Application of SRF by a farmer on her rice field (H.PG.T.N. Kualasinghe)

Recycling rice husks in Sri Lanka as a biochar-based slow-release urea fertilizer (Sri Lanka)

“anguru kata” pohora

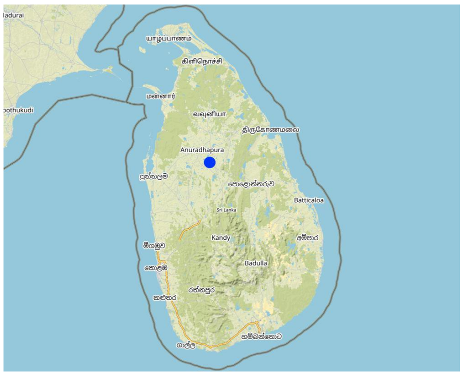
DESCRIPTION

Rice husks, a waste product generated in rice mills, can release its carbon as a greenhouse gas (GHG) to the atmosphere through burning or decomposition. Converting it into biochar and intercalating (filled) with urea can produce a slow-release nitrogen (N) fertiliser that improves N-use efficiency while minimizing GHG emissions.

Rice husks are often considered as a waste, and its carbon is released to the atmosphere as carbon dioxide (CO2) which is a greenhouse gas (GHG) through either decomposition or burning as a biofuel. However, rice husks can be converted into biochar – where its carbon is stable - with a large number of micro and sub-micron size pores in a honeycomb-like structure. Rice husk biochar was produced using an improved batch pyrolizer, “Kunthaniya”, at a temperature of between 450°C and 650°C. Pore spaces in rice husk biochar can be intercalated (filled) with urea and then, slow-release fertilizer (SRF) pellets can be produced through the use of a suitable biodegradable binder. This SRF has found to be more efficient in improving the N-use efficiency, hence the urea requirement of paddy fields in Sri Lanka can be reduced by about 25%, further contributing to environment sustainability. It has been well documented that biochar can improve soil physical, chemical and biological properties in a sustainable manner. This process is a contribution to creative recycling of agricultural waste.
The SRF technology was evaluated against current farmer practice in rice cultivated area in Mahakanumulla village, Anuradhapura district, Sri Lanka. The area belongs to the Dry Zone of Sri Lanka (mean annual rainfall <1750mm). Rice is cultivated during two seasons, yala (May-September) and maha (December – February): the yala season is generally drier. Farmers rely on irrigation water supplied from a small village tank. The SRF was transported to farmers’ fields and applied at 2 weeks (@ 100 kg/ha), at 4 weeks (@ 170 kg/ha) and 7 weeks (@ 145 kg/ha) after direct seeding.
Farmers indicated that the granule size was large and light, hence they had some concerns about even distribution of fertilizer. They perceive that plants receive N slowly compared to granular urea - suggesting the slow releasing nature of the new technology. They did not observe any yield difference. Obtaining rice husks in large quantities from rice mills to produce biochar can sometimes be difficult in some areas of the country due to competition for use in the poultry industry. Some farmers may be discouraged to implement this technology due to lack of knowledge: this can be overcome through extension officers operating at field level.

This new technology qualifies as a sustainable land management practice in number of ways. First it increases N-use efficiency in paddy fields, second it reduces the urea requirement by 25% while sustaining productivity, third it recycles agricultural wastes in paddy fields, fourth, repeated application of SRF improves soil fertility through rice husk biochar, and finally it reduces GHG emissions.

LOCATION



Location: Mahakanumulla village, Thirappane, North Central Province, Sri Lanka

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 80.49616, 8.18388
- 80.49579, 8.18284
- 80.49861, 8.18453
- 80.49605, 8.18309

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: Nee

Date of implementation: 2021

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

Comparison of slow-release fertilizer (SRF) applied in rice fields with conventional fertilizer (H.PG.T.N. Kualasinghe)

Application of SRF by a farmer in her rice field (H.PG.T.N. Kualasinghe)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] 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
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: Nee

Cropland

- Annual cropping: cereals - rice (wetland). Cropping system: Continuous wetland rice

Number of growing seasons per year: 2
Is intercropping practiced? Nee
Is crop rotation practiced? Nee

Water supply

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

Purpose related to land degradation

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

Degradation addressed

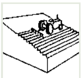
chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion), Cp: soil pollution

water degradation - Hp: decline of surface water quality, Hq: decline of groundwater quality

SLM group

- integrated soil fertility management
- waste management/ waste water management

SLM measures



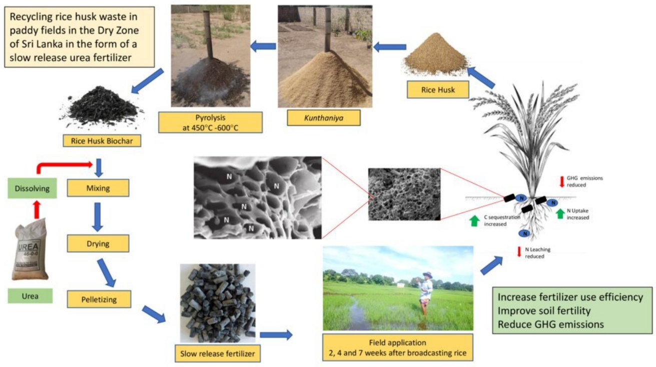
agronomic measures - A2: Organic matter/ soil fertility, A3: Soil surface treatment (A 3.3: Full tillage (< 30% soil cover)), A6: Residue management (A 6.4: retained)

TECHNICAL DRAWING

Technical specifications

Production of SRF: Rice husks were pyrolyzed using a locally modified "Kunthaniya" (a batch pyrolyser) to produce rice husk biochar. The temperature of the pyrolyser was around 450°C to 600°C with a heating rate of less than 20°C per hour. Pore structures were saturated using a urea solution through capillary action. The urea-intercalated rice husk biochar is then mixed with a biodegradable organic substance and pelletized using a medium scale pelletizer and dried to increase its mechanical properties such as resistance to disintegration and shear forces.

Field Experiment : Five paddy farmers were randomly selected from the command area of a small tank in the Mahakanumulla Village Tank Cascade System in the Dry Zone of Sri Lanka. The produced SRF was applied at a rate of 75% of recommended N in three split applications. Yields in SRF applied areas were compared against the current farmer practice. Experimental evidence showed that there is no yield reduction despite the reduction of nitrogen input into their fields.



Author: H.P.G.T.N. Kulasinghe

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1ha**)
- Currency used for cost calculation: **LKR**
- Exchange rate (to USD): 1 USD = 275.0 LKR
- Average wage cost of hired labour per day: 1500

Most important factors affecting the costs

Labour availability and finding raw materials are the major factors that affect the cost.

Establishment activities

1. Collection of paddy husk from rice milling stations (Timing/ frequency: 2 months before cultivation)
2. Pyrolyzing of paddy husk using a pyrolizer or a kunthani (Timing/ frequency: 6 weeks before cultivation)
3. Mixing with urea, ERP and other ingredients and pelletizing (Timing/ frequency: 4 weeks before cultivation)
4. Drying the pellets (SRF) (Timing/ frequency: 2 weeks before cultivation)
5. Packing and transporting SRF to the rice fields (Timing/ frequency: 1 week before cultivation)

Establishment inputs and costs (per 1ha)

Specify input	Unit	Quantity	Costs per Unit (LKR)	Total costs per input (LKR)	% of costs borne by land users
Labour					
Manufacturing SRF	Labour days	2.5	1500.0	3750.0	
Fertilizers and biocides					
Urea	kg	200.0	270.0	54000.0	
Construction material					
Binding materials 1	kg	10.0	25.0	250.0	
Binding materials 2	kg	10.0	250.0	2500.0	
Rice husk biochar	kg	200.0	50.0	10000.0	
Total costs for establishment of the Technology				**70'500.0**	
Total costs for establishment of the Technology in USD				*256.36*	

