USAID FROM THE AMERICAN PEOPLE

IFAD

European Commission

BILL & MELINDA GATES foundation

Guidelines for Dry Seeded Rice (DSR) in the Cauvery Delta Zone, Tamil Nadu, India

IRRI

CSISA

CIMMYT
International Maize and Wheat Improvement Center

Guidelines for Dry Seeded Rice (DSR) in the Cauvery Delta Zone, Tamil Nadu, India

Sudhir Yadav, R. Ganeshamoorthy, Elizabeth Humphreys, R. Rajendran, V. Ravi , Frank Mussgnug, Virender Kumar, Bhagirath S. Chauhan, T. Ramesh, B.R. Kamboj, Mahesh Gathala, R.K. Malik, M.L. Jat, and Andrew J. McDonald

2014

The International Fund for Development (IFAD) is a specialized agency of the United Nations. IFAD is dedicated to eradicating rural poverty in developing countries.

The Cereal Systems Initiative for South Asia (CSISA) is mandated to enhance farm productivity and increase incomes of resource-poor farm families in South Asia through the accelerated development and inclusive deployment of new varieties, sustainable management technologies, partnerships and policies. The project is being implemented by the CGIAR institutions of IRRI, CIMMYT, IFPRI, and ILRI and supported by USAID, and the Bill & Melinda Gates Foundation.

Citation

Sudhir-Yadav, Ganeshamoorthy R, Humphreys E, Rajendran R, Ravi V, Mussgnug F, Kumar V, Chauhan BS, Ramesh T, Kamboj BR, Gathala M, Malik RK, Jat ML, McDonald AJ. 2014. Guidelines for Dry Seeded Rice (DSR) in the Cauvery Delta Zone, Tamil Nadu, India. IFAD and CSISA joint publication. International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT). 38 p.

Contents

1.	**Introduction**	1
2.	**Suitable conditions for DSR**	3
	a. Soil	3
	b. Climate	3
	c. Topography	3
	d. Irrigation water availability	4
3.	**Field preparation**	4
	a. Land leveling	4
	b. Tillage	5
4.	**Cultivars**	6
5.	**Sowing date**	7
6.	**Sowing**	8
	a. Crop establishment	8
	b. Machinery for sowing	10
	c. Seed quality, rate, sowing depth, row spacing	13
	d. Seed treatment	14
7.	**Fertilizer management**	16
	a. Nitrogen (N), phosphorus (P), potassium (K), and zinc (Zn)	16
	b. Iron (Fe)	20
8.	**Irrigation management**	21

9. Weed management 22
a. Cultural practices 23
b. Chemicals 23
c. Physical 28
d. Surface residue retention 30

10. Pests and diseases 30
a. Nematodes 30
b. Insects and pest management 30

Table 1. Suitable cultivars for DSR in the Cauvery Delta Zone 31

Table 2. Common weeds of rice in the Cauvery Delta Zone 32

Table 3. Major knockdown and preemergence herbicides for weed control in DSR in the Cauvery Delta Zone 33

Table 4. Major postemergence herbicides for weed control in DSR in the Cauvery Delta Zone 34

Table 5. Common insects, pests and diseases of rice, and chemical treatments 35

Contributors 36
Acknowledgements 36
For more details and queries, please contact 36
Further information 38

Guidelines for Dry Seeded Rice (DSR) in the Cauvery Delta Zone, Tamil Nadu, India

1. Introduction

Dry seeded rice (DSR) is becoming an attractive option for farmers in the Cauvery Delta Zone (CDZ) due to the elimination of the labor requirement for nursery preparation and maintenance, pulling out and transport of seedlings, and transplanting. Because the soil is not puddled, DSR also has a lower water requirement for crop establishment. Furthermore, the total crop cycle is shorter by 10−15 days because of the absence of transplanting shock. These features of DSR are of major importance for the Cauvery Delta (see below) because of the increasing scarcity of water for irrigation in the area. DSR can be readily adopted by small farmers as well as large farmers, provided that the required machinery is locally available (e.g., through custom hire). Best practice involves using a 2- or 4-wheel tractor-drawn drill to seed in rows in dry or slightly moist soil.

The Cauvery Delta Zone is situated in the mideastern part of Tamil Nadu, and is known as the rice bowl of the state. The region has three seasons: winter (early November to mid-February), summer (March to mid-May), and the monsoon season (June to December). There are two distinct rainfall periods: the southwest monsoon from June to September and the northeast monsoon from October to December, with a dry season from January to May.

There are four cropping seasons:

- Kuruvai (May/June to September/October) – rice cropping is dependent on irrigation from canals supplied by the Mettur Dam on the Cauvery River, and/or from groundwater, supplemented by rainfall from the southwest monsoon.
- Samba (August/September to January) – rice cropping using canal water to establish the crop prior to the start of the northeast monsoon. Rice is grown as a single crop (no prior Kuruvai crop).
- Thaladi (late September/October to January/February) – rice cropping dependent on the northeast monsoon and supplemental irrigation from the canal. The Thaladi crop is the second rice crop following a Kuruvai crop.
- Navarai/summer (December/January to March/April) – pulses (black and green gram) and gingelly (sesame) are grown in rice fallows on residual moisture alone or with supplementary irrigation; access to groundwater also allows the cultivation of cotton, maize, and rice.

The time of release of water from Mettur Dam determines the rice production in the CDZ. When the water is released late, the harvest of Kuruvai crops and planting of Samba/Thaladi crops overlap, leading to a labor shortage.

The major rice production constraints in the CDZ follow:

- Uncertainty about the period when water from Mettur Dam will be available for irrigation.
- Labor shortage during the peak periods of planting and harvest.
- Torrential rains during the northeast monsoon, hindering

both the Kuruvai harvest and late Samba/Thaladi transplanting.

- Lodging during the Samba/Thaladi seasons, which leads to sprouting of rice grains.
- Lack of adequate drainage facilities.
- Low solar radiation during the Samba/Thaladi season.

2. Suitable conditions for DSR

a. Soil

DSR can be grown on the same soils as puddled transplanted rice, which typically range from sandy loam to heavy clay. In the CDZ, DSR has been grown successfully on both the heavy clay soils of the old delta and the sandy loam soils of the new delta.

b. Climate

During the Kuruvai sowing season, the weather is sunny and dry and good for the establishment of DSR. The climate during the early Samba season is also often suitable for the establishment of DSR, while the late Samba/Thaladi period is not suitable due to the high likelihood of monsoon showers around the time of sowing.

c. Topography

During the summer, Kuruvai, and early Samba seasons, all topographies are suitable for DSR as there is no rain during the sowing period. However, topography plays a major role during the late Samba/Thaladi season as sowing may coincide with rainfall, and lower and poorly drained lands should be avoided.

d. Irrigation water availability

During the Kuruvai season, areas with access to groundwater can be sown early and harvested before the onset of the monsoon. Areas with insufficient groundwater have to wait for the release of canal water from Mettur Dam. Normally, the release of water commences on June 12, but the date varies greatly depending upon the amount of water stored in the dam. After the opening of the dam gates, the water takes 7 to 12 days to reach the Delta region. Once the canal water arrives at the farms, the farmers commence seedling nursery preparation. Because of this delay, harvest of the Kuruvai rice crop usually coincides with pre-northeast monsoon showers.

DSR can play a major role in ensuring harvest of the Kuruvai crop before the onset of the monsoon as it allows the rice harvest to be advanced by 7–10 days.

3. Field preparation

a. Land leveling

Key check 1.

– Fields must be accurately leveled.

Good land leveling helps ensure high yield and reliable production of DSR. This is best achieved using laser-assisted land leveling. A level field allows planters/drills to place seed more precisely and enables more uniform irrigation, leading to a uniform crop stand and improved weed control and fertilizer use efficiency. Leveling also helps to reduce irrigation water input.

Land leveling using laser guidance

b. Tillage

DSR can be sown into dry tilled soil ("conventional tillage") or into nontilled soil ("zero tillage"). The decision on whether or not to cultivate the soil depends on site-specific factors, such as the need for leveling, weed infestation, etc.

i) Conventional tillage (CT): The soil should be cultivated to a depth of 5–10 cm to achieve a fine tilth for good seed-to-soil contact. Depending on soil type and field conditions, this might involve two runs of a tine cultivator and one rotavation.

ii) Zero tillage (ZT): For ZT-DSR, existing weeds should be killed by applying a nonselective herbicide such as glyphosate or paraquat (see Table 3 for application

details). In situations where weed infestation is not uniform, the herbicide can be applied as a spot treatment rather than a blanket application. Glyphosate should be applied at least 5 days before sowing, while paraquat can be applied up to 2–3 days before sowing. Apply herbicides when weeds are actively growing and not under stress. If weeds are under moisture stress, a light irrigation should be given 5–7 days before herbicide application for a better weed kill. ZT-DSR has been successfully demonstrated in research plots and large fields in northern India; however, it is a relatively new and untested technology in Tamil Nadu.

Don't apply paraquat if perennial weeds are present. In such situations, apply glyphosate.

Key check 2.

- Use clean water and a plastic container to make spray solution as herbicides bind with suspended soil particles and metal surfaces (e.g., iron bucket).
- Use a multiple-nozzle boom fitted with flat-fan nozzles for full coverage (see later).
- Use protective clothing when applying herbicides (see later).

4. Cultivars

Many of the inbred varieties and hybrids bred for puddled transplanted rice have also been found to be suitable for

DSR. Shorter duration varieties/hybrids are preferred for the Kuruvai crop to reduce the irrigation requirement and to enable early harvest, thus reducing the risk of rain at harvest. The inbreds and hybrids suitable for DSR in the CDZ are given in Table 1. Long-duration varieties such as CR-1009, ADT-44, and ADT 50 are promising for single-crop areas during the Samba season.

5. Sowing date

Key check 3.

- Sowing date for Kuruvai: May 20 to June 25.
- Sowing date for Samba: August 10 to September 10.
- Earlier planting in these ranges is better if water is available.

Do not use dry seeding in the Thaladi season.

