

Drip Irrigation and Fertigation Technology for Rice Cultivation

Dr. P Soman

Session 6b: Tools, Techniques, Innovations

As the demand for water for domestic, municipal, industrial and environmental purposes rise in the future, less and less water would be available for irrigation. Water availability for agriculture in India which is 83.3% of total water used today, will shrink to 71.6% 2025 and to 64.6% in 2050 (Min. Agriculture, GOI). We are almost exhausting all of the irrigation water to increase any more land under irrigation.

Rice is the main grain that is in demand in India and South Asian countries. A hectare of rice in conventional puddle cultivation uses 1300–1600 mm per season according to the literature. But in practice, farmers use much more water (up to 2000 mm) in many delta areas in India. In Asia, 17 million ha of irrigated rice will face “physical water scarcity” and 22 million ha may have “economic water scarcity” by 2025 (Tuong and Bouman, 2001). The highest share of this inadequacy will occur in India, the largest rice producer of the region.

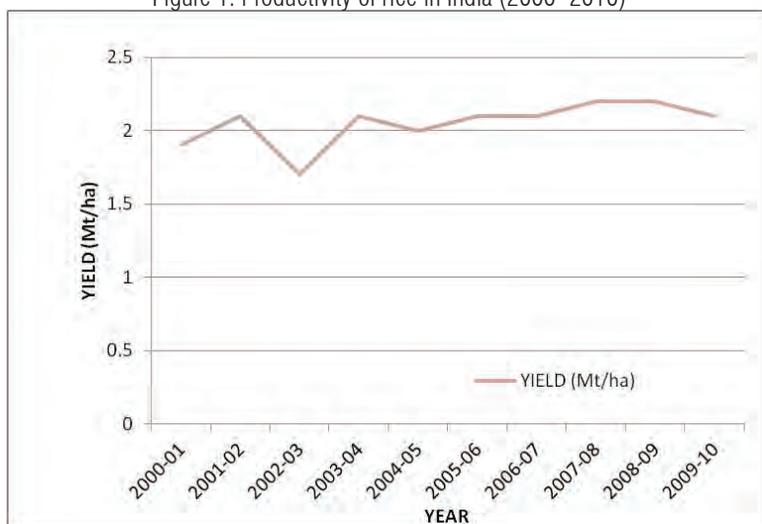
The future of rice production which consumes a lion's share of water (85%) used in irrigated agriculture will therefore depend heavily on developing and adopting technologies and practices which will use less water with highest use efficiency. Rice is cultivated usually in a puddle condition with large volumes of water and grown in standing water. The water productivity is hardly 0.15 kg/m³ water, which is very low.

With all that water use, still the rice yields in India are not very high and seem to have stagnated (figure 1) in the last decade or so.

In the case of several other so called high water user crops—sugarcane, banana, vegetables, etc., we could find that actual water need is found to be 50–60% less than what are thought of the water requirements. This is made possible by drip irrigation technology; moisture availability in soil is kept close to the crop water requirement on a continuous basis. In this method, the crop performs close to its genetic potential and yields are enhanced.

Jain Irrigation, working towards food security thru water and energy securities, has now tested and released an innovative method of irrigating rice crop. The drip technology is tested in the traditional wet rice and the dry seeded rice (DSR). Dry Seeding is practised in aerobic rice cultivation; and it is similar to what is generally referred to as upland rice (topographically high altitude).

Figure 1. Productivity of rice in India (2000–2010)



(Source: Ministry of Agriculture, GOI)

The paper mainly discusses, the experimental trials, farmer demonstrations in an effort to commercialise a package of technology for growing rice.

Experimental stage

Research trials were conducted by establishing drip irrigation systems in several rice ecosystems spread in many States in India—Andhra Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Tamil Nadu. Trials were also conducted in the two major seasons, rainy (Kharif) and Post rainy (Rabi) and summer.

Trials with drip irrigation and fertigation were conducted in both dry seeded rice (DSR) and in transplanted rice methods of cultivation.

Varieties used: Hybrids used are Arize 6129(Bayer), RH 257(Monsanto),MK 2325(Syngenta). Duration of crop after sowing is 115 to 140 days. Other varieties released by PAU like PR 111, PR 113, PR 114, PR 115 and PR 120, are used. Duration of crop after sowing is 130 to 145 days.

In Basmati varieties used are Basmati 370, Basmati 386, Super Basmati, Pusa Basmati 1121 are used; duration of crop 130 to 150 days. Additionally, other local prominent varieties were also included in each location.

Agronomy practices standardized from the trials

1. Prepare well leveled and pulverized soil with adequate moisture. (Do a pre-planting plough, irrigate and germinate weeds and plough gain before land is ready for rice planting).
2. Prepare Bed and furrow as given above.

