Method Article

Low cost zero till *in situ* green manuring for faster decomposition of left over rice/wheat stubbles from combined harvest to minimse field burning : an opinion

- Please review the english of the whole article.

Abstract

Low cost zero till *in situ* green manuringusing different plant species i.e,dhaincha, sunnhemp, rice bean, jute, chocolate weed, khersai, white sweet clover, mustard etc., will eliminate the age old problems of large scale adoption of green manuring across the farming community. It will produce green manure at affordable price for rice, help in quicker decomposition of rice straw and minimise its field burning left after combined harvest (3.5- 6 t/ha), sequester enough carbon to the soil, minimise environmental pollution and improve soil health, soil structure and its water holding capacity. Rice bean, green gram, sunnhemp and, jute etc can also be grown as green manures/easily decomposable biomass resources after wheat harvest which can be mixed with its stubble under i*n situ condition* for its quicker decomposition rather burning the later in open field creating environmental pollution. These different succulent species could successfully geminate after/before rice harvest under zero till condition and has the scope of green manuring at lower cost. Legumes will add 50 to 60 kg nitrogen per hectare along with a biomass of 10 - 30 t/ha. Adding dhaincha as green manure before kharif rice, its nitrogen requirement from chemical fertiliser was eliminated and it produced 39 q raw rice (cv. CR-1009)/ha at Bhubaneswar, Odisha (Khan *et al.*, 2000). Non legumes like jute, mustard and chocolate weed produced succulent biomass of 8-10 t/ha at 30-40 days.

Keywords???

Introduction: Green manuring concept is no longer prevalent across the world except a few places due to abundance of cheap chemical fertilisers, high cropping intensity (leaves no time between crops), high cost of ploughing and irrigations (Khan *et.al*; 2000) which requires at least one ploughing for sowing and two irrigations costing Rs.15000/ha at present. The soil is already hungry of plant nutrients and poor in organic matter in high intensity cropping system across the globe, particularly in tropics. Majority of the Summer rice grown in India (2.971 million hectares, ministry of Agriculture and Farmers' Welfare, Krishak Jagat, 6th May 2022) is under mechanised harvest now. This process leaves a colossal amount of rice stubbles (around 3.5- 6 t/ha) which are primarily brunt by farmers causing huge loss of plant nutrients, adds GHG gases to the environment, destroy soil biota and adds particulate matter to air, causing environmental pollution, a much debated issue today. Apart from this, summer rice is also grown in large area in different tropical countries of the world where mechanised rice harvest is also prevalent. Burning of left over wheat stubbles is also posing environmental threats in many places around the globe. Addition of low cost nitrogen rich biomass from zero till green manure with these rice/wheat stubbles will help its quicker decomposition, add nutrition to the soil, improve soil health and minimise rice straw burning. Different types of plant species from leguminous and malvaceae family were grown after summer and Kharif rice under zero till condition for green manuring purposes which will facilitate quick decomposition of rice stubbles left after mechanised harvest. Non leguminous species (jute, mustard and chocolate weed) can add 8-10 tonnes biomass per ha in 35 to 40 days.

I suggest inserting biographical references from the last five years.

Procedures and results: Consecutive experiments were made in North 24 PGS (ICAR-CRIJAF), Paschim Medinipur and Purulia (Bagmundi farm) districts of WB from 2019 - 2022 to test the validity of different plant species as green manure for rice. Attempts are underway to grow zero till sunnhemp (*Crotalaria juncea* cv. JRG 610 @ 30 kg/ha, Photo 1)and rice bean (*Vigna umbellata*, cv. Bidhan rice bean 2, @ 20 kg/ha, Photo 2), after summer rice harvest using nor-wester rain in Paschim Medinipur, District, village Dakshin Kalapunja in 6 farmers land including a progressive farmer Mr. Milan Kumar Ojha. This requires no ploughing and irrigation and will help in faster decomposition of left over rice stubbles after mechanised harvest. Sunnhemp germinated well both after summer rice and Kharif under zero till system in North 24 PGS and Paschim Medinipur, WB (2021& 2022). Its biomass production potential is not more than 5-7 t/ha in winter months. Dhaincha (*Sesbania spp*) germinates well in zero till sowing after summer rice with good nor-wester shower or irrigation, it has little waterlog tolerance but require puddling by rotavator before kharif rice transplanting. Adding dhaincha before kharif rice, its nitrogen requirement from chemical fertiliser was eliminated and it produced 39 q raw rice (cv. CR-1009)/ha at Bhubaneswar, Odisha (Khan *et al.*, 2000)

Attempts were also made to grow sunnhemp *(Crotalaria juncea*) in ploughed field after summer rice (Mid April) harvest in Paschim Medinipur, WB in 2016 and we got around 30 tonnes of nitrogen rich biomass per hectare in clay soil (Photo 1, 3rd from left). It can add 50-60 kg nitrogen/ha when grown for 60-90 days (Sarkar *et al*, 2015). This has the advantage that it can be terminated by natural water logging from pre-monsoon on monsoon rain and eliminates the cost of turning down by plough. Being rich in nitrogen (0.3% on fresh weight basis) it decomposes faster and its mixture with silicon rich rice or wheat straw helps in quicker decomposition (Ghorai, 2020, www.knowledgebank.iiri.org).

