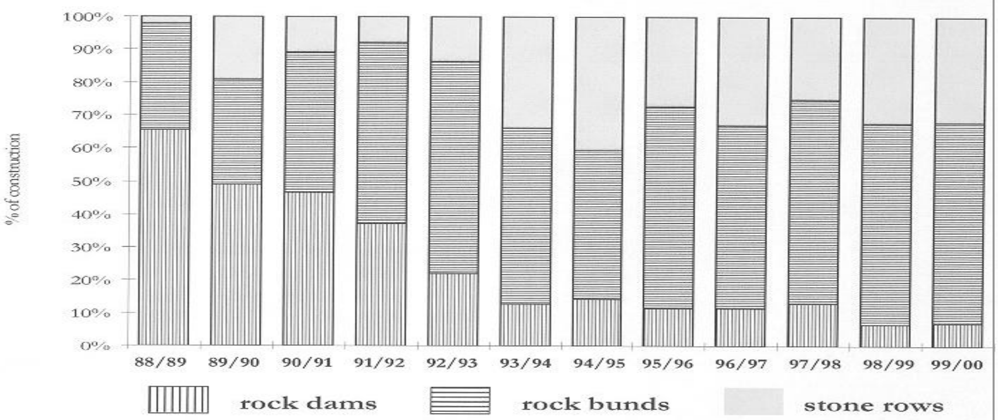
Large scale implementation

In Bam province, the number of villages participating in SWC has increased over the live span of the PATECORE project up to 95 % of the communities in the region and the total area protected by erosion control measures amounts to 24.000 ha of which more 19.000 ha comprise individual fields available to farms for food production. (Figure 1). At least 10% of this land would not be suitable for utilisation without erosion control measures.



Large scale implementation and adoption were enabled through a variety of factors and measures taken. The improved SWC measures proposed, - contour stone rows, rock bunds and permeable rock dams - are based on traditional techniques of erosion control and water harvesting. In the beginning, farmers were encouraged to start conservation works in those areas to which they gave priority, often the middle parts of the catchments were eroded materials from the upper parts are deposited and crops are grown or where gullies were found to be a threat to land use and housing. Since then, conservation works have spread to other parts of the catchments and formerly collective efforts have become more and more individualized. Today each family tries to protect its fields, still benefiting from traditional labour exchange agreements and village level planning based on a traditional land classification. The evolution can be seen at the distribution of structures, when major conservation works of rock dams have given way to smaller structures such as rock bunds and stone rows over the time (Figure 2).

Fig. 2: Distribution of different erosion control structures



Source: PATECORE data base

Following the impact monitoring conducted by PATECORE in 1999 on 184 test fields, the following conclusions can be drawn: Fields with low erosion control structures (stone rows) display from the 4^{th} yield year onwards (age: 4-6 years) a yield decrease of 20%, compared to the first three years following emplacement of the structure. With larger structures (rock bunds) the level of yield in the 4^{th} to 6^{th} years following construction is 40% higher than in the first 3 years (PATECORE 2000a, p. 31). When farmers experienced the higher efficiency of rock bunds compared to stone rows they (re)turned to the first, in spite of the higher labour demand for their construction.

The high degree of relevance and significance of the SWC measures is also clearly reflected by the demand among the farmers' groups: The project intervenes with support solely in response to demand expressed by the farmers. That demand is determined each year at the beginning of the dry season in the form of an annual work program drawn-up in the village, and passed on to the project through the extension unit. Despite the very high requirement for manual labour per hectare, the demand remained at virtually the same high level throughout the last 7 campaigns. Erosion control structures were put in place on an average of 2,800 ha per annum. For the 170 active villages in the province, this is equivalent to an average of 14 ha per village and year. The inputs provided by the population themselves in this context amounted to approximately 420,000 person-days of manual labour per year. Labour requirement for the construction of erosion control structures amounts to 97 person-days/ha for stone rows, 183 person-days/ha for rock bunds and 280 person-days/ha for permeable rock dams (Kunze 1997). The project is cooperating with over 340 farmers' groups, including 50 women's groups. By organizing especially larger villages into sub-groups, it has been possible to ensure that the maximum number of farms can benefit.

