CLIMAADAPT

focuses on climate change adaptation in agriculture and water sectors. The programme aims at strengthening the links between research, innovation and capacity building, and strongly focuses on stakeholder engagement at different stages.

In addition, a major objective of ClimaAdapt is to contribute to the state-level climate adaptation policy framework in Andhra Pradesh and Tamil Nadu states in India.

Main programme objectives

- To map vulnerability, gaps and prepared-ness to address impacts on agriculture and water sectors.
- To select and apply suitable future climate and hydrology scenarios.
- To undertake capacity building of stake-holders, including women and farmers.
- To promote most promising adaptation technologies at a systems level, that will help in developing methodologies for upscaling.
- To strengthen the link between research, innovation and capacity building.

Project Partners in Andhra Pradesh :

ClimaAdapt
Adaptation through Innovation

IWMI International Water Management Institute

DIRECT SEEDED RICE (SEMIDRY)

Adaptation technology for climate change in semi arid regions

WALAMTARI

NORWEGIAN EMBASSY

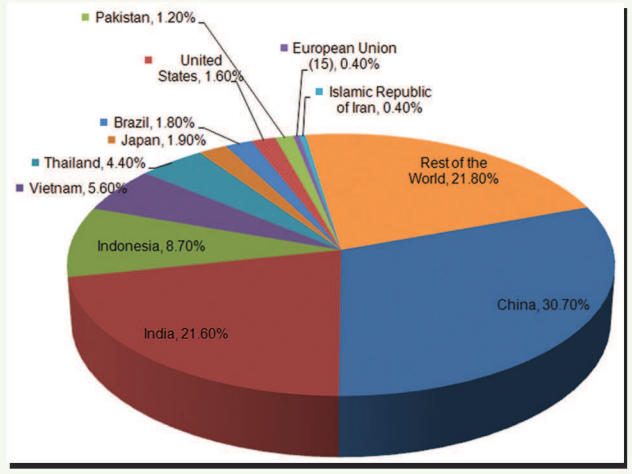
Bioforsk

IWMI International Water Management Institute

ClimaAdapt
Adaptation through Innovation

Rice - Current Status

Rice is grown on all the continents of the world, except Antarctica. As a global food, it has a large influence on human nutrition and food security all over the world. It is the staple food for over half of the world's population. In Asia alone, more than 2 billion people obtain 60 to 70 percent of their caloric intake from rice and its derived products. Rice is the most rapidly growing food source in Africa.

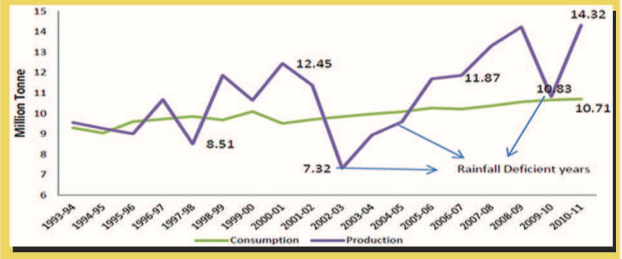


Source : UNCTAD Secretariat from the Food and Agriculture Organization of the United Nations (FAO) data

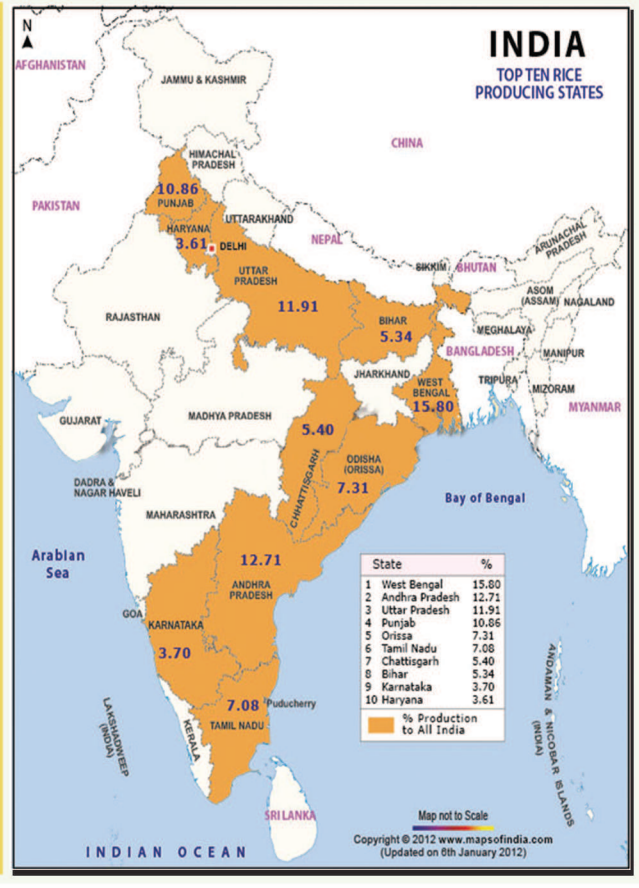
Almost a billion households in Asia, Africa and the Americas depend on rice systems for their main source of employment and livelihood. Rice is therefore on the frontline in the fight against world hunger and poverty. Rice is also a symbol of both cultural identity and global unity.

