System of Root Intensification of Natural Farming of Paddy

Introduction

What is SRI?

SRI refers to System of Root Intensification which refers to efficient management of crop and soil. . It started in 1980s as System of Rice Intensification by a Jesus Priest Father Henry D Laulanae in Medagaskar.It Spreaded in India and Various other more than 70 countries through Dr Norman Uphoff,ex Professor,International Agriculture, Cornell University, Ithaca, USA.In India it started in 2000-2001 through Dr Tyagrajan,ex Dean,Tamil Naydu Agriculture University and various civil society Organisations and State Rural Livelihood Missions under NRLM,MORD,New Delhi across India. In 2007-08 in Bihar when the principles were successfully demonstrated in various crops later on PRAN worked on root systems and termed it as System of Root Intensification method of crop cultivation. The basic principles of SRI of Natural Farming is as follows.

- Young age seedlings/sprouted seeds to preserve the plant inherent growth potential for rooting and tillering
- Sowing/transplanting Single/few seeds/seedlings should be done quickly, carefully and skillfully in order to avoid any trauma to the roots, which are the key to plant success
- Reduce the plant population through wider spacing so that roots and canopy have room to grow and can have greater access to nutrients, sunlight, etc
- Providing growing plants with sufficient water to meet the needs of roots, shoots and soil biota but never in access so that roots do not suffocate and degenerate.
- Active soil aeration improves crop growth so that both the roots and beneficial aerobic soil organisms are in benefit
- Providing more space to roots to access nutrients,aeration,water to support natural nutrient cycle present in the nature and augmenting organic matter in soils, as much as possible improves performance of the crops by improving soil structure and functioning and supporting beneficial soil organisms

Significance of SRI principles

Principles	**significance**
Younge seedlings/sprouted seeds	**Much greater potential for tillering and root growth as earlier arrival within a better growing environment in the main field extends the time for tillering, besides no transplanting shocks if transplanting is done**

	carefully
Single seedling per hill	**Seed requirement is very low no competition for nutrient,water and space within seedlings.Less seedlings per unit area combined with wider spacing enables all leaves to be photosynthetically active whereas with crowding lower leaves do not get enough exposure to sunlight for photosynthesis.This deprives the plants specially the roots of possible supply of photosynthesis.**
Wider spacing	**Promote more profuse growth of Roots and tillers in case of Paddy and wheat . More space (below and above ground) per hill for access to nutrients, water and light .inter cultivation with mechanical weeder is made this possible.**
Moist and unflooded water management system	**Non hypotoxic condition of soil favours roots health and functioning and supports more abundant and diverse communities of beneficial aerobic soil organisms. Besides no degeneration of roots which otherwise will be 75% degraded by panicle initiation within flooding. Exposing the soil to sunlight is favourable for warmth. Also water saving of up to 40% with energy saving where water is pumped.**
Inter-cultivation	**Churning up of the soil activates the microbial, physical and chemical dynamics. Due to reduced seedling per unit area triggers greater root growth and tillering. Weed biomass is incorporated in to the soil as green manure and therefore weeding cost is therefore reduced.**
Use of natural fertilisers,manures	**Gives better plant response than inorganic fertilisers,more sustained supply of nutrients and favourable growth of soil flora and fauna enriches the soil health.**

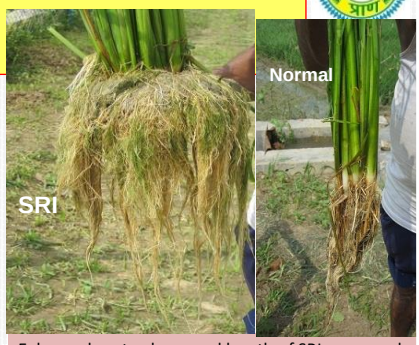
Source: A.Viral 2017,NITI Aayog Report 2022

The effect of climate change is being seen in agriculture. Farmers in both the area whether flood prone or draught prone have started experiencing the effect of climate change. The non uniform distribution of rainfall, variation of temperature, delay in monsoon, has affected the Paddy crop significantly. Due to absence of proper rainfall during rainy season large acreage of lands produce less .Farmers keep getting low yields . Under growing population and this climatic conditions SRI and its principles is a way forward to feed the nation and sustain the livelihoods of large number of small and marginal holders. It also enhances the carrying capacity of natural resources soil, water, Flora, Fauna intact for upcoming generations of human being at large.