Wide-spread application of SWC-techniques is favoured by the fact, that farmers in the project area do not feel insecure about their land tenure situation. A qualitative and empirical study confirmed that “Investments in erosion control are more frequent on owned fields than on borrowed ones, but even on the later they represent more than half of the cases, so that we cannot infer any prohibition of or severe restrictions to such investments on borrowed land” (Sawadogo / Stamm 2000, p.291).

The methods to maintain soil fertility disseminated by the project aim essentially to achieve qualitative and quantitative optimisation of organic fertiliser, as well as its efficient application. 1,800 households (= 15%) in the project region are already operating composting systems to produce fertiliser for ½ - 1 ha of cropland per farm. Every year around 650 new farms are trained in methods to optimise the production of organic fertiliser, and the application thereof.

Project Support

The expertise required for implementation of the recommended methods and measures is being transferred to the target population through an extensive training programme. Covering most of the villages of the province became possible by collaborating with almost all agents engaged in development work. By such, PATECORE has concluded partnership agreements with the technical services (Agric. Extension and Forestry) as well as with a large number of non-governmental organizations and local associations. Their staff is supported for field work by initial and regular training as well as transport allowances.

Every year, the extension workers of the partner organisations receive approximately 1,500 person-days of training in accordance with an updated training programme. This takes the form of theoretical and practical training units lasting between one and several days. The training covers both the technical measures disseminated by the project, and participatory planning, evaluation, as well as motivation and communication techniques.

For large-scale dissemination of the SWC measures in the villages, the project favours a farmer-to-farmer extension approach. The villages appoint a group of 5-10 "farmer trainers" who are extensively trained in the requisite methods by the extension staff. In recent years a total of more than 3,000 farmer trainers, more than 1/3 of them women, have been trained by the project. The training extends over several years, and comprises various levels of training. The subject matter covered ranges beside the SWC-techniques from planning and evaluation instruments, to the interpretation of aerial photographs for land-use planning purposes. The farmer trainers are responsible in the village for the planning, organisation and evaluation of the SWC measures, and for transfer of the requisite technical expertise to individual farming families.

Support is furthermore offered to a bottleneck, which people cannot overcome by their own efforts. This support consists of subsidized lorry transport of stone and rock material from the quarries to the construction sites. Responding to transport requests planned and formulated by village groups for each season has become a major task of the project. In order to treat 2.800 ha in 170 villages in the construction period of six month during dry season, approx. 25.000 lorry trips by own or rented lorries have to be scheduled and executed.

Efficiency and Effects on Yield

For sorghum, yield measurements on 107 test fields revealed an additional grain yield of 130 kg/ha on land with structures. The total yield on treated areas was 780 kg/ha (+20 %), compared to 650 kg/ha on land without erosion control structures. (PATECORE/GTZ, 2000a) The yield measurements were performed in recent years with above-average rainfall. It can be assumed that the relative increases in yield generated by erosion control measures will be significantly higher in dry years. Kunze (1999, p. 4) reports average grain yield increases for the 1993 cropping year in the area of 48 % for sorghum and 75 % for millet on treated plots. The increase in straw yield is respectively 14 % and 56 %. The yield level on land made fertile after surface crusting by erosion control measures is estimated to be at least 500 kg/ha.

A further observed impact of the mechanical erosion control structures is increased growth of wild trees and bushes alongside the structures in the fields. In a random sample of 18 km of rock bunds and dams, an average of 94 saplings were counted per linear kilometre. A total of 15 different species were identified. Given the total length of structures of at least 6,300 km, this means around 590,000 trees will be growing wild on around 24,000 ha of cropland, or around 30 trees per hectare (PATECORE/GTZ 2000c, p. 31).