Worldwide, India stands first in rice area and second in rice production, after China. It contributes 21.5 percent of global rice production. Within the country, rice occupies one-quarter of the total cropped area, contributes about 40 to 43 percent of total foodgrain production and continues to play a vital role in the national food and livelihood security system.

There has been a substantial increase in the rice production from Andhra Pradesh. It has grown from a level of 4.8 million tonnes in 1970-71 to 14.4 million tonnes in 2010-11, which marks an increase of three hundred per cent.



This continuous increase has been largely made possible by shift in area under coarse grains to rice. There are three broad phases in which rice cultivation has expanded in the State. First increase was witnessed during the Green Revolution period during 1971-81 when the high yielding varieties were first introduced in the Godavari-Krishna Delta areas. The second phase of this rise was during 1982-92, which was primarily due to the expansion of canal irrigation in the State. The third phase is between the years 1993-94 and 2010-11 where the increase in area was overwhelmingly contributed by the expansion in bore well irrigation.



The traditional cultivation of rice is both water and labour intensive in the state of Andhra Pradesh

Since most of the rice production in india depends on irrigated paddies, the traditional way of its cultivation requires great amount of water. Water is in short supply in many regions and it's feared that man-made climate changes will trigger variations in precipitation that jeopardise rice production. In the more uncertain climate conditions ahead, the farmers need a whole arsenal of robust methods. Though one single method cannot make agriculture more adaptable to a changing climate, direct seeded rice has been proved in curtailing the above problems in the canal tail end areas.

Estimated seasonal consumptive use of water in rice cultivation

Purpose of Water Use	Consumptive use per season (mm)		Remarks
	Low	High	
Land Preparation	150	250	Refilling soil moisture, ploughing and puddling
Evapotranspiration	500	1200	
Seepage and percolation	200	700	To maintain water layer
Mid-season drainage	50	100	Refill of water basin after drainage
Total	900	2250	

" The productivity of water in rice is very low. Conventional rice cultivation needs 3000 to 5000 L of water to produce 1 kg rice. At global level 70-80% of fresh water is used in agriculture and rice accounts for 85% of this water. "

District-wise Area, Yield and Production of Paddy in A.P during 2010-11

Sl.No	District	Area (Ha)	Yield (Kg/ha)	Prodn.(000 tons)
1	Srikakulam	212,951	1,298	276,513
2	Vizianagaram	133,544	3,921	523,633
3	Visakhapatnam	117,551	2,575	302,662
4	East Godavari	410,528	4,757	1,952,762
5	West Godavari	456,516	4,854	2,215,996
6	Krishna	355,341	4,610	1,638,109
7	Guntur	329,465	3,884	1,279,562
8	Prakasam	156,781	4,953	776,562
9	P.S.Nellore	270,863	5,556	1,504,876
10	Kurnool	136,580	4,343	593,186
11	Anantapur	59,801	4,269	255,278
12	YSR Kadapa	70,382	2,755	193,912
13	Chittoor	61,577	4,494	276,722
14	Rangareddy	52,360	3,909	204,669
15	Nizamabad	221,623	5,661	1,254,602
16	Medak	144,558	5,337	771,569
17	Mahabubnagar	196,698	4,172	820,646
18	Nalgonda	405,315	4,880	1,978,004
19	Warangal	268,060	4,776	1,280,371
20	Khammam	218,252	4,832	1,054,621
21	Karimnagar	381,519	5,348	2,040,359
22	Adilabad	90,547	4,198	380,160
A.P. Total		2,921,793	4,541	2,157,474