Addressing food Insecurity through appropriate Technologies: System of Root Intensification (SRI)- as inclusive socio-economic entity

Root is the mouth of the plant – keep that healthy

SRI method consider root play crucial role (different from green revolution in the country). In addition, SRI uses



Enhanced root volume and length of SRI compared to normal method

- Low external inputs (seed, fertilizers, water, labor) to make this within reach of resource poor families. THIS LEADS cost-effective CROP ECONOMY
- **HOUSEHOLD FOOD SECURITY:** High productivity to ensure enhanced availability of home-grown food grains to small and marginal farmers
- SRI is an inclusive system and ensure Sustainability (Conserving precious soil, water and environment carrying capacity for future generations)

Why SRI-Paddy?

The population of country is growing at a fast rate. Every year 1.3 Cr people is added to the total.The productivity and the production of Paddy crop has been stagnant over the years .Also the per capita land availability is decreasing since 1951.The availability of land per capita decreased from 0.37 ha in 1951 to 0.19 ha in 2001.By 2051 this is going to be as low as 0.13 ha. In densly populated states like Bihar and West Bengal it is as low as 0.08ha and 0.07 ha respectively.

Year	Cropped area	Total Population	Overall average land/capita
1951	131.89	361.1	0.37
1971	165.79	548.2	0.30
1991	185.74	846.3	0.22
2001	190.76	1027	0.19
2051	200	1600	0.13

The foodgrain particularly rice availability per capita(gm/day) has decreased from 221.7 in 1991 to 206.4 in 2000.This is affecting food security of rural masses in general and poor and marginal communities in particular. Rice is staple foodgrain for the Indians.The poor people in villages consume *manr-bhat* to survive.with low productivity of rice when this is also not available to poor people they are forced to migrate to other places.The only option to increase production in Paddy is left with us through vertical expansion i.e increasing productivity per unit area.By 2020 to feed our country we will have to produce 15-20 million tones additional rice for the people.

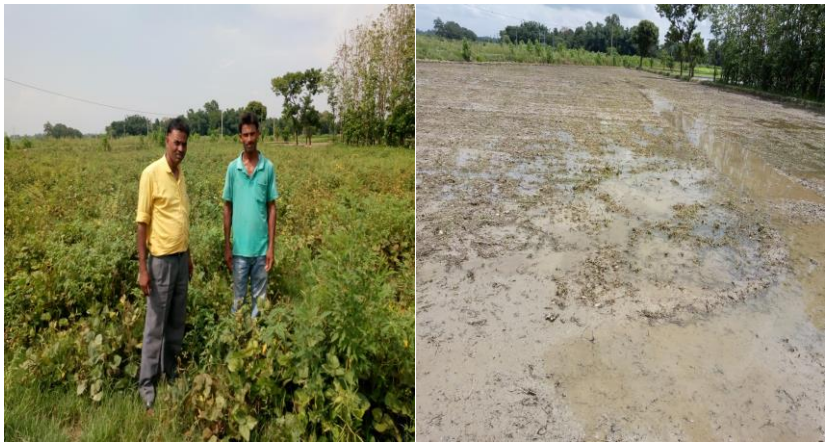
Wherever System of Rice intensification(srividhi) has been tried out and demonstrated among Indian farmers the productivity has almost doubled.The demonstration and field trials carried out by various stakeholders have generated intensity among farmers.At many places like Tripura,Tamil Nadu,Andhra Pradesh and other states large number of farmers have experienced the advantages of SRI.The extension mechanism to scale up this programme need to come forefront and make this an integral part of the extension systems prevailing in the country. It should be promoted unilaterally as it is advantageous over improved paddy cultivation methods.

- It requires less seed rate of 2 kg per acre as compared to 20 kg per acre under improved paddy cultivation.
- With availability of weeder the labour cost reduces by 21%.
- It requires no chemical fertilizers as compared to normal cultivation and saves the soil from health hazards.
- The productivity under SRI is doubled.
- It suits the need of small and marginal farmers.
- It has capacity to feed the large population
- It will ensure high productivity along with keeping the soil health in good condition.
- The scarcity of good quality seeds will be addressed as seed rate is reduced by 90%.
- It requires less water,less seed and matures in comparatively less number of days.
- It has more capability to sustain the climatic hazards like erratic rainfall,dry spells during rainy season thus also suitable for rainfed area.
- The damaged caused by rats is less as compared to improved cultivation of Paddy.
- The poor agricultural labourers get more wage per harvesting days where wage is given in Kind.
- The cost of cultivation is less as compared to normal paddy .
- Benefit:Cost ratio is higher than improved cultivation of paddy

Module content: PoP / Intervention / Framework /implementation of technology etc

Deep summer ploughing and promotion of green manuring through Dabholkar method adds large organic matter in the soil which enhances water holding capacity, Permeability and soil aeration necessary for growing of crops and plants. The improvement in physical properties such as soil structure and soil texture adds to the overall improvement of soil and its nutrient availability to the plants.

