

## Low Cost Zero Till *in situ* Green Manuring for Faster Decomposition of Rice/Wheat Stubbles Left after Combined Harvest to Minimise Field Burning

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### ABSTRACT

Low cost zero till *in situ* green manuring using 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, 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 *in situ condition* for its quicker decomposition rather burning the later in open field creating environmental pollution. These different succulent species could successfully germinate 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. Non legumes like jute, mustard and chocolate weed produced succulent biomass of 8-10 t/ha at 30-40 days. Jute as green manure alone before rice produced 2.6 t rice grain /ha, where no chemical fertiliser was applied.

**Key words:** Low cost; zero tillage; *in situ* green manuring; rice/wheat stubbles; decomposition.

**1. 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 [1] which requires at least two ploughing and two irrigations costing Rs.20000/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 (2.971 million hectares) grown in India, [2] ministry of Agriculture and Farmers' Welfare, is under mechanised harvest now. This process leaves a colossal amount of rice stubbles (around 3.5- 6 t/ha) which are primarily burnt 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.

### 2. PROCEDURES AND RESULTS:

**2.1 Zero till sunnhemp, rice bean and dhaincha as green manure.** 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

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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 and dhaincha germinated well both before and after summer and Kharif rice harvest under paira/zero till system in North 24 PGS at ICAR-CRIJAF and Paschim Medinipur, WB (2021& 2022). Its biomass production potential is not more than 5-7 t/ha in winter months. 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 [1]. The grain yield of both direct sown and transplanted crops increased with dhaincha green manuring compared with the control (no application of dhaincha) and was equal to the application of 40 kg N/ha applied as urea fertilizer [3] .

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 [4]. This has the advantage that it can be terminated by natural water logging from pre-monsoon on monsoon rain. 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 [5,6] of straw.



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

**2.2 Self seeded 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. nitrogen/acre, but can

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produce up to 200 lb. nitrogen/acre with good fertility and rainfall. In Ohio, it contained about 125 lb. nitrogen/acre by May 15, increasing to 155 lb. by June 22. Illinois researchers reported more than 290 lb. nitrogen/acre. 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./acre and rapeseed was sown at 4.5 lb./acre [7]. Mustard (cv. Pusa bold ) production potential with self seeded white sweet clover was 10 q/ha (Photo 3) 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

**2.3 Zero till jute as green manure:** Young zero till jute canopy sown after summer rice (15<sup>th</sup> 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 [8,9] in kharif season. This young jute canopy (8-10 tonnes/ha) growth can also be terminated with natural water logging. Rice yield following jute green manure alone, from Burdwan was 2.6 t/ha over 2.4 t/ha when cow dung was applied @ 5t/ha before rice and in un manured plot it was only 1.3 t/ha [10]. Rice yield from jute and rice mixed cropping was 3 t/ha (cv. Kshitish) and jute added around 5 tonnes of green biomass/ha at 35-40 days after sowing, ICAR-CRIJAF, 2019.



Photo 4 (a): Zero till dense 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

**2.4 Self seeded *Melochia corchorifolia* as green manure:** Self seeded zero till chocolate weed, *Melochia corchorifolia* , 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 kharif rice prior to its flowering to avoid its undue spread. Use of *Melochia corchorifolia* as green manure has been reported [11] in Maharastra.

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

**2.5 Zero till paira Khesari and mustard as green manure before summer rice:** In winter months Zero till paira Khesari (*Lathyrus satyvus*), produces nitrogen rich fresh biomass (5-7 t/ha) by 60 days depending on soil fertility and its moisture content. It is suitable for green manuring [12] in rice fallows or before summer rice. In winter zero till paira young mustard/rape seed will also add around 5-7 tonnes of biomass before summer rice depending on soil fertility and moisture (Photo 5). Green manuring potential of rape in Northern America and Europe has been reported by [13]. Rapeseed incorporation in soil as green manure reduced weed density by 85 and 73% and weed biomass 96 and 50% in 1992 and 1993, respectively, in following potato compared to potato after fallow. Potato grown after rapeseed incorporation as green manure yielded 25% and 17% more total tuber yield than potato after sudangrass in 1992 and fallow in 1993, respectively. Depending on location, planting date and soil fertility, rapeseeds produce up to 8,000 lb. biomass/acre. Because of their fast fall growth, brassicas are well-suited to capture soil nitrogen (N) remaining after crop harvest. The amount of nitrogen captured is mainly related to biomass accumulation and the amount of N available in the soil profile [14] only.



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

**3. CONCLUSION :** This renewed attempt of low cost green manuring will eliminate the age old problems of adoption of green manuring at large, produce green manure at permissible cost, sequester enough carbon to the soil, improve soil health including soil biota, improve soil structure and its water holding capacity, help in quick decomposition of silica rich rice straw, avoid field burning, and minimise environmental pollution. Dhaincha, rice bean [15] sunnhemp or jute can also be grown as

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green manures/easily decomposable biomass resources after wheat harvest which can be mixed with its stubble under *in situ condition* for its quicker decomposition rather burning the later in open field creating environmental pollution.

**COMPETING INTERESTS :** Authors have declared that no competing interests exists.

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