

Ratoon rice

A climate smart rice technology

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Ratoon rice is a second rice crop that originates from auxiliary buds on the culm (stem) left behind after the harvest of the main crop. Ratoon rice requires 50 to 60% less labour and reduce the growth duration by nearly 50%. In India, out of 43 Mha rice area, about 19 Mha is suitable for ratoon rice cultivation. Within two-month duration, ratoon crop produces up to 50% of main crop yield and increases the cropping intensity and resource use efficiency (water, fertilizer, energy). Although ratoon rice has multiple benefits, it is not widely adopted primarily because of lack of suitable cultivars and best agronomic management practices, higher incidence of insect pest and disease, and lower and unstable yield. Thus, future research should provide prime importance to varietal improvement, development of best agronomic management practices and host plant resistance to insect pest and disease.

Keywords: Cultural practice in ratoon rice, Ratoon rice, Resource use efficiency

RICE-rice cropping system occupies 5.9 Mha area in India. It is the second largest cropping system next to rice-wheat system. Rice-rice cropping system is water, energy, capital, input (pesticides) and most importantly labour intensive. This system is also blamed for its negative impacts on the environment through emission of greenhouse gases (GHGs). Hence, there is increasing interest to identify options that can help increase productivity while reducing environmental impact which together ensures profitability. With growing national concerns about both food grain self-sufficiency and climate change, it is important to identify alternative cropping systems that can meet growing food grain demand and environmental goals, while ensuring farmer profitability.

Ratoon rice (RR) has been proposed as an alternative system that reconcile both high system productivity and relatively lower production costs, labour requirements and global warming potential (GWP). It also increases

cropping intensity and resource use efficiency. Ratooning is the ability of the plant to regenerate new tillers from stubbles of the main crop. RR is a second rice crop that originates from auxiliary buds on the culm left behind after the harvest of the first crop (main crop, MC). Many countries in the world (USA, Brazil, Japan, India, Philippines, Thailand, and Taiwan) are practicing rice ratooning; however, it is practiced only in limited areas.

Scope

There is significant scope to adopt this technology in areas where adequate water is available after the main crop harvest. It is particularly suited to areas where mono-cropping is practiced and resources are not utilized during the off-season, because no crops other than rice can be grown under the climate and moisture limitations. Similarly, rice ratooning could be practiced as an alternative to double-cropping in limited irrigation water available areas. In the tropical monsoon areas

where rice is the principal crop and cultivated mostly as a monocrop, resources go to waste during the off-season. In tropical Asia, the area that could be put under a ratoon system could be roughly estimated as 30% of the rice area, or about 26.63 million hectares. In India, out of 43 million hectares under rice, about 18.9 million hectares constitute the lowland where ratooning is possible. In India ratoon rice can be practiced extensively in Assam, hilly tracks of Karnataka, Meghalaya, and in some patches of Odisha, west Bengal, Tamil Nadu. In flood affected areas, ratoon rice is an effective method to mitigate the yield loss due to heavy flooding. Considering the cost, duration and management practice of rice ratoon crop, the production might be satisfactory for the marginal farmers of the hill region for using the same field within the short duration which will provide extra gain for sustainable rice production in tropical hill area. The growing public negative perception about use of pesticides in agriculture, the higher

farm-gate purchase price is expected for the ratoon crop because of its lower pesticide load in rice grain, which will further increase the profitability of ratoon rice system in the future. Ratoon rice is a climate smart rice technology for changing climate. The scope for ratoon rice is more in coming years because of its lower carbon, water and environmental footprint. The recent development and availability of improved cultivars with multiple resistance to several diseases and insects further widens its scope.

Ratooning mechanisms

The auxiliary buds present in main crop stubble grow into ratoon tillers. These buds exist in various stages of development. The growth and vigour of ratoon tillers depend on carbohydrate reserves of the stubble and the root system after harvest of the main crop. The higher concentration of total carbohydrate (TCA) in stubble and root will give faster development of ratoon tillers. Plants with thick culms store more carbohydrate than those with thin culms. The amount of TCA in the stubbles increases with increasing cutting height. Reducing the cutting height from 15 to 5 cm increased the number of missing hills significantly, from 12% to 37%, and the growth period of the ratoon crop from 73 days to 86 days. Ratoon crop will yield well if main crop stubble is left with 2–3 nodes during harvest. Production of more number of tillers in ratoon crop is pre requisite to achieve high yield. Tillers from lower nodes will have a lower C:N than tillers from higher nodes. The lower tillers resemble young seedlings. Such

Varieties found suitable for ratoon rice

Suitable region/eco system	Cultivar
Old varieties which give ratoon grain yield >2 t/ha	D52-37, IR28, C3810, Labelle, IR8, Intan, IET 7191, IET 9667, IET 9668, IET 9670, IR42 and IR2058-78-1-3-2-3
Recent varieties	Naveen, Swarna Sub-1, Savitri/ Ponmani, Gayatri, Ranjit

Reason behind non-adaption of ratoon rice cultivation

- Lack of improved cultivars for ratoon rice system.
- Lower and unstable yields compared to other rice systems.
- Lack of best agronomic practices to improve productivity and input-use efficiency.
- Mechanical harvest of first crop (main crop) causes damage to mother plant and reduce the plant population in ratoon crop.
- Higher incidence of insect pest and diseases infection.
- Grain quality is inferior to that of the main crop.