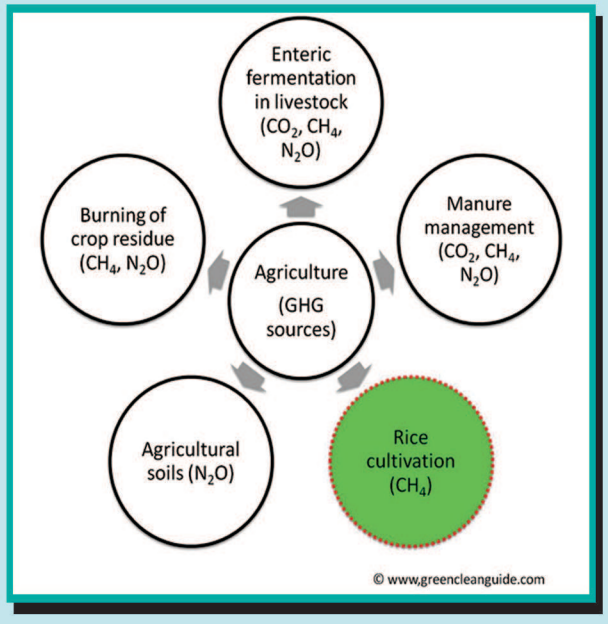
Source: Department of Economics and Statistics, Government of Andhra Pradesh.

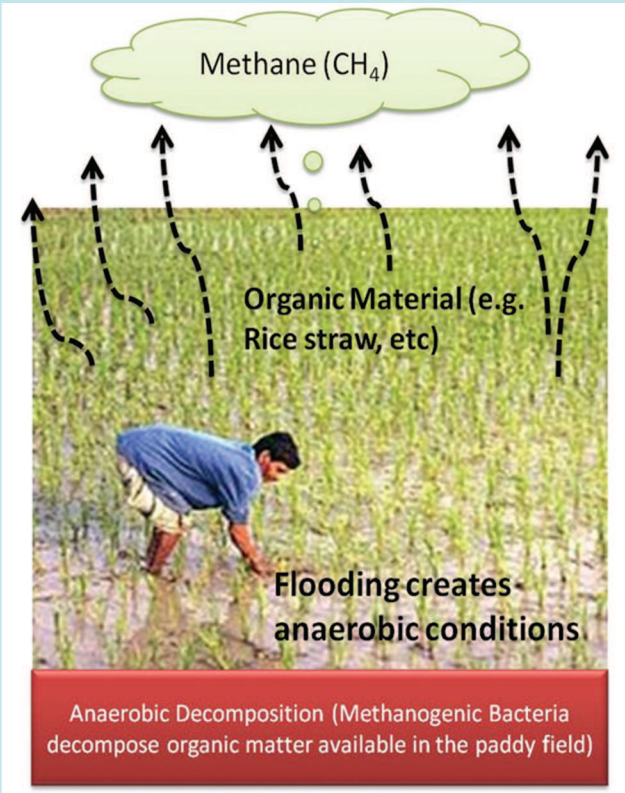
Rice & Climate Change :

At between 50 and 100 million tonnes of methane a year, rice agriculture is a big source of atmospheric methane, possibly the biggest of man-made methane sources. The warm, waterlogged soil of rice fields provides ideal conditions for methanogenesis, and though some of the methane produced is usually oxidized by methanotrophs in the shallow overlying water, the vast majority is released into the atmosphere.

" Paddy fields are among the world's biggest producers of methane, contributing around 10% of global emissions in India Paddy fields emitted 3.33 million tons of CH4 (69.87 million tons of CO2 equivalents) "

Source : www.nicra.iari.res.in/achieve.html





Rice Paddy Field

It is, therefore, important that alternative methods that are more water-efficient and less labor-intensive be developed to enable farmers to produce more at less cost. One way to reduce water demand is to grow direct dry-seeded rice (DSR) instead of the conventional puddled transplanted rice.

In order to improve conservation agriculture (having elements of no-till/reduced till, residue retention, and controlled traffic to minimize soil compaction), it is absolutely essential to find alternative options for replacing puddled transplanted rice. Options include zero-till or reduced-till DSR or transplanting in unpuddled soils.

Direct Seeded Rice

A Low Input Rice Production Technology

Introduction :

Transplanted rice has deleterious effects on the soil environment and nearly 30% of the total water used (1, 400 – 1,800 mm) in rice culture is consumed mainly during puddling and transplanting operations. Puddling requires lots of scarce water at a time when there is little water in the reservoirs, destroys soil structure and adversely affects soil productivity.Therefore, a key concern is how the water requirement of rice culture can be reduced and how farmers can avoid puddling and transplanting operations without yield penalty.

