Recently stabilised dike with old rice bags and Pandanus, next to an irrigation channel and an eroding sand road. (Stefan Graf)

Stabilisation of irrigation channels in sandy soils with old rice bags and Pandanus plants (Cambodia)

(Khmer)

DESCRIPTION

In sandy areas, old rice bags are filled with sand and piled up as dikes bordering irrigation channels, and Pandanus plants are used to stabilize them on the long term.

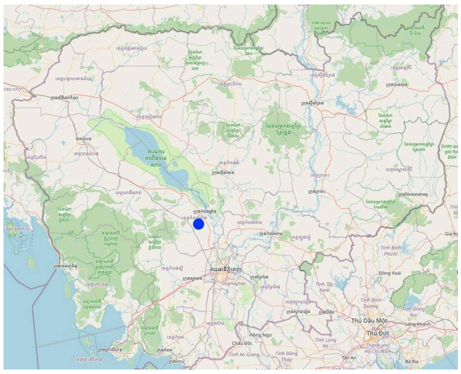
The paddy fields are surrounded by dikes and fed by local temporary streams and irrigation channels, as well as by rain. In sandy soils the dikes around the irrigation channels and fields cannot hold the water due to erosion. Old rice bags are filled with sand and piled up to form stable dikes on the short term, and Pandanus suckers are planted every 0.5 – 1 m to ensure a stability on the long term due to the root system.

The purpose of the dikes, stabilized for short and long term, is to ensure the flow of water to the paddy fields by reducing the riverbank erosion. It also helps to keep the water in the paddy fields. The Pandanus can be used to make mats and baskets, although this use diminishes due to the low cost of plastic. After a few years, the Pandanus on the dike is tall and spiky enough to fence off cattle and protect the rice from grazing.

To stabilize 50 m of dike, around 100 old rice bags are filled with sand and piled up on a height of 2 bags. Pandanus suckers are planted on the water side, between the bags, and sand is used to cover the plants and bags. Poles and sticks are used to stabilize the bags and plants until the root system is established. This is done in the beginning of the rainy season to ensure the growth of the sucker. In the first year, after each rain the eroded sand has to be added back to the dike. After the establishment phase, from the second year on, the Pandanus have to be cut back as they grow quickly and can grow tall.

The analysed area is flat (slope < 2%), with a tropical climate (dry season from November to May and wet season from June to October), and the soils are mostly sandy or loamy. The soil has a low fertility, contains little organic matter, and acidifies. The area has been deforested a long time ago, and the groundwater table is rather high (1-2 m during the dry season, on the surface during wet season).
Due to climate change, farmers notice more erratic rainfall, temperature rises and more recurrent droughts. Rice is the predominant crop grown in the area, since it serves as staple food (mix subsistence and commercial activities). Cattle are usually grazing on the fields after the harvest, without much control. Thus the cattle grazes too often and too much on the same spot, leading to degradation.
The increasing migration rate (the young generation leaves the villages to work in the cities, garment industry or abroad) results in a decrease of available labour force in the area which has detrimental effects on the agricultural activities. Furthermore, the civil war in the 1970s (Khmer Rouge) led to the loss of agricultural knowledge. Several NGOs are trying to re-establish the knowledge.

LOCATION



Location: Chrey Bak/Rolea Pha'ear, Kampong Chhnang, Cambodia

No. of Technology sites analysed:

Geo-reference of selected sites
- 104.5907, 12.11291

Spread of the Technology: evenly spread over an area (approx. 1-10 km2)

In a permanently protected area?:

Date of implementation: more than 50 years ago (traditional)

Type of introduction
- [ ] through land users' innovation
- [x] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

Pandanus suckers growing between rice bags (Stefan Graf)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

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

Land use


Cropland

- Annual cropping: cereals - rice (wetland)

Number of growing seasons per year: 1


Waterways, waterbodies, wetlands -

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

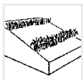

soil erosion by water - Wr: riverbank erosion

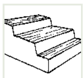

water degradation - Ha: aridification

SLM group

- irrigation management (incl. water supply, drainage)
- water diversion and drainage
- surface water management (spring, river, lakes, sea)