For large scale adoption, several problems in ratoon cropping need to be tackled immediately. Varietal improvement, incorporating ratooning ability, and resistance to diseases and insect pests is of prime importance.

healthy tillers generally emerge from lower nodes and will have the best ratoon yield potential. However, tillers formed on higher nodes grow faster and mature earlier.

Physiological difference between main and ratoon crop

There are many difference in the growth and development of ratoon rice crop in comparison to main crop. The plant height is lower and effective tillers are fewer in the ratoon crop. Within same cultivar, in ratoon crop the number of effective tillers are fewer compared to the main crop. However, the actual number of tillers may be higher in the ratoon crop. Similarly, the panicle development and heading are more uneven in ratoon than that of the main crop. All the yield attributing parameters like panicle length, spikelet size, number of productive tillers, filled grains per

panicle were less pronounced in the ratoon crop than in the main crop.

Advantages of rice ratooning

The advantages are manifold. Shorter growth duration (avoid raising seedlings in the nursery and transplanting in the main field); 50–60% less labour requirement; 60% less water requirement and high water use efficiency; lower production costs; 35–45% lower global warming potential (GWP) over conventional rice-rice system; 50% reduction in pesticide input; increased cropping intensity; avoiding elaborate land preparation and saving of seed; economic use of machineries; higher resource use efficiency per unit time and per unit land area.

Selection of cultivar

Though ratoon development is a

Automatic irrigation system for rice

Rice, a water intensive crop, is commonly cultivated under submerged condition and remains under ponding water for 80% of crop duration. The existing automated irrigation systems are based on soil moisture measurement, which fail to recognize the moisture level beyond the 100% saturation level. The automatic irrigation system, designed for alternate wetting and drying (AWD) method of irrigation, detects ponding water in rice fields. It can detect water level and transmit signal to the controller wirelessly. The controller unit is programmed to operate the pump based on the desired water level in the field at different crop growth stages. Manual colour based system for water level (above and below soil surface) indicator in rice field was also developed. Farmers can operate their pump after seeing the status of water in the rice field. Both the systems were evaluated and the results were compared with the farmers' practice of rice cultivation. The irrigation water productivity of 6.15, 5.71 and 3.06 kg/ha.mm, and the total water productivity of 4.80, 4.49 and 2.63 kg/ha.mm were recorded for automated, manual and control (farmers' practice) system, respectively. Rice yields of 4.8, 4.6 and 4.1 tonnes/ha were obtained for automatic, manual and control system, respectively.

Source: DARE-ICAR Annual Report 2019-20

varietal characteristic, the geography and climate determines the selection of suitable cultivar for ratooning. Early-maturing cultivars perform better as ratoon crops in temperate areas because they do not require early seedling and also allow a favourable growth period for the ratoon crop and intermediate-to late-maturing cultivars are better for raising a good ratoon crop in tropical hills and valleys. In Madagascar, japonica varieties showed better ratooning ability than indicas. Japonica/indica crosses such as *Mahsuri* have shown high ratooning in experiments at Mandya, Karnataka. Many cultivars yield more than 2 t/ha under ratoon rice system. The high yielding ratoon cultivar have less than 5% missing hills and at least 16 tillers/hill with excellent vigour.

Varieties, which are screened for ratoon rice, are very old and most of the cultivars recommended for ratoon rice are not under cultivation. In general, long duration varieties tend to have stronger ratooning ability. Thus, again there is a need to screen suitable rice cultivars for ratoon rice system. The best performing cultivars (yielding more than 50% of the main crop) should be pooled as genetic stocks and temporarily used for breeding. Systematic breeding efforts should be undertaken to synthesize cultivars specially for ratooning. New cultivars should pose host plant resistance to various insect pests and disease.

Recommended agronomic management practices for ratoon rice

The management of the ratoon crop begins with management of the main crop. Better yield of ratoon crop is possible by adopting appropriate management practices for the main and the ratoon crop. These management practices include field preparation, spacing, selection of cultivars, water management, nutrient management, time and height of cutting of main crop, and control of diseases, insects and weeds. In India most of the research on optimizing the agronomic management practices for obtaining the high yields have been focused in



Main crop of rice (Variety Naveen) grown in Regional Rainfed Lowland Rice Research Station, Gerua, Assam.

main crop. Agronomic management practices applied before main crop maturity, or immediately after main crop harvesting had a significant impact on the growth and development of the ratoon crop.