Direct seeded rice which removes puddling and drudgery of transplanting the young rice seedlings provides an option to resolve the adaphic conflict and enhance the sustainability of rice and subsequent cropping system. DSR overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operations. DSR facilitates timely establishment of rice and succeeding crops.

Scarcity of water is on the increase and the excessive dependence on ground water and poor irrigation systems are leading to declining of ground water table resulting in higher cost of pumping aggravating energy crisis. Continued puddling over decades has led to deterioration in soil physical properties, and transplanting operations are usually performed by migratory labor, which has an element of seasonality and thus increasingly becomes a serious concern for the timely transplanting of rice.

"Rice can be grown just like wheat and maize. Aerobic Rice Cultivation Saves 37% Water. Direct seeded rice requires 7 to 9 irrigations compared to around 30-40 irrigations required in rice cultivation in flooded fields "

http://oryza.com/content/oryza-exclusive-aerobic-rice-cultivation-saves-37-water-india-us-joint-research-project

UN's facts and figures about increasing water requirement in the world:

- ***Global population is projected to grow by 2–3 billion people over the next 40 years; food demand is expected to grow 70% by 2050.***
- ***Energy demand from hydropower and other renewable energy resources will rise by 60% by 2050. The UN says, increasing agricultural output will substantially increase both water and energy consumption, leading to increased competition for water between water-using sectors.***
- ***Water availability is expected to decrease in many regions. But the future global agricultural water consumption alone is estimated to increase by around 19% by 2050.***
- ***Water for irrigation and food production constitutes one of the greatest pressures on freshwater resources. Agriculture accounts for around 70% of global freshwater withdrawals (up to 90% in some fast-growing economies).***
- ***Economic growth and individual wealth are shifting diets from predominantly starch-based to meat and dairy, which require more water. Producing 1 kilogram of rice, for example, requires about 3,000 - 5000 liters of water, 1 kilogram of beef around 15, 000 liters, and a cup of coffee about 140 liters.***

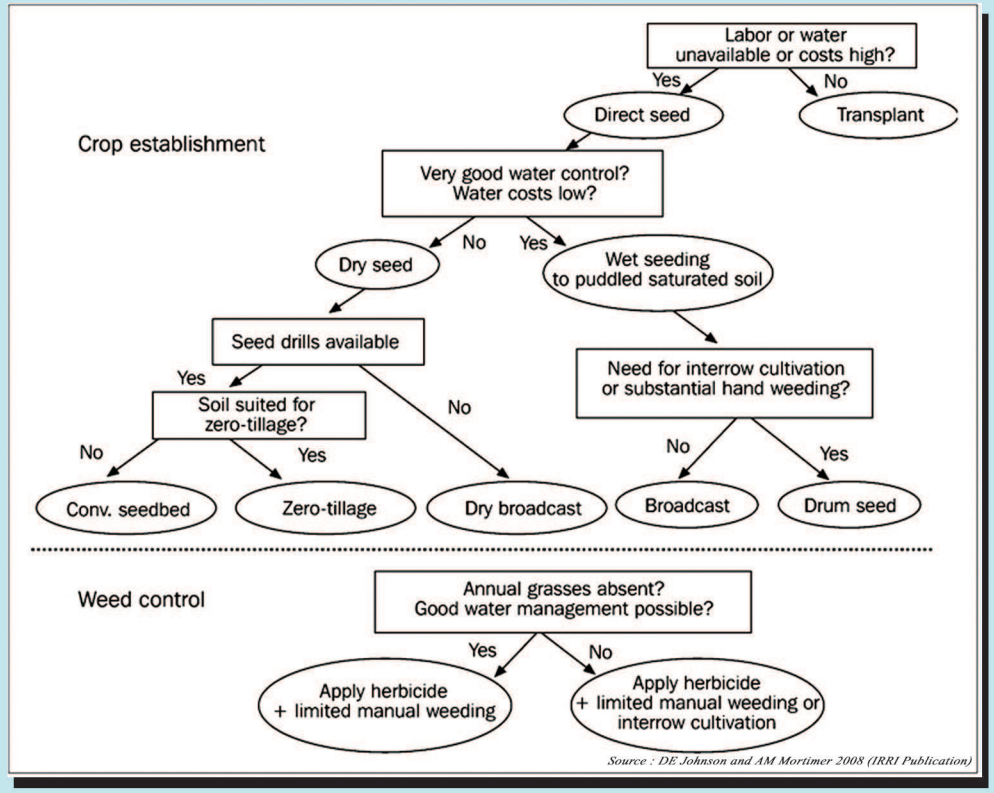
It is, therefore, important that alternative methods that are more water-efficient and less labor-intensive be developed to enable farmers to produce more at less cost. One way to reduce water demand is to grow direct dry-seeded rice (DSR) instead of the conventional puddled transplanted rice. In order to improve conservation agriculture (having elements of no-till/reduced till, residue retention, and controlled traffic to minimize soil compaction), it is absolutely essential to find alternative options for replacing puddled transplanted rice. Options include zero-till or reduced-till DSR or transplanting in unpuddled soils.