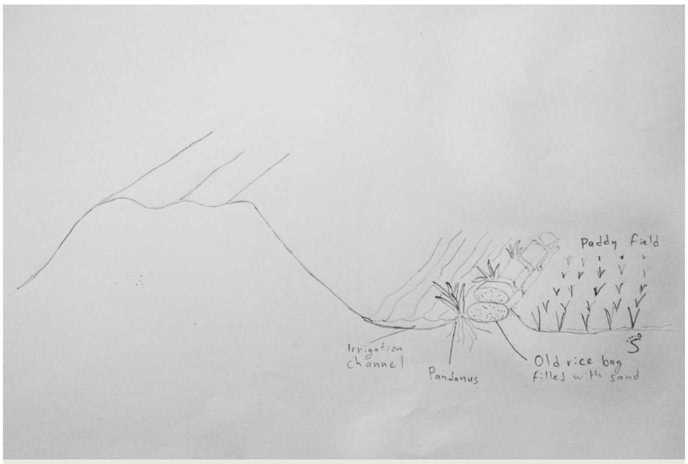
SLM measures


vegetative measures - V1: Tree and shrub cover


structural measures - S3: Graded ditches, channels, waterways

TECHNICAL DRAWING

Technical specifications



Author: Stefan Graf, Switzerland

Next to a road, (left) there is an irrigation channel in sandy soil. To prevent the little dam next to the rice field (right) from eroding, old rice bags are filled with sand and piled up. Between the rice bags, Pandanus suckers are planted. Sometimes they are also used to stabilise roadsides (not shown in this picture).
Kampong Chhnang
Date: 2014

Technical knowledge required for field staff / advisors: low
Technical knowledge required for land users: low
Main technical functions: stabilisation of soil (eg by tree roots against land slides), water harvesting / increase water supply, sediment retention / trapping, sediment harvesting

Vegetative measure: On dikes, allong irrigation channels
Vegetative material: T : trees / shrubs
Vertical interval within rows / strips / blocks (m): 0.5 - 1 m
Vegetative measure: Vegetative material: T : trees / shrubs
Trees/ shrubs species: Pandanus grown from suckers

Bund/ bank: graded
Height of bunds/banks/others (m): 0.3
Width of bunds/banks/others (m): 0.75

Construction material (other): Sand and sandbags
Vegetation is used for stabilisation of structures.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **Riels**
- Exchange rate (to USD): 1 USD = 4000.0 Riels
- Average wage cost of hired labour per day: 5.00

Most important factors affecting the costs

The labour is the most costly part in this technology. Through the use of old rice bags filled with sand the costs are already reduced.

Establishment activities

1. Fill the old rice bags with sand, pile them up, stabilize with sticks and add more sand after each rain, till the root system of the Pandanus plants have established (1 year) (Timing/ frequency: Beginning of wet season (Jun/Jul))
2. Plant the Pandanus suckers between the bags (Timing/ frequency: beginning of wet season (June/July))

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Riels)	Total costs per input (Riels)	% of costs borne by land users
Fertilizers and biocides					
Construction of biodigester		1.0	400.0	400.0	50.0
Total costs for establishment of the Technology				**400.0**	
Total costs for establishment of the Technology in USD				*0.1*	

Maintenance activities

1. Maintain the dikes (Timing/ frequency: every rainy season)
2. Cut back the Pandanus plants (Timing/ frequency: Once a year, before planting rice)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Riels)	Total costs per input (Riels)	% of costs borne by land users
Labour					
labour		1.0	121.5	121.5	100.0
Total costs for maintenance of the Technology				**121.5**	
Total costs for maintenance of the Technology in USD				*0.03*	

NATURAL ENVIRONMENT

Average annual rainfall

- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☑ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone

- ☐ humid
- ☑ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate

1486.45 mm 2013 in Kampong Chhnang
Thermal climate class: tropics. 27° to 35°C

Slope
- ✓ flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landforms
- ✓ plateau/plains
- ridges
- mountain slopes
- hill slopes
- ✓ footslopes
- valley floors

Altitude
- ✓ 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- not relevant

Soil depth
- very shallow (0-20 cm)
- ✓ shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- high (>3%)
- ✓ medium (1-3%)
- ✓ low (<1%)

Groundwater table
- ✓ on surface
- < 5 m
- 5-50 m
- > 50 m

Availability of surface water
- excess
- ✓ good
- medium
- poor/ none

Water quality (untreated)
- good drinking water
- ✓ poor drinking water (treatment required)
- for agricultural use only (irrigation)
- unusable

Water quality refers to:

Is salinity a problem?
- Ja
- Nee

Occurrence of flooding
- Ja
- Nee

Species diversity
- high
- medium
- ✓ low

Habitat diversity
- high
- medium
- low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- ✓ subsistence (self-supply)
- ✓ mixed (subsistence/ commercial)
- commercial/ market

Off-farm income
- less than 10% of all income
- ✓ 10-50% of all income
- > 50% of all income

Relative level of wealth
- very poor
- poor
- ✓ average
- ✓ rich
- very rich

Level of mechanization
- manual work
- animal traction
- mechanized/ motorized

Sedentary or nomadic
- Sedentary
- Semi-nomadic
- Nomadic

Individuals or groups
- ✓ individual/ household
- groups/ community
- cooperative
- employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- children
- youth
- middle-aged
- elderly

Area used per household
- < 0.5 ha
- 0.5-1 ha
- ✓ 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Scale
- small-scale
- ✓ medium-scale
- large-scale

Land ownership
- state
- company
- ✓ communal/ village
- group
- ✓ individual, not titled
- individual, titled

Land use rights
- open access (unorganized)
- ✓ communal (organized)
- leased
- ✓ individual

Water use rights
- ✓ open access (unorganized)
- communal (organized)
- leased
- individual

Access to services and infrastructure

health	poor	✓			good
education	poor		✓		good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor			✓	good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor			✓	good
drinking water and sanitation	poor	✓			good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

decreased							✓	increased

Dried residues are put in the garden (cucumber, pumpkin,

fodder production	decreased	increased	watermelon) which increases nutrient availability.
risk of production failure	increased	decreased	
production area (new land under cultivation/ use)	decreased	increased	
energy generation (e.g. hydro, bio)	decreased	increased	Before the installation of the biogas system, the land user bought firewood.
expenses on agricultural inputs	increased	decreased	He saves 50 $ on chemical fertilizer per year.
farm income	decreased	increased	
diversity of income sources	decreased	increased	
workload	increased	decreased	

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved	
health situation	worsened	improved	No smoke from open fire.
contribution to human well-being	decreased	increased	On the long term livelihood is improved, because he saves over 60 $ per year in firewood and battery charging for light, as well as 50 $ for chemical fertilizer.

Ecological impacts

water quantity	decreased	increased	
water quality	decreased	increased	Pollution of groundwater due to washing out of nutrients.
soil moisture	decreased	increased	
soil loss	increased	decreased	
soil organic matter/ below ground C	decreased	increased	Most of the carbon is transformed into methane, not available as organic matter.
pest/ disease control	decreased	increased	
Reduced weed seeds	decreased	increased	Compost usually not completely decomposed, as well as raw manure, contain lots of weed seeds.

Off-site impacts

groundwater/ river pollution	increased	reduced	Sludge is left to dry outside, nutrients washed out into groundwater. Not measurable.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Difficult question for farmers.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well	

Climate-related extremes (disasters)

local rainstorm	not well at all	very well	Answer: not known
local windstorm	not well at all	very well	
drought	not well at all	very well	
general (river) flood	not well at all	very well	Answer: not known

Other climate-related consequences

reduced growing period	not well at all	very well	

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

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

- [ ] Ja
- [ ] Nee

To which changing conditions?

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

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The Pandanus leaves are used for baskets and mats.
- The water is stored in the rice fields. Without stabilisation, the berms would not hold any water at all in sandy conditions.
- Cattle is fenced off the rice fields through tall and thick (old) Pandanus plants growing on the dikes.
- The irrigation channels are not eroded, water keeps flowing

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

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The Pandanus grow too quickly and too tall, and require workload which is not available. Select slow growing species or individuals.
- Rodents use the Pandanus as niches. Protect natural predators (snakes), or hunt/trap the rodents.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- the plastic from the rice bags disintegrates with time and causes river pollution. Use organic material (e.g. rice bags) to stabilize the dike for the first year.

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_1650/

Linked SLM data
n.a.

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- Society for Community Development in Cambodia (SOFDEC) - Cambodia

Project

- n.a.

Key references

- NBP National Biodigester Program: www.nbp.org.kh
- Lam et al. 2009. Domestic Biogas Compact Course. University of Oldenburg.: http://www.nbp.org.kh/publication/study_report/2_domestic_biogas%20.pdf
- Gurung. 2009. Review of Literature on Effects of Slurry Use on Crop production. The Biogas Support Program: