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

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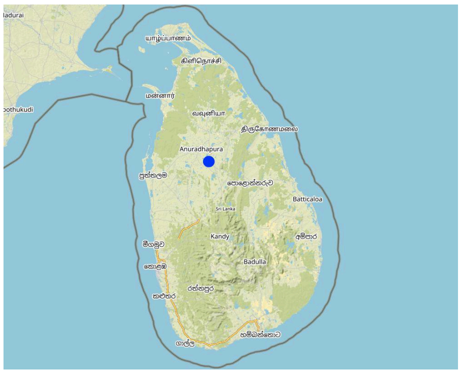
“anguru kata” pohora

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.



: Mahakanumulla village, Thirappane, North Central Province,

: 2-10

- 80.49616, 8.18388
- 80.49579, 8.18284
- 80.49861, 8.18453
- 80.49605, 8.18309

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: 2021

(> 50)

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✓ /

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)

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Cropping system:

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- Cn:

(

), Cp:

- Hp: , Hq:

SLM

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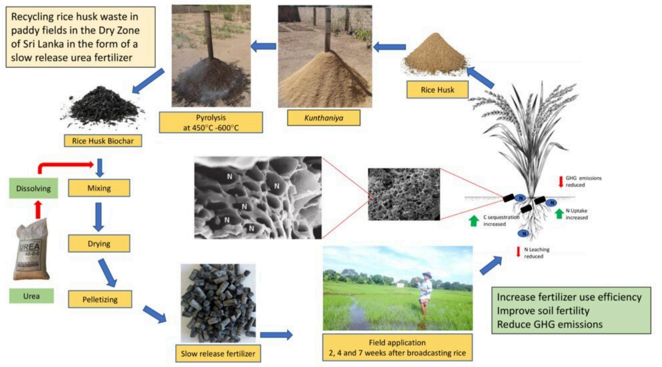
SLM

- A2: /

, A3: (A 3.3: Full tillage (< 30% soil cover)), A6: (A 6.4:)

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

- (**1ha**)
- **LKR**
- ( ) 1 USD = 275.0 LKR
- 1500

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

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

			(LKR)	(LKR)	%
Manufacturing SRF	Labour days	2,5	1500,0	3750,0	
Urea	kg	200,0	270,0	54000,0	
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	
				70'500.0	
				256.36	

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

			(LKR)	(LKR)	%
Labour for SRF application	Labour days	3,0	1500,0	4500,0	100,0
				4'500.0	
				16.36	

- < 250
- 251-500
- 501-750
- 751-1,000
- ✓ 1,001-1,500
- 1,501-2,000

✓

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

- 2,001-3,000
- 3,001-4,000
- > 4,000

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).

Mahailuppallama, Anuradhapura

Recorded minimum and maximum temperatures in the area are 20.8°C and 29.5°C respectively

- ✓ (0-2%)
- (3-5%)
- (6-10%)
- (11-15%)
- (16-30%)
- (31-60%)
- (>60%)

- 0-100
- ✓ 101-500
- 501-1,000
- 1,001-1,500
- 1,501-2,000
- 2,001-2,500
- 2,501-3,000
- 3,001-4,000
- > 4,000

- (0-20)
- (21-50)
- ✓ (51-80)
- (81-120)
- (> 120)

( ) (> 20)

- ✓ / ( )
- (,)
- / ( )

- / ( )
- ✓ (,)
- / ( )

- (>3%)
- ✓ (1-3%)
- (<1%)

- ✓ < 5
- 5-50
- > 50

( ) ?

SLM

- 10%
- ✓ 10-50%
- 50%

- < 0.5
- ✓ 0.5-1
- 1-2
- ✓ 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- > 10,000

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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 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.

SLM: 6.5 t/ha (two seasons)
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.

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SLM: LKR 60,750.00/ha for urea
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

SLM: LKR 520,000/ha
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.

Although a longer time is required for SRF application because of higher bulk volume (175kg more), this application cost is negligible

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Expected improvements in productivity due to SRF application could strengthen the food security

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SLM /

Farmers gain awareness through extension programmes when implementing the SRF technology

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N accumulation in water bodies is reducing due to lower N losses of SRF

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It is expected to have a better moisture content as a result of accumulation of biochar with repeated application of SRF

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

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SLM: N uptake: 167 kg of N/ha
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.

SLM: Electrical Conductivity : 0.11 dS/m
SLM: Electrical Conductivity : 0.09 dS/m
The above values were obtained from 5 farmer fields in the year 2021.

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SRF contains biochar which is a good source to improve the soil C.

SLM: pH : 7.42
SLM: pH : 7.38
The above values were obtained from 5 farmer fields in the year 2021.

Efficient uptake of N cause to improve the crop growth, thereby vegetation cover

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SLM: 5.2 t/ha (straw) + 8.1 (grain)
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.

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Because of the better growth of the rice plants micro climate in the paddy fields is expected to be improved.

(-springs)

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N accumulation in water bodies is expected to be reduced due to lower N losses from SRF

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- [x]
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

?

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

/

5 farmers/households

?

- [ ] /
- [x]

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- [ ] /
- [ ]
- [ ] ( )

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- 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

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- 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.

/ / :

- 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

/ / :

- 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

- 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.

extension officers to teach and disseminate knowledge for farmers.

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https://qcat.wocat.net/km/wocat/technologies/view/technologies_6184/

SLM

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