Classification of direct-seeded rice systems

Direct Seeding method	Seedbed Condition	Seed Environment	Seeding Pattern	Where Commonly Practiced
Dry Direct Seeded Rice (D-DSR)	Dry Soil	Mostly Aerobic	Broadcasting; Drilling or Sowing in rows	Mostly in rainfed areas and some in irrigated areas with precise water control
Wet Direct Seeded Rice (W-DSR)	Puddled Soil	Aerobic / Anaerobic	Various	Mostly in irrigated areas with good drainage
Aerobic Wet Seeded Rice (W-DSR)	Puddled Soil	Mostly Aerobic	Broadcasting on puddled soil surface; row seeding in open furrows or on flat soil surface	In irrigated areas with good drainage
Anaerobic Wet Seeded Rice (W-DSR)	Puddled Soil	Mostly anaerobic with a thin layer of settling mud; row seeding in furrows and covering with soil	Broadcasting and covering	In irrigated areas with good drainage
Water Seeding (DSR on water)	In standing water	Mostly anaerobic	Broadcasting on standing water	In irrigated areas with good land leveling and in areas with red rice problem

Source : V. Balasubramanian and J.E. Hill, 2002 Direct Seeding : Research issues and opportunities page no. 23 (IRRI Publication)

Decision making guide for choosing planting methods in Rice



Source : DE Johnson and AM Mortimer 2008 (IRRI Publication)

Rice can be directly seeded either through dry or wet (pregerminated) seeding. Dry seeding of rice can be done by drilling the seed into a fine seedbed at a depth of 2-3 centimeters. Wet seeding requires leveled fields to be harrowed and then flooded (puddling). The field is left for 12-24 hours after puddling, then germinated seeds (48-72 hours) are sown using a drum seeder. Seed can be broadcast for either dry or wet seeding, but manual weeding is more difficult. Indeed, weed management is a critical factor in direct seeding. Timely application of herbicides (timing is dependent on the method of seeding) and one or two hand weedings provide effective control.

Land preparation

- Plough the fields during summer to control emerging weeds
- Leveling the fields facilitates uniform irrigation and better germination

Machinery Requirement

- Minimum-till drill/Power tiller drill
- Zero-till drill
- Bed drilling

Seed depth and soil moisture

- Optimum depth of seeding is 2-3 cm. The seed should be covered by soil for proper germination and to avoid bird damage.
- In lowlands and finer textured soils, planking may not be necessary after seeding.
- Soil moisture content at seeding should be sufficient for proper germination
- Surface mulch helps retain soil moisture longer to improve emergence and reduce weed menace

6 Rules for DSR

1) Laser land leveling is essential for crop establishment when direct dry-seeding rice.

2) Type of cultivar - vigorous, quick growing, competitive open pollinated varieties perform best for direct seeding.

3) Precision planting technique and timing is crucial for quick and uniform crop establishment.

4) Seed priming, seed rate, and seed depth are the key to early germination and emergence of seedlings.

5) Fertilizer management - Apply full dose of N, P, and K as per normal recommendation.

6) Weed management - weeds are a major concern for high productivity of direct seeded rice but reducing tillage combined with retained residues and effective system-based weed management during the early stages of growth are crucial to overcome the weed problem.