Pre-Ploughing(Dabholkar) and after incorporation in to soil



Source: **A BRLPS –PRAN -SLACC demonstration at Madhubani, Bihar**

Land preparation: when seeds 40 kg/acres(4:2:0.5:0.5) 4 parts cereals: 2 parts pulses : 0.5 part oilseeds:0.5 part spices grains are broadcasted just after first rainfall after ploughing the land.These after 35-40 days when actual rainfall start for puddling for preparing the main plot for transplantation of SRI fields, these grown up green manures are incorporated in to the soil.In initial year it is required on year to year basis seeing the status of organic carbon in the soil.

Priming of Paddy seeds and Seed Treatment

The priming of seeds is not a common practice in India among farmers. This helps in segregating productive seeds for good cultivation of the crop. The seed with high vigour also contributes in productivity. The infected and infested seeds are segregated from the lot of seeds. Only those seeds are left which have good viability. In normal shining packets available in market have also 4-11% of poor seeds in the lot. These seeds produce poor crop which easily gets infested by disease and pests.

Practical 1 : Priming of Paddy seeds

Practical content:

1. Seed- 2 Kg
2. Bucket with water - 1(5 lit)
3. Egg/potato- 1 nos
4. Salt- 2 kg

Process- Prepare a brine solution using common salt. Using egg or potato of 40 g mix salt in water till egg or potato comes on surface of water. If one fourth of egg or potato is visible stop adding salt to the

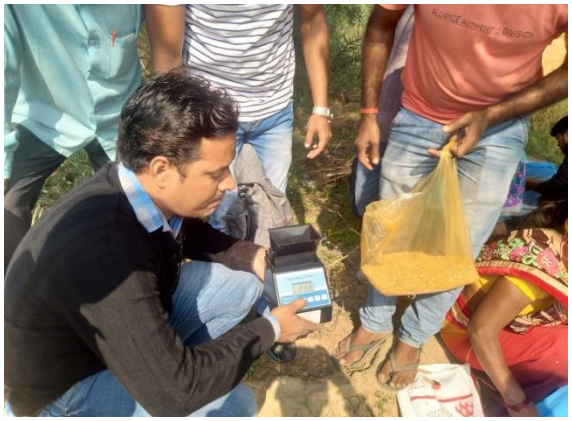
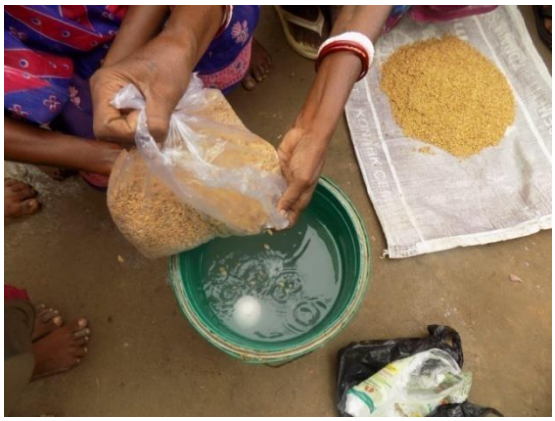
water. While moving your hand in water holding the egg or potato ensure that the salt added to the water is properly dissolved in water.

Remove the egg or potato out of water and keep that aside. The solution thus prepared is brine solution. In this brine solution put the paddy seeds in to the brine solution. Take double quantity of water as compared with quantity of paddy seeds. Mix the seeds in to salt water and allow this solution to rest for few minutes. After few minutes the paddy seeds in the salt water gets divided in to three layers. The surface layer of seeds are chaffy seeds, also some infected seeds come on the surface. The second layer neither settles down nor it comes on the surface. It is in between the surface and bottom of the pot. The third layer settles at the bottom in the pot.

Remove the first layer by filtering with hand from the upper surface. The middle layer paddy seeds will come out only when water is allowed to fall by tilting the pot. The middle layer seeds come out along with water. These are also underweight seeds which should not be allowed to take part in production process.

The bottom layer paddy seeds is cleaned with plain water three or four times so that salt is completely removed.After that Paddy seed is tied in a jute bag and drawned in to water for 18-20 hours.After 18-20 hours the priming of seeds is complete.

Preparation of brine solution(photo-Tata Trust-PRAN-SRI project)

A slacc worker of BRLPS invoved in priming(photo-SLACC,BRLPS,Gaya) and women involved in priming of Paddy seeds –APPI-PRAN-SRI project photo from Nawada,Bihar)

Seed treatment

The farmers should compulsorily treat his seeds/seedlings initially just after priming so that it is affected less by insect pests and diseases during its life cycle. By treating seeds/seedlings the inherent ability and initial requirement of nutrition is also met and the crop develops immunity in to it which helps crops/plant to resist diseases and pest infestations during its growth period.

Material Required:-

1. Paddy seeds(priming done)-2kg
2. Sribeejamrit-4l
3. Pot-1pc(10 lit)
4. Trichoderma herzianum-40g

Process

After priming of Paddy seeds the seed treatment of paddy seed is done. The paddy seed is drawned in to the solution of freshly prepared sribeejamrit for 20 to 25 minutes. After this the seeds are taken out and spread on the surface on a jute bag. After treatment with Sribeejamrit the paddy seeds are partially allowed to dry. After that treatment is done with Trichoderma @ 20gram per kilogram of Paddy seeds. It is further spreaded and dried partially and tied in a jute bag .The tied jute bag is kept at a dry and shade place for 15 -16 hours for germination of seeds.During this period the water can be sprayed to keep the seeds moist. It should be noted while spraying of water that water drops do not fall down, just moist condition should be maintained. After sprouting the seeds should be used for nursery raising.


After first treatment with sribeejamrit, the women is treating her Paddy seeds for second time with Trichoderma Powder(photo-APPI-PRAN-SRI-Project, Nawadah, Bihar)

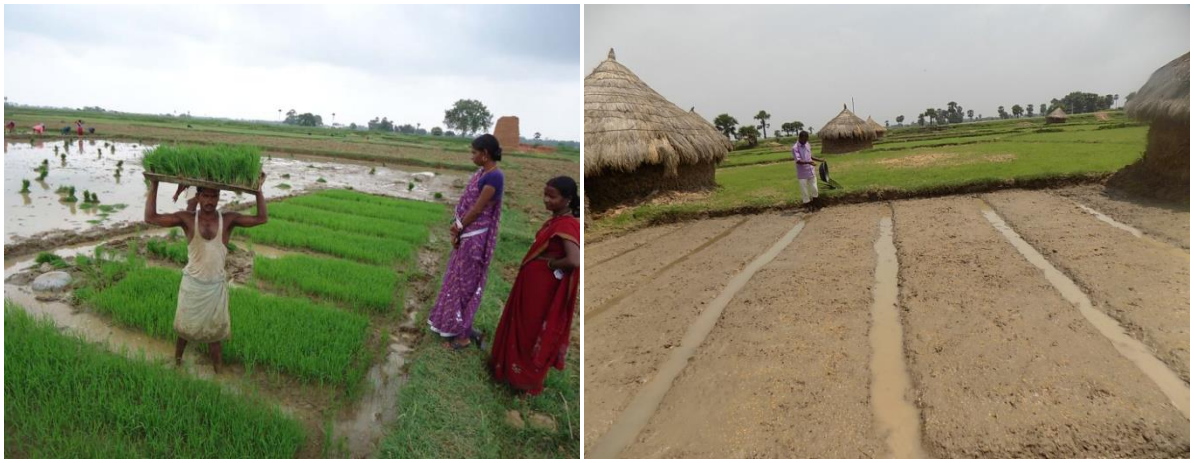
Raising of Nursery and its management

For one acre of SRI cultivation

Select 30 ft length X 30 ft width piece of land area close to the main field. . 150-200 kg of sripranamrit compost may be spreaded in the field before last ploughing. wet bed nursery for SRI has been found more suitable. For practical purpose following steps are followed.