Where irrigation is available, or when there is a high probability of premonsoon showers, the best date for sowing DSR is 10–15 days prior to the onset of the monsoon. The optimum time of dry seeding rice in the Kuruvai season is the end of May to mid-June, delay crop maturity until after the start of the north east monsoon. Heavy rain, especially on heavy (clayey) soils, can seriously impair establishment. Therefore, it is safer to sow earlier in the Samba season. However, the earlier the crop is sown, the greater the need for irrigation.

6. Sowing

a. Crop establishment

DSR can be sown in dry or moist soil: (1) rice seeded in dry soil requires a light irrigation after sowing to germinate the seed and (2) seeding in moist soil is done after a presowing irrigation or rainfall.

Seeding in tilled soil

When seeding into moist soil, planking after seeding helps to conserve soil moisture and improve establishment. When using conventional tillage, rice can be established by sowing into dry or moist soil. However, for ZT-DSR, sowing into moist soil is better as the soil is softer.

Seeding in nontilled soil (ZT-DSR)

Seeding with strip tillage using a PTOS (“power tiller–operated seeder” – a seeder with tiller powered by a 2-wheel tractor)

b. Machinery for sowing

For precise seed placement, rice should be drilled using a multicrop planter fitted with an inclined-plate seed-metering mechanism (see photo), and with the ability to drill both seed and fertilizer simultaneously. DSR can also be sown with a conventional seed-cum-fertilizer drill with a fluted-roller seed-metering mechanism; however,

Seed and fertilizer in the seed drill

Seed drills with inverted-T tines are suitable for seeding into both tilled and nontilled soil.

Inclined-plate (left) and fluted-roller (right) metering systems

the seeds will not be spaced evenly and a higher seed rate is required to avoid seed breakage. The inclined-plate seed-metering mechanism also provides the opportunity to use primed seed as there is no problem of seed breakage in contrast with the use of fluted-roller seed metering.

There should be good coverage of the seed with soil to prevent desiccation and predation by rodents and birds.

Coverage of seeds with soil using chains or flaps

Therefore, it may help to use chains or flaps behind the tines.

For ZT-DSR, when no or only anchored residues of the previous crop are retained, the same multicrop planter can be used for seeding if fitted with suitable tines (e.g., inverted T, as commonly provided on multicrop planters in India). However, if loose or bulky crop residues are present on the soil surface, the Turbo Happy Seeder should be used.

Seed-cum-fertilizer drills for 2-wheel tractors are now also available in India, commonly attached to a power tiller. These drills are available with inclined-plate seeding

Crop being sown by a seed-cum-fertilizer drill with inclined-plate seeding mechanism, using full tillage, powered by a 2-wheel tractor. Tillage and seeding are done in a single pass.

mechanisms, and sowing can be done in a single pass with full tillage or strip tillage (achieved by removing at least 50% of the rotor blades and aligning the remaining rotor blades so that they till a narrow strip in front of the seeding tines, with the curved ends angled toward the sowing line). No prior tillage is needed. The new seed-cum-fertilizer drills/planters for 2-wheel tractors are an improvement on the "power tiller–operated seeders" (PTOS) that have been available for some time. The standard PTOS has a seed box but no fertilizer box, and a fluted-roller seeding mechanism.

c. *Seed quality, rate, sowing depth, row spacing*

Key check 4.

- Use certified seeds.
- 25–35 kg/ha (with inclined-plate seeding mechanism).
- 35–40 kg/ha (with fluted-roller seeding mechanism).
- Seeding depth: 1–2 cm.

Seed quality greatly influences germination rate; therefore, it is recommended to use certified seeds. A seed rate of 25–35 kg/ha (using good-quality seeds with more than 95% germination) is optimal for DSR with a row spacing of 20 cm sown with a multicrop planter. Under good establishment conditions, the rate can be at the lower end of the range. However, where there is risk of reduced establishment due to factors such as

suboptimal leveling, waterlogging, or seed predation, the seed rate should be at the higher end of the range. There is no yield penalty for sowing at higher rates up to about 50 kg/ha. The seeding depth for rice is critical and the rice should be sown at 1–2 cm, and definitely not deeper than 3 cm.

d. Seed treatment

i) Priming

Avoid priming if there is no assured irrigation facility.

As DSR needs to be sown at a shallow depth (<2 cm) in advance of the monsoon rains, inadequate soil moisture can be a major constraint to rapid establishment of a good crop stand. Sowing with primed seeds into moist soil can assist rapid establishment. Priming (soaking the seeds in water for 10–12 hours in a gunny-bag (Sakkupai)) accelerates crop emergence. After soaking, the seeds are air-dried for a couple of hours prior to seeding, which facilitates the free flow of seeds through the seed drill. Further, the seeds can be incubated for an additional 8-12 hours for pregermination if sowing is to be done into moist soil. The seeds should be sown shortly after priming or incubation. Emergence of pregerminated seeds will be adversely affected if sown into dry soil. Primed seeds can be sown into dry soil provided there is an irrigation immediately after sowing.