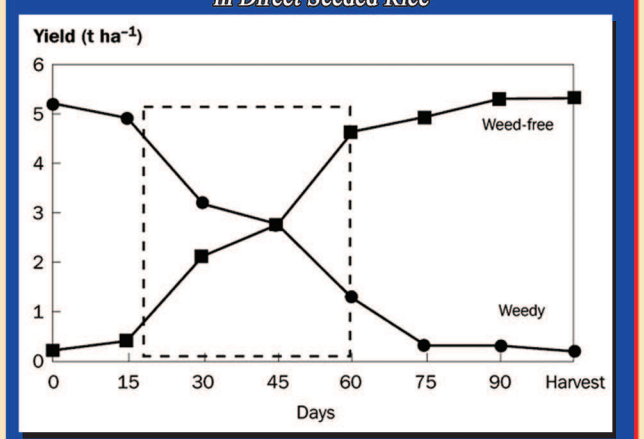
Seed rate and cultivars for DSR

- Seed rate:12 to 18 kg/acre, in general fine grain cultivars require much less seed.
- Early to medium short duration cultivars having early vigor.
- Suitable Varities are: MTU 1001, MTU 1010 & BPT 5204 and the cultivars which resist drought are suitable.

Sowing

- Seed hardening with 1% KCI for 16 hours (seed and KCI solution 1:1) and shade dried to bring to storable moisture. This will enable the crop to withstand early moisture stress.
- On the day of sowing, treat the hardened seeds first with *Pseudomonas fluorescnes* 10gIkg of seed and then with *Azophus* 2000g or *Azospirillum* and *Phosphobacteria* @ 500g each per ha seed.
- Drill the dry seed of normal rice at the start of monsoon i.e. when farmers put seed into nursery bed.

Critical Duration of Weed-Crop Competition in Direct Seeded Rice



Source : DE Johnson and AM Mortimer 2008 (IRRI Publication)

Weed management

The weed growth is the major problem in this method. Weed problem can be addressed by following measures.

- Pre-germinated weeds can be knocked down with glyphosate/grammoxone (at 0. 5% two days before seeding) or by 1-2 very shallow ploughings (stale seed bed method).
- Land can be watered during May, June and ploughed.
- After sowing, within 2-3 days before the seeds germinate, farmers can take up spraying Pendimethalin 1lt (or) pretilachlor along with safener (sofit) 600ml (or) Pyrazosulfuron ethyl (saathi) 80-100g. mixed with 200 litres of water and sprayed over for the one acre. The higher the content of the moisture in the soil the better they work (Pre emergence).
- After seeding, within 20-30 days, 400ml of cyhalofop butyl (or) 400 ml 2,4D (for broad leaf weed) (or) 80ml of bispyribac sodium per acre should be sprayed in order to kill the germinated weeds (Post emergence).
- Dhaincha (green manure crop) can be grown in paddy fileds to control the weed germantion and soil moisture. In addition, it also increases the nitrogen content of the soil.
- Second flush of weeds can be removed manually.

Water Management

- Inititally for first 45-60 days, crop survives under rainfed conditions in the black cotton soils. In coarse or light soils irrigation has to be provided within 10-15 days after sowing.
- If any prolonged dry spell occurs, suppplemental irrigation has to be applied.
- At later stages crop is irrigated as irrgated dry crop based on water availability in the canal.
- In the water assured conditions or availability of supplementary source alternate wetting and drying can be followed. This improves the yield in the direct seeded method.
- Care should be taken that crop should not suffrer from moisture stress during Critical stages (panicle initiation, tillering and grain maturity stages).
- Uniform level of field is crucial for good water management.
- Draining of the field is essential at the time of maximum tillering when organic manures are applied basally.
- Water should be drained prior to top dressing of nitrogen fertilizers and reflood the field after 48 hours.
- Crop can be grown under irrigated dry (ID) conditions even after canal water avaialble without any stress during critical stages of crop growth.

Alternate wetting and drying of rice fields eliminated the second flux of methane because strong anaerobic conditions could not develop in the scheduled irrigation (Cai et al., 1997). This favours an increased oxygen supply to the soil inhibiting methane production by methanogens (Wang et al., 1999). The direct seeding method combined with a reduced number of irrigations at the intial stages of crop gowth, followed by alternate wetting and drying of rice fields, can reduce methane emissions. Many studies report that introduction of mid season drainage and alternate flooding/drying reduces emissions by 30 up to 50% without compromising on yield (Lu et al., 2000). Adhya et al. (2000) found that conversion of rice-rice production systems into rice-non-rice could reduce emissions to one third only. The water regime of soil is an important factor for the gas exchange between soil and atmosphere and has a direct impact on the processes involved in methane emission. For methanogenesis to take place, it is of primary importance that the soils should have enough moisture to create an anoxic condition.