1. Select a piece of land near the main plot and irrigation source.
2. After 10-15 days of composting plough the land with a heavy plough
3. Make 5 beds of 30 ft length and 5ft width at 1 ft interval

4. Make channel0.5 ft deep between two beds in 1ft space left between the beds.
5. Also make 1 ft width and 0.5 ft depth channel from outerside of the bed
6. Put compost or Vermi-compost and spread it over all the beds in 3-5 cms layer.
7. The germinated seeds should be equally divided in to 5 equal parts as there are 5 raisedbeds of nursery beds area,
8. Now pour the seeds on each bed one by one(as onion) in a uniform way.
9. The seeds then should be covered with vermicompost or hay(If vermicompost is not there).
10. The water should be given in drainage channel.
11. After 3 days the hay(if used) should be removed.
12. The bed should remain moist.To maintain it irrigation should be given in irrigation cum drainage channel
13. In 7-8 days seedlings become ready to transplant.Use 2 leaf stage seedling for transplanting.



Paddy nursery for SRI (PRAN photo)

Transplantation

A day before transplanting farmer should ensure following.

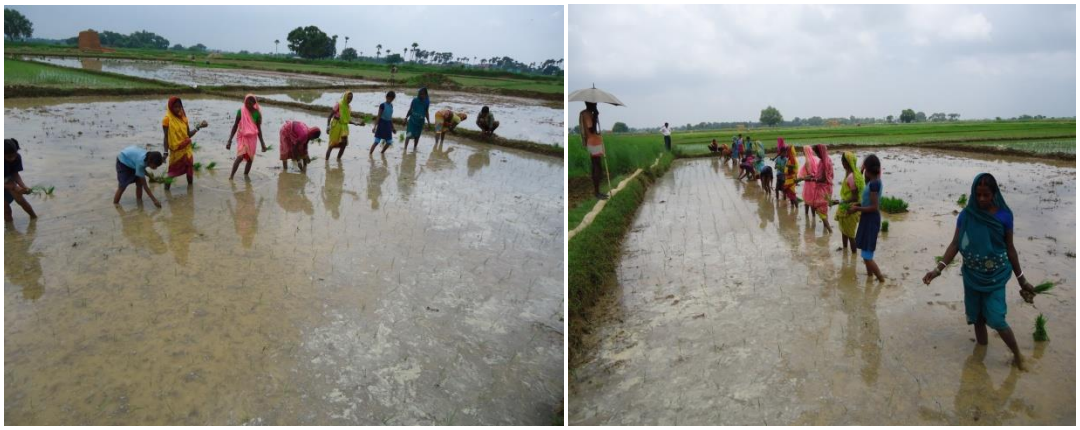
- Availability of tagged rope(tagged at 10 inches).
- Medium and large farmers can get the marker ready
- Medium and large farmers can get trained labourers for transplantation.

The prepared land should be left overnight or 6-8 hrs so that the dense soil solution at the surface settles down.The drainage channel measuring 6 inches width and 6 inches depth should be made all around the main field from inside.

Uprooting of seedlings should be done very carefully.The seedling is uprooted alongwith the soil attached to the root zone of the plant to retain similar and natural micro agro climatic condition around the root i.e mouth of the plant.if water is dried in the nursery bed then a day before transplanting water should be poured in the nursery bed. It will facilitate easy uprooting and damage to the root zone will be minimum.
The uprooted seedlings should be transplanted within 15-30 minutes in the main field.it should be carried from nursery to the main field in such a way that minimum trauma is created in the root zone of the young child of the paddy crop. There should be surface transplanting at 25 cm X 25 cm wider spacing.The seedling should not be pushed deeper inside the soil rather it should be shallow surface transplanted.Two leaf stage seedling is best for SRI cultivation.

If more water is there in the main field at the time of transplanting water may be drained out as the seedlings is too young (8-12 days old). 2nd or 3rd day light watering may be done.with help of tagged rope transplanting is done at 10 inches apart. After every 15 line, one line should be

transplanted leaving 30 cm space for drainage channel.This spacing facilitates aeration, light and excess water if any is drained out through it.in case of dry spells it also helps in sustaining minimum moisture in the field comparatively for longer period.in 30 cm wide spacing drainage channel measuring 25 cm width and 25 cm depth should be made simultaneously.