Seed hardening of paddy seeds with 1% KCl is recommended for DSR to empower the tender young seedlings to withstand drought in the early phase.

ii) Seed treatment with fungicides and insecticides

Seed treatment with fungicides is recommended to manage diseases such as loose smut, flag smut, root rot, collar rot, and stem rot. For this, a weighed quantity of seed is soaked in water treated with fungicide (tebuconazole—Raxil Easy® at 1 mL/kg seed, or carbendazim—Bavistin® at 2 g/kg) for 24 hours. The volume of water used for soaking is equivalent to the volume of seed. The seeds are then removed from the fungicide solution and dried in the shade for 1–2 hours before sowing.

Thiamethoxam 30% FS (Cruiser® 35 FS at 1 mL/kg seed) is a broad-spectrum insecticide that is well suited for seed treatment to control sucking pests.

Where soil-borne insect pests (e.g., termites) are a

Rice seed treatment with chemicals prior to sowing with a seed drill

problem, seed treatment with an insecticide is beneficial (imidacloprid—Gaucho 350 FS® at 3 mL/kg, alone or in combination with tebuconazole—Raxil Easy® at 0.3 mL/kg seed). The combination treatment will protect the seed from both soil-borne fungi and insects. The use of imidacloprid, alone or in combination with tebuconazole is also suitable for treating dry seeds. Mix the chemicals in 15 mL of water/kg seed.

7. Fertilizer management

Key check 5.

– Avoid basal dose of urea at sowing.

– Use a minimum of three splits of N fertilizer.

a. Nitrogen (N), phosphorus (P), potassium (K), and zinc (Zn)

The N fertilizer requirement varies from 100 to 120 kg N/ha depending on the attainable yield target and inherent soil fertility. The blanket recommendation for other fertilizers is P2O5 at 50 kg/ha, K2O at 50 kg/ha, and zinc sulfate (ZnSO4) at 25 kg/ha. All fertilizer except urea (N) can be applied at sowing. To avoid leaching losses from high K fertilizer rates applied on light-textured soils, split the K fertilizer application (50% at sowing, 50% at panicle initiation). Compound fertilizers (DAP or NPK formulations) should be placed in the soil at the time of sowing using the seed drill. If Zn is not applied at sowing, it can be applied as a foliar spray (0.5% zinc sulfate plus 1.0% urea) 30 days after sowing (DAS) and at panicle

initiation, approximately 3–4 weeks prior to heading. N fertilizer should be applied in three to four equal splits evenly spaced between about 3 weeks after sowing and PI. However, if some of the N is applied at sowing, the remaining nitrogen should be applied as urea in two splits at mid-tillering (40−50% of the remaining amount) and at PI (50−60% of the remaining amount). A third split of 15−20 kg N/ha at early flowering can be applied to support a high yield level. Apply N fertlizer immediately before irrigation.

However, rather than using the blanket approach above, which does not take into account the conditions of an individual field, it is better to use site-specific nutrient management (SSNM). SSNM enables farmers to better match the nutrient supply to crop need. The approach takes into account the attainable yield of the variety to be grown and nutrient contributions from soil, residues, organic fertilizer, and irrigation water. For more information on SSNM, refer to the Tamil Nadu Agricultural University Agritech portal (link on last page of this booklet).

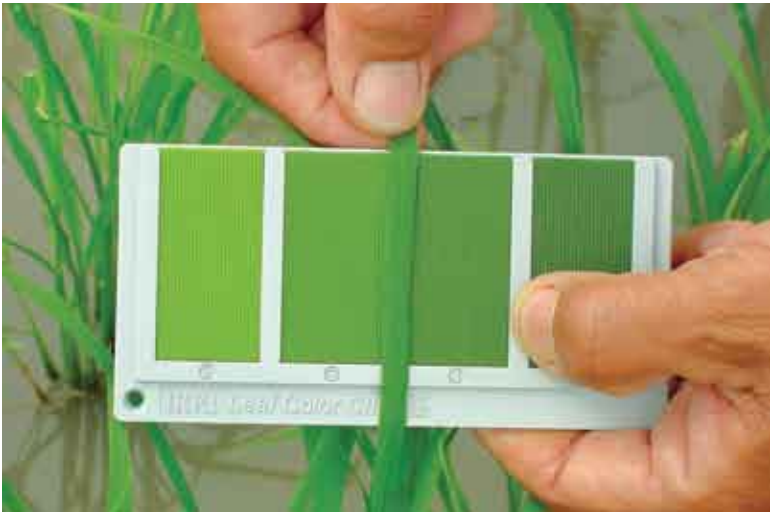
Field-specific SSNM recommendations can be obtained through the mobile platform “Nutrient Manager for Rice” for Tamil Nadu, which is currently (October 2013) under evaluation in farmers’ fields in the CDZ and will be released soon.