3. Hand sow / drill the seeds.
4. Row to distance (20 x 15 cm)(ROW – ROW x PLANT – PLANT)
5. Depth of seed 2 cm in dry seeded cultivation.
6. Fully drip Irrigate the field after sowing to provide the required moisture.
7. Drill the basal dose using a drill or apply on the bed before planting and incorporate.
8. Weed control: In the absence of standing water, heavy weed infestation was envisaged. However weeds could be easily controlled by a combination of hand weeding and rice husk mulching or by weedicide application. Application of Pendimethalin at 500ml/acre at 72 hours after sowing provided effective control.
9. Routine inspections for insects (stem borer , leaf roller) and disease incidence were made during the crop.
10. Irrigation in drip plot was done by placing two drip lines on each bed (Jain inline drip laterals 16 mm diameter with drippers of 4 lph placed at 50 cm spacing along the drip line).
11. Fertilizers were injected (fertigation) thru a ventury system following a schedule that was prepared for each location.

The quantum of irrigation varied from location to location based on the evaporation of the location. The fertilizer doses are varied based on the fertilizer recommendations prevailing in each location.

Rice yield and water and power use in drip irrigation

Table 1: Water and power use under two different Irrigation methods (2009–2010) trial, Elayamuthur farm, (10o 34' 48" N /77o 14' 24" E), Coimbatore, Tamil Nadu (Rice variety, T 45)

Irrigation	Yield (t/ac)	Water use (million liter/ac)	Power use (units/ac)
Flood	3.1	9.5	467
Drip	3.8	3.2	226
Difference (%)	22.5	66.3	52

Table 2 : Yield of different varieties under drip and conventional flood plots (harvested from Jalgaon, (21o 2' 54" N / 76o 32' 3") Maharashtra)
RICE YIELD IN A TRIAL, JALGAON, Maharashtra (t/ac)

Variety	Flood	Drip + Husk Mulch
SBH-999	2.4	3.2
25P25	1.8	2.7
25P31	2.8	3.2
MAS- 946-1	2.5	2.5
Try (R)-2	2.8	2.9
BPT	1.9	2.2
Pusa Sugandha	2.3	3.4

Table 3: Water productivity in flooded and drip irrigated rice (kg/m³)

Variety	Flood rice	Drip + Husk Mulch
SBH-999	0.13	0.67
25P25	0.10	0.57
25P31	0.14	0.62
MAS- 946-1	0.14	0.52
Try (R)-2	0.13	0.53
BPT	0.10	0.46
Pusa Sugandha	0.12	0.70

The field trials proved that: (1) Keeping the soil wet alone and not providing standing water results in yields comparable or more than in flooded (with standing water) condition; (2) Weeds, thought to be a major issue in non-flood situation can be managed by a) mulching the seedbed with rice husk at planting and one manual weeding or by minimum weedicide application 3. The performance of several varieties indicated that provision of soil moisture is the key and not standing water for rice production.

Demonstrations in farmers' field

As a second step the drip irrigation technology for rice production was demonstrated in farmers' fields in many states during 2009–2011. Irrigation systems were installed by the company and operated by farmers. Necessary training on operation and maintenance were given to the farmers.

State	Punjab	Rajasthan	Chhatisgarh	Andhra Pradesh
Farmer details	Didda Singh, Mahalo, SBS Nagar Dist.,	Rajesh Vijay, Bhadana village, Kota dist.	Nanda Kumar Varma, Pirda, Durg dist.	Siva Reddy, ddaipally, Kadapa dist.,
Rice variety	Arize, 6129	Pusa-4 (1124)	1010	MTU 4870
Crop area	0.5 acre	15 acre	1 acre	0.5 acre
Yield	3.24 t/acre	1.2 t/acre	3t/acre	3.8 t/acre
Incremental yield (due to drip)	0.8 t/acre	0.6 t/acre	1.0 t/acre	1.5 t/acre
Cost of Cultivation	9,260.00 /acre	11,000.00/acre	9,000.00/acre	13,300.00/acre
Cost of drip equipment	30,000 .00/acre	60,000.00/acre	28,000.00/acre	45,000.00/acre
Subsidy for equipment##	18,000.00/acre	42,000.00 /acre	nil	40,500.00/acre

Life of the equipment\$\$	7 years (14 seasons)	7 years (14 seasons)	3 years (6 seasons)	7 years (14 seasons)
State	Punjab	Rajasthan	Chhatisgarh	Andhra Pradesh
seasonal cost of equipment	2142.9/acre	4285.7/acre	4667.00/acre	3214.3/acre
COP + equipment cost (seasonal)	11,402.9/acre	15285.7/acre	13667.00/acre	16514.3/acre
Gross income	35640/acre	44,000.00/acre	34,500.00	38,000.00/acre
Net income	24,380.00/acre	28714.3/acre	20833	23867.00/acre
B C ratio	2.1	1.9	1.5	1.4
Pay Back period&&	1.23 seasons (= 1 year)	2.09 seasons (= 1 year)	1.3 seasons (= 1 year)	1.9 seasons (= 1 year)
water saving % **	40	40	335	45

** As % of water applied in conventional flooded plots.

\$\$ Drip equipment is generally used for 7 years ; total of 14 crops on rotation.