Maintenance activities

1. Application of first dose of SRF (Timing/ frequency: 2 weeks after direct seeding of rice)
2. Application of second dose of SRF (Timing/ frequency: 4 weeks after direct seeding of rice)
3. Application of third dose of SRF (Timing/ frequency: 7 weeks after direct seeding of rice)

Maintenance inputs and costs (per 1ha)

Specify input	Unit	Quantity	Costs per Unit (LKR)	Total costs per input (LKR)	% of costs borne by land users
Labour					
Labour for SRF application	Labour days	3.0	1500.0	4500.0	100.0
Total costs for maintenance of the Technology				**4'500.0**	
Total costs for maintenance of the Technology in USD				*16.36*	

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

Average annual rainfall in mm: 1400.0

The Mahakanumulla area receives monsoon rainfall during two distinct seasons, namely yala (May – September) and maha (December – February), hence a bimodal rainfall pattern can be observed. The highest amount of rainfall is received during the maha season, in which most of the rainfall comes from the North-eastern monsoonal rains. Lesser rainfall is received from the South-west monsoonal rains, during the yala season. Hence prolonged dry

periods are observed during the yala season. Other than that, this area receives rainfall from two inter-monsoonal rains (March-April and October-November).
Name of the meteorological station: Mahailuppallama, Anuradhapura
Recorded minimum and maximum temperatures in the area are 20.8°C and 29.5°C respectively

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

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [x] 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
- [x] not relevant

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

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

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

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [x] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

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

Water quality refers to: both ground and surface water

Is salinity a problem?
- [ ] Ja
- [x] Nee

Occurrence of flooding
- [ ] Ja
- [x] Nee

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] 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

Comments
The villagers of Mahaknumulla have access for most of the resources like infrastructure and energy/electricity/fuel. But most of the villagers/landusers complain about technical assistant/support for agricultural practices, finding markets for their produce and availability of good quality drinking water. The villagers go to nearby

roads and transport	poor			✓	good
drinking water and sanitation	poor	✓			good
financial services	poor		✓		good

shops to buy day-to-day needs, but they have to go to the town, which is 8-10km away, for other services such as health and financial services.

IMPACTS

Socio-economic impacts

Impact										Comments
Crop production	decreased				✓				increased	Quantity before SLM: 6.5 t/ha (two seasons) Quantity after SLM: 6.9 t/ha (two seasons) Although farmers could not observe a yield increase , experimental evidence suggests upto10% yield increase compared to farmer fertilizer management. A decrease in yield however not observed by farmers despite 25% reduction in N input. The above figures are for average of five farmers over two seasons.
crop quality	decreased				✓				increased	
risk of production failure	increased				✓				decreased	
product diversity	decreased				✓				increased	
production area (new land under cultivation/ use)	decreased				✓				increased	
land management	hindered				✓				simplified	
drinking water availability	decreased				✓				increased	
drinking water quality	decreased				✓				increased	
water availability for livestock	decreased				✓				increased	
water quality for livestock	decreased				✓				increased	
irrigation water availability	decreased				✓				increased	
irrigation water quality	decreased				✓				increased	
demand for irrigation water	increased				✓				decreased	
expenses on agricultural inputs	increased				✓				decreased	Quantity before SLM: LKR 60,750.00/ha for urea Quantity after SLM: LKR 70,500/ha for SRF LKR 270/kg urea and LKR 167/kg of SRF. Expenses were calculated assuming all other costs are constants under two situations
farm income	decreased					✓			increased	Quantity before SLM: LKR 520,000/ha Quantity after SLM: LKR 552,000/ha LKR 80/kg of paddy. Average yields mentioned above was used to calculate the farm income. Therefore, farm income is expected to be increased more than the expenses in SRF applied fields.
diversity of income sources	decreased				✓				increased	
economic disparities	increased				✓				decreased	
workload	increased				✓				decreased	Although a longer time is required for SRF application because of higher bulk volume (175kg more), this application cost is negligible