Use of the leaf color chart (LCC) to determine the N fertilizer requirement also enables more precise N application according to the crop requirement, and often results in a reduction in the amount of N fertilizer applied

Cover page of the Tamil Nadu version of “Nutrient Manager for Rice”

while maintaining yield. The standardized LCC developed by IRRI (photo below) is five inches long, made of high-quality plastic, with four color shades from yellowish green (No. 2) to dark green (No. 5). For high-yielding varieties/hybrids, N application for DSR should be based on a critical LCC value of 3 (for puddled transplanted rice, a critical value of 4 should be used). LCC use can follow a (1) real-time or a (2) fixed-time approach. Real-time use of the LCC involves regular LCC readings every 7 to 10 days starting at 21 DAS for dry seeded rice. The last reading is taken at the start of flowering. Whenever the LCC reading falls below the critical level between 21 DAS and PI, 25–45 kg N/ha should be applied (use the higher rates if the soil N supply/fertility is poor). If the LCC reading falls below the critical value between PI and

flowering, 25 kg N/ha should be applied. For the fixed-time approach, estimate the required total amount of fertilizer N and develop a schedule for fertilizer N split applications. Use the LCC at critical growth stages to adjust the predetermined fertilizer N rates up or down. Before using the LCC with either approach, it is recommended that you inform yourself about and use the calibrations available for the varieties and specific conditions in Tamil Nadu. The LCC is available in the state agriculture departments and at research stations.



The IRRI leaf color chart (LCC)

Don't broadcast urea on moist soil after irrigation or rain. Apply urea before irrigation (or rain if likely).

b. Iron (Fe)

Dry seeded rice often suffers from iron deficiency when grown on lighter soils (sandy loams and loams), and the deficiency is worse in low-rainfall seasons. The symptoms generally appear during the early vegetative stage in the form of yellowing, stunted plants, and seedling death. The crop should be sprayed with 1% ferrous sulfate solution as soon as the symptoms appear (repeat applications after a week if the symptoms persist). For severe symptoms, try to keep the field flooded/saturated for a few days at the time of ferrous sulfate application. If iron deficiency symptoms appear later during crop growth, they may be due to cereal cyst nematodes—check the roots for galls to determine whether this is a likely cause. If galls are present, avoid using this field for DSR in the future.

Symptoms of iron deficiency (foreground)

Root galls indicating nematode infestation

8. Irrigation management

Key check 6.

- Keep the soil in the seed/root zone moist during establishment.
- Keep the soil close to saturation from the start of heading to the start of grain filling.

The goal of irrigation management is to minimize the use of irrigation water while maintaining yield because of increasing water scarcity and/or the high cost of pumping groundwater.

Rice does not need to be continuously flooded for good growth and yield. It can be grown with periodic irrigation, allowing the soil surface to dry for a few days between irrigations (alternate wetting and drying). This reduces the amount of irrigation water needed to grow the crop, and is recommended where there is water scarcity and to reduce irrigation costs. However, if the soil becomes too dry too often between irrigations, the rice crop will suffer and a loss of yield will occur. Therefore, irrigation needs to be managed carefully. The irrigation requirement for DSR depends very much on the weather and the soil type. The lighter (less clayey, more sandy) the soil, the more frequently it will need irrigation in the absence of adequate rain.

DSR needs an assured water supply for the first 3 weeks after sowing for good establishment. When DSR is established in hot and dry conditions, irrigation is done on the day of sowing or within 1 day after sowing. The next one to two irrigations are required at intervals of 3–5 days to keep the soil moist in the root zone. During the active tillering phase, and the heading to grain-filling stage, the topsoil (0–15 cm) should be kept close to saturation, with irrigation applied as needed. At other stages, the topsoil can be allowed to become drier, but never to the degree that the leaves show signs of rolling (no longer flat) in the early morning. For clayey soils, the appearance of hairline cracks on the soil surface is a general indication of the need to irrigate.

9. Weed management

Weed management is usually the biggest challenge for successful production of DSR. A much larger range of weeds occurs in DSR than in puddled transplanted rice,

and, if uncontrolled, the degree of infestation can be great enough to reduce rice yield to zero. There are three broad classes of weeds—grasses, broadleaves, and sedges. Table 2 lists the weeds commonly found in DSR in CDZ, Tamil Nadu.

Don't grow DSR in fields used for fodder crops or with a history of heavy weed infestation.

a. *Cultural practices*

Stale seedbed technique: This technique is highly desirable if the field has a large weed seed bank (i.e., lots of weed seeds in the soil as a result of weed infestation in the past). Weeds are germinated by giving one or two irrigations starting about 1 month prior to sowing, and then killed by either a nonselective herbicide (paraquat or glyphosate) or a shallow tillage. If the soil condition is suitable for sowing, use a nonselective herbicide to kill the weeds and sow the crop without any tillage (tillage brings more weed seeds near the soil surface and thus promotes their germination). Note that the weeds must be actively growing at the time of herbicide application; so, if the soil is dry, an irrigation will be needed prior to herbicide application. This method has great potential for reducing weeds and volunteer rice in DSR.

b. *Chemicals*

A wide range of herbicides is available for controlling weeds (Table 3).