Subsidy component is not considered for B C and Payback period estimates.

&& Income from rotation crop (Rotation crop after rice) is taken as equivalent to rice net income.

In all these demonstration farms drip field recorded higher yields than what the respective farmers used to get in conventional cultivation. On average, the investment cost of the equipment could be recovered within a year, in two seasonal crops. Although subsidy was obtained for the equipment in 3 out of 4 cases , the subsidy component is not adjusted for estimating payback period and BC. Introduction of subsidy for equipment is not for rice crop per se. Most of the framers we were working with already had drip equipment that could be easily modified for rice crop planting pattern.

Irrigation water could not be metered in the farmers' fields. However, from the pumping data, the water use for drip could be estimated.

Commercialisation of the technology

Building reach

While the experimental and farmer field data are promising for the introduction of the technology, we realise that it will not be an easy ride all the way through. The attitudinal change required to accept the new method of irrigation especially for rice is huge. The following steps are taken to accelerate the process: 1. Working in collaboration with public scientific and extension institutions: national agriculture research bodies, regional research stations, Krishi vigan Kendras, international research institutions, and progressive farmers.

Jain irrigation has been working with agriculture universities in Tamil Nadu, Punjab, West Bengal and Uttarakhand. We are encouraging these institutions to conduct field days, farmer visit to demonstrations and seminars besides providing technical and material support.

Regional rice research stations were keeping drip irrigated rice plots for visiting farmers. Work is underway for the last two years with International Institutions; both in the area of rice research and water management.

Press and media are also brought into the scene to propagate the technology.

This year more progressive farmers would be brought in.

Already an additional 5 farmers in AP, 2 in Punjab, 1 in Maharashtra, 2 in Tamil Nadu, are going to take up drip irrigated rice cultivation.

Strategy

It is envisaged that the upland rice areas that are currently irrigated, some 6 mha would be the first target for drip technology reach. These farmers easily understand and seen rice crop standing on drying soil. Introduction to these areas can be hastened through governmental support; provision of capital subsidy to the growers.

The equipment requirement has undergone standardisation and cost optimisation. The system cost could be optimised by modifying planting pattern and soil management to some extent.

Environmental issues

Apart from the water conservation issue by the large scale adoption of the drip technology; conversion of one acre into drip from flooding would generate (based on our field data) sufficient water for another 2.9 acre rice or 3.2 acre vegetable crop; drip adoption would result in other benefits.

Emission of methane gas in rice ecologies is a major environmental issue; one of the factors, resulting in methane emission from rice fields is the standing water and the anaerobic decomposition of organic matter. In the non-flooded situation like drip irrigated rice the conditions for methane formation would be minimal. We are into research to estimate the variation in methane emission in drip irrigated rice. Similarly fertigation—application of fertilizer as a dilute solution in multiple

doses for rice crop—would also bring down nitrate pollution into community water bodies. This observation also needs scientific confirmation.

Issues for consideration

The following issues have to be addressed as we go along with the popularisation of the technology:

1. Identification of rice varieties most suited for Drip based cultivation; varieties with of high WUE (water use efficiency) will further enhance the performance.
2. Enhancement of yield and returns with such varieties. From the experience in other irrigated crops, it is fair to say that farmers do not adopt technology for the sake of water or other resource saving alone. In India, water is not metered and power is subsidized to a large extend, both of which act as disincentives for conservation. They accept new technologies only if gives them more profit. With modified fertigation dosing and precision management of the crop it is possible for higher returns to farmers.
3. In India, as such the use of herbicides to any crop is very limited compared to neighbor countries. Non-flooding is found to increase weed incidence and the role of herbicide would become critical in drip irrigated rice farming.
4. Drip technology (for host of crops) got a shot in the arm by governmental investment as subsidies to the farmers. Considering the level of conservation of water and power in rice cultivation is enough reason for introducing governmental support, at least in the coming 5-10 years.
5. Capacity building and training should be given a very high priority; and public agencies can draw support from private partners to make the programs effective and focused.
6. Material science also should progress to eventually produce degradable plastics for drip equipment.

References

All water resource and rice production data of India - Ministry of Agriculture, GOI, website.

Related papers

Water balance in dry seeded and puddled transplanted rice in Punjab, India – Sudhir Yadav, et al. (2010); 19th World Congress of Soil Science, Soil solutions for a changing World.

On-farm Performance Evaluation of aerobic rice technologies and its impact, G.sah, et al., 25th National Summer Crops workshop, held at NARI, Khumaltar.

Revised IPCC Guidelines for National Green House Gas inventories 1999–Revised Manual.