Socio-cultural impacts

Impact										Comments
food security/ self-sufficiency	reduced						✓		improved	Expected improvements in productivity due to SRF application could strengthen the food security
health situation	worsened				✓				improved	
land use/ water rights	worsened				✓				improved	
cultural opportunities (eg spiritual, aesthetic, others)	reduced				✓				improved	
recreational opportunities	reduced				✓				improved	
community institutions	weakened				✓				strengthened	
national institutions	weakened				✓				strengthened	
SLM/ land degradation knowledge	reduced							✓	improved	Farmers gain awareness through extension programmes when implementing the SRF technology
conflict mitigation	worsened				✓				improved	
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened				✓				improved	

Ecological impacts

Impact										Comments
water quantity	decreased				✓				increased	
water quality	decreased						✓		increased	N accumulation in water bodies is reducing due to lower N losses of SRF
harvesting/ collection of water (runoff, dew, snow, etc)	reduced				✓				improved	

surface runoff	increased	☐☐☐✓☐☐☐	decreased	
excess water drainage	reduced	☐☐☐✓☐☐☐	improved	
groundwater table/ aquifer	lowered	☐☐☐✓☐☐☐	recharge	
evaporation	increased	☐☐☐✓☐☐☐	decreased	
soil moisture	decreased	☐☐☐☐✓☐☐	increased	It is expected to have a better moisture content as a result of accumulation of biochar with repeated application of SRF
soil cover	reduced	☐☐☐☐✓☐☐	improved	Experimental evidence suggests that soil cover is more with rice plants that grow better and tiller more due to better N utilization for crop growth
soil loss	increased	☐☐☐✓☐☐☐	decreased	
soil accumulation	decreased	☐☐☐✓☐☐☐	increased	
soil crusting/ sealing	increased	☐☐☐✓☐☐☐	reduced	
soil compaction	increased	☐☐☐✓☐☐☐	reduced	
nutrient cycling/ recharge	decreased	☐☐☐☐☐✓☐	increased	Quantity before SLM: N uptake: 167 kg of N/ha Quantity after SLM: N uptake: 219 kg of N/ha Higher uptake of N by rice plants due to SRF application, nutrient recycling is expected to be improved. The above values were obtained from 5 farmer fields in the year 2021.
salinity	increased	☐☐☐✓☐☐☐	decreased	Quantity before SLM: Electrical Conductivity : 0.11 dS/m Quantity after SLM: Electrical Conductivity : 0.09 dS/m The above values were obtained from 5 farmer fields in the year 2021.
soil organic matter/ below ground C	decreased	☐☐☐☐☐☐✓	increased	SRF contains biochar which is a good source to improve the soil C.
acidity	increased	☐☐☐✓☐☐☐	reduced	Quantity before SLM: pH : 7.42 Quantity after SLM: pH : 7.38 The above values were obtained from 5 farmer fields in the year 2021.
vegetation cover	decreased	☐☐☐☐☐✓☐	increased	Efficient uptake of N cause to improve the crop growth, thereby vegetation cover
biomass/ above ground C	decreased	☐☐☐☐☐✓☐	increased	Quantity before SLM: 5.2 t/ha (straw) + 8.1 (grain) Quantity after SLM: 6.0 t/ha (straw) + 8.7 t/ha (grain) Higher crop growth results higher biomass production. The above values were obtained from 5 farmer fields in the year 2021.
plant diversity	decreased	☐☐☐✓☐☐☐	increased	
invasive alien species	increased	☐☐☐✓☐☐☐	reduced	
animal diversity	decreased	☐☐☐✓☐☐☐	increased	
beneficial species (predators, earthworms, pollinators)	decreased	☐☐☐✓☐☐☐	increased	
habitat diversity	decreased	☐☐☐✓☐☐☐	increased	
pest/ disease control	decreased	☐☐☐✓☐☐☐	increased	
flood impacts	increased	☐☐☐✓☐☐☐	decreased	
landslides/ debris flows	increased	☐☐☐✓☐☐☐	decreased	
drought impacts	increased	☐☐☐✓☐☐☐	decreased	
impacts of cyclones, rain storms	increased	☐☐☐✓☐☐☐	decreased	
emission of carbon and greenhouse gases	increased	☐☐☐✓☐☐☐	decreased	
fire risk	increased	☐☐☐✓☐☐☐	decreased	
wind velocity	increased	☐☐☐✓☐☐☐	decreased	
micro-climate	worsened	☐☐☐☐☐✓☐	improved	Because of the better growth of the rice plants micro climate in the paddy fields is expected to be improved.