All herbicides and pesticides should be regarded as dangerous. Proper safety precautions should be followed. These include:

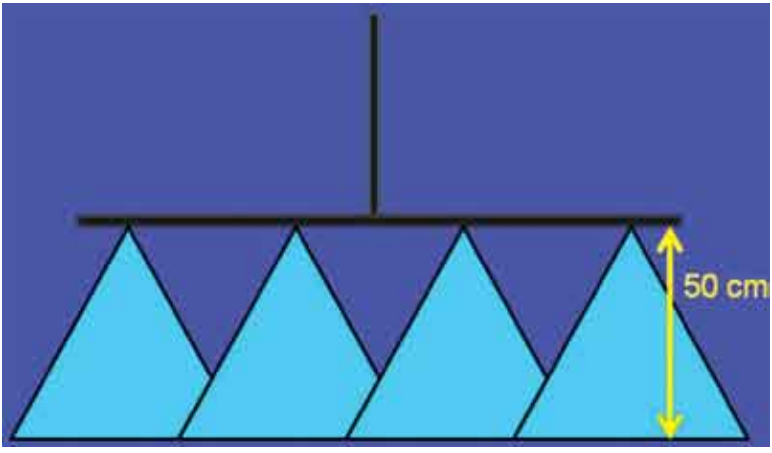
- Wearing protective clothing when mixing the chemicals with water and when spraying. This includes wearing of rubber gloves, a face mask, goggles, a hat, a long-sleeved water repellent coat or apron, coat sleeves covering the gloves, rubber boots, long trousers – worn over boots.
- Protective clothing should be removed and washed after use, and operators should take a bath/shower with soap after applying chemicals.
- Operators should not smoke or eat when mixing or applying chemicals.
- Spray tanks must not be washed out in rivers or ponds as many chemicals are toxic to fish and amphibians.
- Pesticide containers should be buried at least 50 m from running water and 1 m deep, burnt well away from people/houses, or recycled where this is available.
- Empty pesticide containers should not be used to store food or drinks.
- Pesticides should be stored in a locked container out of reach of children.

All herbicides need to be mixed with water prior to application. Clean water should be used, as muddy

water reduces herbicide efficacy. Spray tanks, booms, and nozzles should be cleaned properly with clean water after use. Chemicals should not be mixed together unless recommended, as this may reduce their effectiveness on weeds and/or be harmful to the rice plants. Chemicals should always be applied at the recommended rate.

Uniform application of the spray across the entire field is needed to avoid "misses" (with costly follow-up hand weeding needed) and overspraying (waste of costly chemicals). The best way of achieving this is with a multinozzle (e.g., three) boom fitted with flat-fan nozzles and slightly overlapping

Use of multinozzle boom for herbicide application



Boom height for desired spray pattern with slight overlap at ground level to avoid “misses”

spray patterns at the soil surface. The overlap is achieved by holding the boom at the right height (approximately 50 cm) above the target (for preemergence, the soil surface is the target; for postemergence, weeds are the target, so the boom should be 50 cm above the top of weeds).

All herbicides and pesticides are dangerous. Proper safety precautions should be followed. These include

- Wearing gloves, a breathing mask, and goggles when handling neat (undiluted) chemicals and when spraying.
- Wearing protective clothing while spraying (e.g., made from washed fertilizer bags).

i) Preplant/knockdown herbicides

These herbicides are used to kill existing vegetation prior

Protective clothing for spraying

to rice sowing under ZT-DSR. Glyphosate (1.0 kg a.i./ha) and paraquat (0.5 kg a.i./ha) are recommended. If fields are infested with perennial weeds, use glyphosate, not paraquat.

ii) After crop sowing

Key check 7.

- Ensure that the soil surface is moist before applying preemergence herbicide.
- Use a high volume of water when preemergence herbicide is applied on moist soil.
- Apply irrigation 24 h after postemergence herbicide application if the soil is not moist.

The choice of herbicide depends on the types of weeds, and no single herbicide can control all weeds in the rice crop. In many situations, the best method for effective weed control is the application of a preemergence herbicide (1–3 DAS, before the weeds and rice emerge), followed by a postemergence application at 15–25 DAS. This will typically involve the use of pendimethalin or oxadiargyl as a preemergence herbicide followed by a postemergence application of bispyribac-sodium or azimsulfuron or bispyribac-sodium plus azimsulfuron. However, in cases where the preemergence herbicide is missed (e.g., due to rain) or fails (e.g., due to management errors, such as soil too dry at the time of spraying), early herbicide application at 15 DAS should be made based on the types of weeds present.

Don't apply preemergence herbicide on dry soil; irrigate first if needed.

Don't allow water stress after the application of postemergence herbicide.

Don't apply herbicide while it is raining or if rain is likely within 6−8 hours.

c. Physical

Physical weed control consists of removing weeds by hand (manual weeding) or by machine (mechanical weeding). It is practically and economically impossible to control weeds solely by hand weeding because of labor scarcity and rising labor wages. However, one or two spot hand weedings are strongly recommended to remove weeds

Hand-operated cono weeder for single-row and double-row weed control in DSR (front and side views)

Motorized weeder

that escape herbicide application to prevent weed seed production and the accumulation of weed seeds in the soil. Mechanical weeding can be useful in reducing labor use in weeding. Manual or motorized cono weeders and other hand weeders are available in the region and can be included as part of integrated weed management.

d. Surface residue retention

Retention of crop residues on the soil surface in zero-tillage systems also helps to suppress weeds.