After Cultivation

- Azospirillum inoculants 10 packets (2000g/ha) and Phosphobacteria 10 packets (2000g/ha) or 20 packets (4000g/ha) of Azophos mixed with 25kg of FYM may be braocated uniformly over the field just after the receipt soaking rain / moisture.
- Thinning and gap filling should be done 14-21dasy after sowing, taking advantage of the immediate rain
- Spray Cycocel 1000ppm (1 ml of commercial product in one lit. of water) under water deficit situations to mitigate ill-effects.
- Foliar spray of Kaolin 3% or KCl 1% to overcome moisture stress at different physiological stages of rice.

Source : http://agritech.tnau.ac.in

Fertilizer Management

Recommended dose of N:P:K for the Guntur district is 160:40:40 Kg/ha respectively.

- Apply 1/3rd N, Total P and half K as basal along with sowing. Care should be taken that seed can be sown in 2-3 cm deep and fertilizer in 5-6 cm deep.
- In some areas initial basal dose has not been followed by the farmers and they will apply later stages of crop growth as per the moisture availability after 15 DAS.
- Apply another 1/3rd N at active tillering and remaining 1/3rd at panicle initiation stages.
- Top dress half of the recommended potash at panicle initiation in addition to the half of potash at basal.
- Use coated or modified urea materials like neem coated urea, sulphur coated urea, coal tar coated urea and gypsum coated urea as basal where top dressing is not possible due to excess water.
- Apply the fertilizers when there is little or no water in the field and irrigate after 2days only.
- For correction of zinc deficiency on standing crop, spray zinc sulphate 0.2% solution 3 times at 5 days intervals.

General Problems in Direct Seeded Rice

If greater amount of seed is used than recommended

- Some panicles can develop without any grains.
- There are chances of the crop lodging.
- More number of pest incidences.
- Amount of nitrogen supply will be decreased.

Reasons for having a lower rate of germination in some cases may be due to

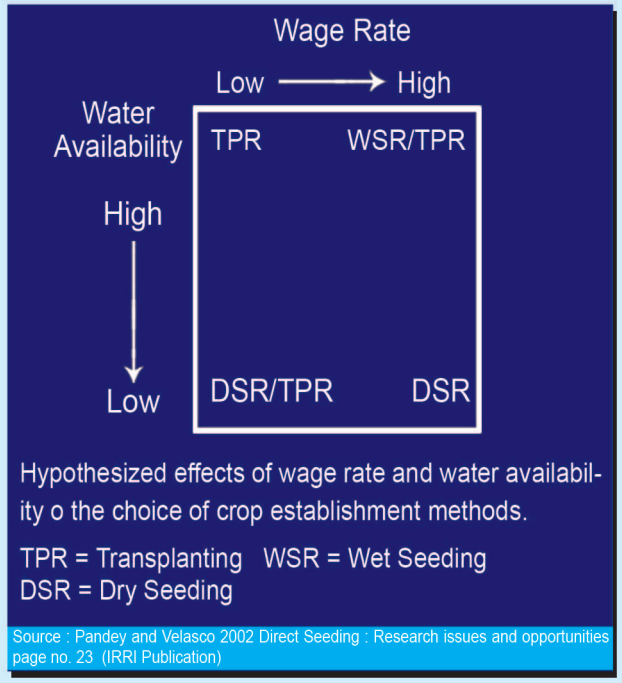
- Deep seeding.
- Formation of a hard layer of soil over the seed.
- Germination layer having less amount of moisture.
- Usage of lower or cheap quality seeds.

Wrong Practice of Fertilizer Application

Performance of DSR in farmers fields :

- A saving of 3 to 4 thousand rupees was observed in the first stage.
- A 20-40% of reduction in water usage compared to transplantion method.
- Harvesting can be done in 7 to 10 days ahead.
- As seeding is done by the tractor, nursery and the transplantation labor is not required.
- Dependency on the labor is reduced, as this process can be done by using the machines. Water usage in this process is 4.77 to 7.99 kg/ha/mm compared to the traditional process using 5.82 kg/ha/mm to 3.53kg/ha/mm.
- Because of the recent advances in improved efficiency of pesticides and herbicides, initial growth phase of the weeds can also be eradicated.
- In this method, the growth of panicles is 25-27, whereas for the traditional method it was only 21-22.
- For the transplantation method we need 8-10 laborers (which is equivalent to 10 labour days) where as in the direct-seeding method one person can work for one hour to finish the seeding process.