In 1998 and 1999, the project observed the yield-increasing effects of fertilisation with compost enriched with rock phosphate (RP), as compared with an application of traditional dry manure, on a total of 23 test fields. Using the enriched compost (5t/ha + 400 kg RP), sorghum yields were increased by 64%, or 520 kg, compared to the dry manure application (5t/ha). To date, it has not been possible to conclusively link the yield increases to either one of the two components (compost or rock phosphate). Within the scope of the 2000 campaign, test fields have been set up with 20 farms to investigate this issue. Results are not yet available.

As well as directly increasing yields, compost application also has a positive effect on yield security: In years with irregular distribution of precipitation during the cropping period, a delay in the wilting point is observed in crop plants on soils fertilised with compost, as compared to those on land treated with dry manure. In case of prolonged dry periods, this can lead to considerable differences in yield.

Socio-economic Impacts

Soil- and water-conserving measures significantly improve the level of subsistence and food security, or conversely reduce the risk of total crop failure in low rainfall years.

In 5 out of 6 farmers' groups investigated, all farms have implemented SWC measures in at least one field, the approximately 14,000 households have meliorated an average of 1.5 ha each. The number of farms not applying SWC measures is below 5%. Thus, benefits are widespread within the target population.

As construction of erosion control structures dominantly takes place on family land, women benefits in the first place of a better food availability for household subsistence purposes. Concerning individual plots, women have the same access to land as other individual land users such as young unmarried men. But a study shows that they receive less often fields with already established conservation works (Kunze 1998, p. 1469).

In the course of their village surveys, Neubert et al. (2000) conducted empirical yield surveys in order to ascertain the opinion of the population concerning the impacts of the SWC measures. Yield increases of up to 250% in the first 6 years following the construction of stone bunds were reported. Yield increases on highly degraded land expressed as a percentage are estimated to be much higher than the annual increase in yield on land already more productive prior to the measures.

Based on yield measurements (see above), it can be assumed that the incremental production on meliorated land in 1999 was approximately 3,400 tons of grain which is equivalent to 9,5 % of the total production figure of 35,000 tons in the province. At the same time, for the entire duration of the project to date a figure of 16,000 tons of additional grain yield can be ascribed to the SWC measures The meliorated land represents 27% of the total area under grain cultivation, and generates an estimated 37% of total grain production for Bam province. This equivalents to a total value of approx. DM 4,7 million.

A social impact analysis reported that 11 of 18 surveyed villages consider the SWC measures of the project (including land-use planning) as being the most important activities for social development. Similarly, indirect effects were also ascribed to the SWC measures: Improved availability of drinking water through increased infiltration of water into the soil, and improved health status due to increased availability of food resulting from increased yields (Neubert et. al 2000, p. 62).

The vision : food self-sufficiency

A long-term strategy up to the year 2006, based on a farm model of sustained food production, proposes to reverse the structural grain deficit in the region.

An average farm-household in the province of Bam shows the following characteristics: 12 family members, 4,7 ha cropping area. Out of this area 4 ha (85%) are used for grain production. The household disposes of 4-5 tropical livestock units with a potential production of organic fertiliser of 1 t per tropical livestock unit. The household has a food demand of 2400 kg of grain per year (12x200).

With the techniques for erosion control and improvement of soil fertility promoted by the project an average farm-household can cultivate 2 ha intensively and sustainably by applying 5t of compost per ha every 2 years.

The meliorated and fertilised area of 2 ha produces about 2/3 of the cereal demand of the household (based on a conservatively estimated yield level of 1000 kg per ha). Together with the yields (500 kg per ha) of the 2 ha of less extensively utilised land an annual production of 3000 kg can be achieved. Considering about 15% of post-harvest losses and additional seed use approximately 2500 kg of cereals are available to satisfy the subsistence needs of an average farm-household.

To achieve food self-sufficiency, another 13.500 ha of land will have to be protected by SWC measures.

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