10. Pests and diseases

a. Nematodes

Cereal cyst nematodes tend to be a problem on lighter soils, more so in drier years. The problem initially appears as small patches of stunted growth, reduced tillering, and pale green-yellowish plants. The problem is likely to be exacerbated by continuing to grow nonflooded DSR in the same field. It is better to avoid growing DSR in fields where nematode problems begin to appear.

b. Insects and pest management

The common insects and pests of rice in the region, and chemicals for controlling them, are listed in Table 5.

Table 1. Suitable cultivars for DSR in the Cauvery Delta Zone.

Cultivar	Duration (days)	Yield potential (t/ha)	Days to heading	Situation
Inbred				
Kuruvai				
CO - 47	105	5.0	75–80	Irrigated
CO - 51	105	5.2	75–80	Irrigated
ADT - 36	110	4.4	75–80	Irrigated
ADT - 37	110	4.5	85–90	Irrigated
ADT - 43	105–110	5.5	80–85	Irrigated
ADT - 45	105–110	5.7	80–85	Irrigated
Samba				
ADT – 44	145–150	5.4	120–125	Irrigated
ADT – 40	150	4.5	120–125	Irrigated
ADT – 50	150	5.3	125–130	Irrigated
CR – 1009	160	7.0	120–125	Irrigated & Rainfed
Hybrid				
Kuruvai				
CORH – 3	110	6.0	85– 90	Irrigated

Table 2. Common weeds of rice in the Cauvery Delta Zone.

Grass		Broadleaf		Sedge	
Botanical name	**Local name**	**Botanical name**	**Local name**	**Botanical name**	**Local name**
Cynodon dactylon	Arugam pil	*Eclipta prostrata*	Karisalangani	*Cyperus iria*	Korai
Echinochloa colona	Kuduraivaali	*Crotons sparsiflorus*	Rayil poondu	*C. rotundus*	Korai
E. crus-galli	Kuduraivalli	*Commelina benghalensis*	Aduthinna thalai	*C. difformis*	Korai
Eleusine indica		*Ammannia baccifera*	Neermel neruppu		
Dactyloctenium aegyptium	Nandu pil	*Astercantha longifolia*	Neermulli		
Panicum repens	Inji pil	*Centella asiatica*	Vallarai		
		Marsilea quadrifolia	Aalakodi		
		Monochoria vaginalis	Neer Thamarai		
		Lippia nodiflora	Poduthazhai		

Table 3. Major knockdown and preemergence herbicides for weed control in DSR in the Cauvery Delta Zone.

Herbicide	Product (trade) name*	Concentration (g a.i./ha)	Product dose (g/ha or mL/ha)	Application time (DAS)	Strengths	Weaknesses
Knockdown/nonselective						
Glyphosate	Roundup	1,000	2,500 mL	5 (before sowing)	Good control of most grasses, some broadleaves and annual sedges	Weak on *Ipomoea triloba* and *Commelina* species
Paraquat	Gramoxone	500	2,000 mL	2 (before sowing)	Good control of most grasses, some broadleaves and annual sedges	
Preemergence						
Pendimethalin	Stomp/Stomp xtra	1,000	3,330 mL 2,580 mL	1–3	Good control of most grasses, some broadleaves and annual sedges. Has residual control.	Sufficient soil moisture is needed for its activity
Oxadiargyl	Topstar	90	112.5 g	1–3	Broad-spectrum weed control of grasses, broadleaves, and annual sedges. Has residual control.	Sufficient soil moisture is needed for its activity

**Does not imply endorsement of the product*

Table 4. Major postemergence herbicides for weed control in DSR in the Cauvery Delta Zone.

Herbicide (active ingredient, a.i.)	Product (trade) name*	Concentration (g a.i./ha)	Product dose (g/ha or mL/ha)	Application time (DAS)	Strengths	Weaknesses
Postemergence						
Bispyribac-sodium	Nominee Gold/ Macho/ Tata Taarak/ Adora Macho	25	250 mL	15–25	Broad-spectrum weed control of grasses, broadleaves, and annual sedges. Good control of Echinochloa species.	Poor on grasses other than Echinochloa species, including Leptochloa chinensis, Dactyloctenium aegyptium, Eleusine indica, and Eragrostis species. No residual control.
Azimsulfuron	Segment	17.5−35	35−70 g	15−20	Broad-spectrum control of grasses, broadleaves, and sedges. Good control of sedges, including Cyperus rotundus.	Poor on Echinochloa species.
2,4-D sodium salt	Fernoxone	1,200	1,500 mL	15−25	Controls braodleaf weeds.	Effective only on a single group of weeds
Chlorimuron + metsulfuron	Almix	4 (2 + 2)	20 g	15–25	Effective on broadleaves and annual sedges.	No control of grassy weeds and poor on C. rotundus.
Bispyribac-sodium + azimsulfuron		25 + 17.5	250 mL + 35 g	15–25	Broad-spectrum weed control of grasses, broadleaves, and sedges, including C. rotundus.	Poor on grasses other than Echinochloa species.
Bispyribac-sodium + pyrazosulfuron		25 + 25	250 mL + 250 g	15–20	Broad-spectrum weed control of grasses, broadleaves, and sedges, including C. rotundus.	Poor on grasses other than Echinochloa species.