Ongoing transplantation of SRI-Paddy (photo-PRAN-SDTT –SRI project)

Nutrition Management

- Sripranamrit -4 quintals per acre- 2 quintals at transplanting, 1 quintal at first weeding and 1 quintal at 2nd weeding.
- Srijeevamrit-200 litre per acre per application at incorporation of Dabholkar green manuring, after incorporation of green manuring just before transplantation,1st weeding, 2nd weeding.
- After panicle initiation after filtering Srijeevamrit by a plain cloth, 10 litre srijeevamrit in 100 litre of water should be sprayed per acre.
- Phosphatic Solubilising Bacteria(PSB)8kg /acre and Trchochoderma Virdae 10 kg/acre should be incorporated in to the soil.PSB half dose at 1st weeding and half dose at 2nd weeding should be incorporated in to the soil. Similarly Trichoderma virdae and PSB along with other natural formulation should also be used in soil and or on crop when sufficient moisture is there in the soil.
- Alternate spray of sriamritpani and Srimathhastra keep plants healthy during its life cycle.Srijeevamrit and Sriamritpani should be stopped at the time of maturity of the plants.
- To meet the requirement of Nitrogen Srigajramrit 20% can be sprayed as and when required.
  Using markers lines may be drawn before transplanting to facilitate square transplanting.
- Srijeevamrit should be applied every 15 days after second weeding till panicle initiation.

Various natural formaluations(fertilisers&pesticides) being used under SLACC under BRLPS

Application of Srijeevamrit

Various natural/organic fertilizers and pesticides being prepared and used in SLACC project

Weed management

Under SRI weed is not treated as enemy of the crop rather they are also made part of enhancing productivity of the crop. Intercultivation using weeder is most crucial part of entire SRI components. The first weeding is done between 12 to 15 days after transplanting using Mandwa or cono-weeder .It should be done in both ways.The second weeding is done between 25-30 days after transplanting. At least two times use of weeder is essential in SRI. It is done at proper time because delay in weeding affects tillering and due to more number of tillers running a weeder becomes difficult later-on.

Weeder cuts the weed and incorporates in to the soil adding organic matter to the soil.it makes the soil lighter and breaks the thin sheet layer on soil surface to provide more aeration in the root zone of the crop.It enhances the growth of roots and enbles them for more nutrient and moisture uptake from the soil.

weeding in Paddy

The farmers are weeding their plots(photo-BRLPS-slacc and SDTT-PRAN-SRI project

Water Management

Water management is important component of SRI. At the time of transplanting only thin film of water is maintained in the field. The excess water from the puddled land should be drained out as seedlings are young and of two leaf stage.With standing water the seedlings will be destroyed. After two days of transplanting light irrigation may be provided so that the root of the plants remain moist.Only 1 cm of water is sufficient for SRI crop during the tillering phase.More standing water restricts tillering of paddy as young tillers die due to excess water and do not come out of the soil surface.At the time of weeding there should be sufficient water in the plot to facilitate weeding operation.If required additional water is added before weeding and excess water is drained out after weeding.

Alternate wetting and drying facilitates more tillering. Though in rainfed area where water is scarce entity it happens automatically particularly in medium upland and upland area.The stagnation of water should be avoided. The land should be kept moist and not flooded as in normal cultivation. However after tillering when booting stage comes in then a thin film (1-1.5cm) is essential in the plot for proper growth of grain filling in the crop.

Nipping practices of Pigeon Pea in BRLPS SLACC, Bihar

Pheromone trap And Sticky Plate used under BRLPS-PRAN SLACC project

Plant protection measures in SRI-Paddy grown under BRLPS-SLACC project

Harvesting of SRI-Paddy

The crop should be harvested at its physiological maturity.When panicles of paddy bow down after maturity it is the right time to harvest paddy crop.At this time complete yellow colour may not get attained by plant. If we do not harvest at right time amylase content in the grain rises to higher level and the rice after milling starts breaking in to smaller one affecting the market value. when a farmer leaves the crop for long even after physiological maturity the concentration of oxalate in the hay of Paddy enhances.When animals eat these as feed they get infected. Harvesting at right time provides quality rice to farmers and quality feed to animals.

A photo from PRAN's SRI-Paddy project

Yield Estimation

An iron rod of 1 sq.m should be made. The five samples should be collected from one farmer's field i.e two samples from average stand of the crop, two samples from weak stand of the crop and one sample from good stand of the crop. The average, weak and good should be decided jointly by farmers and officials.

After extracting the grains first of all moisture of grain should be measured using digital moisture meter. The average yield is estimated at 14% grain moisture.

If SRI is done for the first time in the area then in a similar manner yield estimation is done for normal paddy cultivation also. The farmers and officials or scientists should be able to experience the differences in grain yield. This helps farmers to have yield experience of both traditional and SRI method.

For example

If the average weight of Paddy sample at the time of harvesting is 1000gram and moisture of Paddy seed is 30% then calculate the yield of Paddy per hectare.

Ongoing crop cutting in Paddy (BRLPS-SLACC project)

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