Off-site impacts

water availability (groundwater, springs)	decreased	☐☐☐✓☐☐☐	increased	
reliable and stable stream flows in dry season (incl. low flows)	reduced	☐☐☐✓☐☐☐	increased	
downstream flooding (undesired)	increased	☐☐☐✓☐☐☐	reduced	
downstream siltation	increased	☐☐☐✓☐☐☐	decreased	
groundwater/ river pollution	increased	☐☐☐☐☐✓☐	reduced	N accumulation in water bodies is expected to be reduced due to lower N losses from SRF
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	☐☐☐✓☐☐☐	improved	
wind transported sediments	increased	☐☐☐✓☐☐☐	reduced	

damage on neighbours' fields	increased	✓ (neutral)	reduced
damage on public/ private infrastructure	increased	✓ (neutral)	reduced
impact of greenhouse gases	increased	✓ (neutral)	reduced

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	✓ (neutral)	very positive
Long-term returns	very negative	✓ (slightly positive)	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓ (positive)	very positive
Long-term returns	very negative	✓ (slightly positive)	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well	Answer: not known
annual rainfall decrease	not well at all	very well	Answer: not known

ADOPTION AND ADAPTATION

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

- [x] 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%
- [ ] 91-100%

Number of households and/ or area covered

5 farmers/households

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

- [ ] Ja
- [x] 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

- This technology uses less chemical fertilizer and therefore it is good for their health and environment
- This technology gives better crop growth and slightly higher yield
- Biochar could improve the fertility of the soil

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

- SRF reduces the N losses from the soil and allows the rice crop to uptake N effectively from soil at required growth stages. Efficient N uptake promotes the crop growth and increase the productivity.
- Reduced N losses of SRF directly influence the water quality by reducing the losses of N through surface runoff and leaching and avoid accumulation in water bodies at the lower positions of the landscape.
- Rice husks, which is are good source of C, are utilized for SRF production; hence it promotes C sequestration as it is added back to the soil as biochar. It improves the soil organic carbon pool and promotes carbon sequestration in soil.
- Utilizing rice husks by returning back to the rice fields is an effective solution for rice waste management.
- If the SRF production technology can be transferred to farmers, their societies can produce the SRF by themselves from the wastes generated in small scale rice mills.

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

- Additional cost despite reduced chemical fertilizer increased crop yields can partially compensate this. They can produce their own SRF if the production technology is transferred to them
- Uneven distribution of nitrogen in the field Changing the water management practices that have been currently adopted by farmers

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

- The raw materials need to be formulated accurately to get the benefits of the technology. Hence, technical knowledge and experience is required when preparing SRF. Proper guidance and technical support from the beginning to the end of the process is essential. This can be achieved through educating and training extension officers to teach and disseminate knowledge for farmers.

REFERENCES

Compiler
Head Soil Science

Editors

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Maart 17, 2022

Last update: Maart 24, 2022

Resource persons
Lakmini Dissanayaka - SLM specialist
Renuka Senarathna - land user
Lekam Ralalage Nandasena - land user
Vimalawathi Kirihamige - land user
Saman Dharmakeerthi - co-compiler
Tharindu Kulasinghe - co-compiler

Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_6184/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- Faculty of Agriculture, University of Peradeniya, Sri Lanka (AGRI.PDN) - Sri Lanka

Project
- n.a.

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