Photo 1. Zero till Sunnhemp for green manuring after summer and kharif rice (1st & 2nd from left), Pashim Medinipur, WB

Photo 2. Zero till rice bean after rice harvest for green manuring, Pashim Medinipur, WB

White sweet clover as green manure: It is also imperative to mention that attempts are already underway in North 24 PGS and Purulia Districts (Bagmudi) to grow white sweet clover, *Melilotus alba,* a land race from ICAR-CRIJAF, Photo 3, having self regeneration capacity after Khraif rice in winter, adds 10-15 tonnes of green biomass (maximum 100 cm height in 45-60 days) rich in nitrogen and can be terminated by water logging and puddled before summer rice transplantation. Sweet clover

is traditional green manure crop in the upper Midwest before nitrogen fertilizer became widely available, sweet clover usually produces about 100 lb. N/A, but can produce up to 200 lb. N/A with good fertility and rainfall. In Ohio, it contained about 125 lb. N/A by May 15, increasing to 155 lb. by June 22. Illinois researchers reported more than 290 lb. N/A. Rapeseed (*Brassica campestris*) is a summer annual cash crop in the dry land West that can serve as a nurse crop for sweet clover. A Saskatchewan study of seeding rates showed optimum clover yield came when sweet clover was sown at 9 lb./A and rapeseed was sown at 4.5 lb./A (USDA, SARE 2012). Mustard production potential with white sweet clover was 10 q/ha (cv. Pusa bold) at ICAR- CRIJAF. Growth and seed production ability of *Melilotus alba* in winter months in red lateritic soils of Purulia district have been confirmed in 2021 and 2022 under supervision of Dr. Ankit Kumar Ghorai, Assistant Director of Agriculture, (Bagmundi), Purulia, WB.

Photo 3. White sweet clover and its mixed cropping with mustard (Pusa bold) at ICAR-CRIJAF

Jute as green manure: Young zero till jute canopy sown after summer rice (15th April) with a seed rate of 6-7 kg/ha and basal nitrogen of 20 kg/ha, can be turned down at 40 days with left over wet rice stubbles at early rain (Photo 4a) or with irrigation for its faster decomposition. This will sequester enough carbon to the soil and smother composite weeds before rice transplantation (Ghorai and Roy 2022) in kharif season. This young jute canopy (8-10 tonnes/ha) growth can also be terminated with natural water logging also. Rice yield from jute and rice mixed cropping was 3 t/ha and jute added around 5 tonnes of green biomass/ha at 35-40 days after sowing.

Photo 4 (a): Zero tilldense sole jute canopy (*Corchorus olitorius* L*)* after summer rice and its mixed cropping with rice for green manuring (ICAR-CRIJAF) and weed smothering in rice at early stage

Melochia corchorifoila **as green manure:** Self seeded zero till *Melochia corchorifoila* grown after summer rice (Photo 4b) has the potential to add 10 tonnes of biomass before kharif rice. It can be ploughed by a rotavator at knee high stage before rice transplantation before its flowering to avoid its undue spread.

Photo 4 (b): Dense and succulent canopy of *Melochia corchorifoila* for green manuring and weed smothering at early stage, ICAR-CRIJAF,WB.

Khesari as green manure: In winter months Zero till Khesari (*Lathyrus satyvus*) produces enough nitrogen rich fresh biomass (5-7 t/ha) by 60 days depending on soil fertility and its moisture content suitable for green manuring in rice fallows (Photo 5). In winter zero till young mustard/rape seed will also add around 5-7 tonnes of biomass depending on soil fertility and moisture.

Photo 5. Zero till khesari after Kharif rice at ICAR-CRIJAF, Brrackpore.

Conclusion : This attempt will eliminate the age old problems of adoption of green manuring at large, produce green manure at lower cost, help in quick decomposition of rice straw and its field burning, sequester enough carbon to the soil, minimise environmental pollution and improve soil health including soil biota, improve soil structure and water holding capacity of soil. Rice bean, sunnhemp or jute can also be grown as green manures/easily decomposable biomass resources after wheat harvest which can be mixed with its stubble under i*n situ condition* for its quicker decomposition rather burning the later in open field creating environmental pollution.

Authors should explore the results further.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because

we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

Please review the bibliographic references it is important to place them in the journal format.

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