** Does not imply endorsement of the product.*

Table 5. Common insects, pests and diseases of rice, and chemical treatments.

Name of pest	Period/stage of attack	Chemical name and product dose (kg/ha, g/ha, or mL/ha)
Insects		
Yellow stem borer	July to Oct.	Cartap hydrochloride 4 G (15 kg), monocrotophos 36 SL (1,000 mL), chlorpyriphos 20 EC (2,000 mL)
Leaffolder	Aug. to Oct.	Monocrotophos 36 SL (500 mL), chlorpyriphos 20 EC (1,000 mL)
Diseases		
Brown leaf spot	Tillering to flowering	Zineb (1–1.25 kg)
Bacterial leaf blight	Just after transplanting	Copper oxychloride (1,250 g)
Blast	Maximum tillering	Carbendazim 50 WP (500 g), tricyclazole 75 WP (300 g)
Sheath rot	Boot leaf stage	Carbendazim 50 WP (250 g), metominostrobin (500 mL), mancozeb (1,000 g)
False smut	Flowering stage, heavy dew situation, January	Propiconazole 25 EC (500 mL), copper oxychloride 50 WP (1,250 g)

*Dissolve this in 5 L of water and then mix it with 50 kg of sand and broadcast uniformly in saturated to flooded conditions.

Contributors

Sudhir-Yadav	International Rice Research Institute
R. Ganeshamoorthy	CSISA, International Rice Research Institute
Elizabeth Humphreys	International Rice Research Institute
R. Rajendran	TRRI, Tamil Nadu Agricultural University
V. Ravi	TRRI, Tamil Nadu Agricultural University
Frank Mussgnug	International Rice Research Institute
Virender Kumar	International Maize and Wheat Improvement Center
Bhagirath Singh Chauhan	International Rice Research Institute
T. Ramesh	TRRI, Tamil Nadu Agricultural University
B.R. Kamboj	CSISA, International Maize and Wheat Improvement Center
Mahesh Gathala	International Maize and Wheat Improvement Center
R.K. Malik	CSISA, International Maize and Wheat Improvement Center
M.L. Jat	International Maize and Wheat Improvement Center
Andrew J. McDonald	International Maize and Wheat Improvement Center

Acknowledgements

We thank Bill Hardy for editorial assistance and Poornima Shankar for the cover design and other publication assistance.

For more details and queries, please contact

Dr. R. Rajendran
Director i/c
TRRI (TNAU), Aduthurai
Mobile: +919443421207
Email: rajendrankmu@yahoo.co.in

Dr. V. Ravi
Professor and Head
Soil and Water Management Research Institute (SWMRI)
Kattuthottam, Thanjavur 613 501
Mobile: +919443141045
Email: ravitnjagri@gmail.com

Mr. R. Ganeshamoorthy
Extension Agronomist, Tamil Nadu CSISA Hub, International Rice Research Institute
c/o Soil and Water Management Research Institute (SMWRI), Kattuthottam, Thanjavur 613501
Mobile: +919585504667
Email: r.ganeshamoorthy@irri.org

Further information

Visit the following Web sites for further information (fact sheets, videos, manuals) on many topics, including laser leveling, tillage, sprayers and spray techniques, pest management, nutrient management, and many more:

www.knowledgebank.irri.org/csisa/en/direct-seeding.html

www.knowledgebank.irri.org/csisa/en/tamil-nadu-csisa-hub.html

www.knowledgebank.irri.org/csisa/en/gazipur-csisa-hub/itemlist/category/71-direct-seeded-rice.html

www.knowledgebank.irri.org/csisa/en/land-leveling-and-bunds/item/16-laser-land-leveling.html

www.knowledgebank.irri.org/csisa/en/home/item/152-sprayers-and-spray-techniques-manual.html

www.knowledgebank.irri.org/csisa/en/disease-management-a-weeds/item/30-mechanical-weed-control.html

www.knowledgebank.irri.org/csisa/en/disease-management-a-weeds/item/28-main-weeds-of-rice-in-asia.html

Kumar, V. and Ladha, J.K. 2011. Direct seeding of rice: recent developments and future research needs. *Adv. Agron.*, **111**: 297-413.

TNAU SSNM portal at *http://agritech.tnau.ac.in/agriculture/agri_nutrientmgt_rice.html*




The DSR Series available in English and local languages:

Volume 1: Guidelines for Dry Seeded Rice (DSR) in the Eastern Gangetic Plains of India
Volume 2: Guidelines for *Aman* Dry Seeded Rice (DSR) in Bangladesh
Volume 3: Guidelines for Dry Seeded Rice (DSR) in Nepal
Volume 4: Guidelines for Dry Seeded Rice (DSR) in the Cauvery Delta Zone, Tamil Nadu, India

www.knowledgebank.irri.org