(Source: Climarice II pilot demonstrations in Guntur district, 2010-2012)



Source : Pandey and Velasco 2002 Direct Seeding : Research issues and opportunities page no. 23 (IRRI Publication)

JDA and entire team of Department of Agriculture, Guntur visiting Clima Rice II DSR Fields on 05-11-2011 at Jonnalagadda.

Case Study -1

Stakeholder participation as key in upscaling Direct Seeded Rice : A case of Guntur ditrict, Andhra Pradesh, India

In the dissemination and adaption of a practice on large scale, stakeholder particiaption in the framework is very important. Series of steps were followed in the dissemination of the direct seeding practice. The initial step taken was to conduct the research trials in the farmers' field and record the scientific information as part of Clima Rice II project. Training programs and exposure visit were conducted to the agricultural department to take the direct seeded rice information to the other villages and mandals. The visit of the Principal Secretary (Agriculture), who also happens to be the then Vice chancellor, ANGRAU has given much needed focus to the practice. Dissemination material for the farmers and departments in the local language was published to spread the practice in the suitable areas. The stakeholder workshop was also conducted before the season.

Sharing Results with Stakeholders

Concerted efforts of Department of Agriculture, Guntur

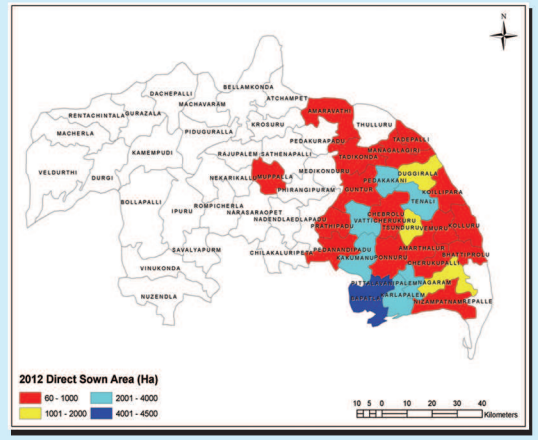
In Guntur District the Department of Agriculture has taken strenuous efforts to promote the Direct Seeded Rice by conducting more than 1000 Campaigns, Group discussions and Result demonstrations at village level by which an area of 52,210 ha has been covered with direct seeded rice during the year 2012-13 as against the total 1,75, 000 ha of Rice are (nearly 30 %).

The steps include

- Timely supply of seed drills: about 400 seed drills on subsidy to the farmers, which makes the basic requirement for seeding.
  Incentives for Direct Sowing Farmers: organized Cluster
- Demonstrations under NFSM Scheme, by supplying inputs on 100% subsidy, for a selective compact block of 100 ha.
- Timely technical backup: In coordination with the Regional Agricultural Research Station (RARS), Lam of ANGRAU timely messages at critical stages were organized

Media too deserves a pat in this regard. Extensive coverage about the practice and timely publishing the technical advises helped a large scale adoption.

Sharing Results through Publications



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Case Study-II
The Adopted village of RARS, Lam (ANGRAU) become model village:
Jonnalgadda village in Guntur district

Jonnalgadda is a village of Guntur Rural Mandal in the Guntur District. It all receives water from Kondaveetivagu a small scale project. The inflows for kondaveetivagu are from the drained water of tail end Nagarjuna Sagar Project canal. Hence, water available for agriculture during August to September months, half fast kharif (Rainy Season) season. It necessitated them to practice direct seeded rice. The practice has got into limelight after RARS, Lam adopted the village as part of its Village Adoption Programme during 2010-11, then under Clima Rice II project the Direct Seeded Rice was field validated for three consecutive seasons and the technology was exposed to all the stakeholders. The visit of the Principal Secretary (Agriculture), who also happens to be the then Vice chancellor, ANGRAU has given much needed focus to the village and practice as well. After three years of adoption programme, Jonnalagadda, a less known village for agriculture has become most sought after one. It has been receiving visiting farmers from other districts of the state also. The farmers from the village have been hired across the district for seeding the rice as it requires skill.

"DSR Facilitated to takeup Succeeding Crop intime"
- Mr. V. Sambi Reddy
Farmer, Jonnalagadda

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