Time of harvest

Any delay in planting the main crop will delay harvest and affect ratoon crop yields as well. Low temperature at post-maturity of the main crop will reduce the tillering ability and yield performance of the ratoon significantly. The best time to harvest the main crop for raising a good ratoon crop is when its culms are still green and physiologically viable for ratoon tillering. Culms should be cut before the main crop is fully matured.

Cutting height

Among the various cultural practices cutting height of the main crop is correlated with regrowth potential or ratoon vigour, nodal and basal tillers, missing hills, uniform growth and maturity, filled spikelets and yield of the ratoon crop. Ratoon crop will yield well if main crop stubble is left with 2–3 nodes during harvest. The total carbohydrate content available for ratoon regeneration increases with increasing cutting height, however it also

increases the incidence of various insect/disease. Cutting the main crop at ground level also lowers ratoon yields than cutting at 50% of the height of the main crop.

Water management

Irrigating the fields immediately after harvest may cause the stubbles to rot, especially where plants are cut close to the ground, resulting in missing hills. Studies suggest that fields should not be flooded until the new ratoon tillers are 10–15 cm high.

Fertilizer management

The ratoon rice system provides higher efficiency in the use of key agricultural inputs such as N fertilizer and water compared with conventional double rice system. Application of inorganic fertilizer increase the growth and yield of ratoon rice crop. The literature review on nutrient management in ratoon rice shows that nitrogen fertilizer rather than phosphorus and potassium fertilizer significantly affect the growth and yield of ratoon rice. Application of nitrogen fertilizer is the most important single nutrient element which determines the growth and yield of the ratoons. Applying N fertilizer immediately after cutting the main crop promotes early and abundant ratooning and

facilitates obtaining healthy tillers and vigorous plants. Absence of nitrogen fertilizer application in ratoon rice causes 25% yield reduction. The ratoon crop yields are high at nitrogen levels of 75% of the main crop. Studies on the time of application of nitrogen fertilizer to the ratoon crop reveal decrease in grain yield with delay in application. Application of nitrogen fertilizer at 1-20 days after heading of the main crop increase the TCA accumulation in the main crop culm, the ratoon sprouting and the leaf area index (LAI) of ratoon tillers.

Plant protection

The success of ratooning is largely dependent on the care with which the main crop is cultivated. Ratoon rice is more prone to insect pests and diseases than the main crop and would act as alternate host (borer, gall midge, leafhopper) for various insect pest/disease during off-season. Adoption of appropriate plant protection measures against various insect pests and diseases in the main crop ensure higher yield in ratoon rice. Stem rot, grassy stunt virus and rice yellow dwarf virus infection in

the ratoon crop tend to be greater with increasing main crop cutting height. This factor needs consideration when recommending ratoon cropping. Varieties bred for ratooning should possess insect resistance to minimize the cost of plant protection chemicals. In addition, economic plant protection schedules must be developed for maintaining higher yields.

Yield

Ratoon yield is generally less than the main crop yield. The reduction of yield in ratoon crop is mainly due to reduction in number of productive tillers and shortened growth period. However, there could also be cultivars that can give ratoon grain yields as high as 140% of the main crop, as reported from Karnataka, with variety Intan. In Ethiopia, a ratoon crop of IR8 yielded an unusual 8.7 t/ha. The highest yield obtained by scientists at IRRI with cultivar IR2058-78-1-3-2-3 was 3.3 t/ha. On an average, ratoon rice can give a yield roughly equivalent upto 40% of that of the main crop with 40% reduction in crop duration. Cutting the plants 35 cm above

ground level (50% of the height of the main crop) gives maximum yield (566 kg/ha) as against plants cut close to the ground (68 kg/ha).

SUMMARY

The rice ratooning is a viable option to achieve higher system productivity together with increased cropping intensity, resource use efficiency and lower production cost, irrigation water requirement and GWP. The practice of ratooning is less common due to its low grain yield and higher insect/disease incidence. However, the recent development and availability of improved cultivars with multiple resistance to several diseases and insects increase its scope of adoption in India. Future research should be focused on development of best agronomic management practice and new rice cultivars with high ratooning ability. Change in government policy is also required to ensure rapid and large scale cultivation of ratoon rice in India.

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Success Story

Popularization of flood tolerant paddy varieties in West Godavari, Andhra Pradesh

Lodging due to frequent floods and cyclones, is the main problem in paddy crop grown in West Godavari district of Andhra Pradesh. The yield loss ranged from 50 to 100% based on stage of crop affected. The popular variety in the district is Swarna (MTU 7029), which is highly prone to lodging, leading to huge losses to farmers. The average yields of Swarna during cyclonic situation is around 2.8 to 4.7 t/ha. To combat the problem, the KVK West Godavari (Undi) conducted OFTs and FLDs on flood tolerant varieties MTU 1061 (Indra) and MTU 1064 (Amara) and organized training for farmers and extension personnel. Besides, information on these varieties were also disseminated through print and electronic media, literature and awareness programmes.

The average yield of MTU 1061 (Indra) and MTU 1064 (Amara) in OFTs and FLDs were around 6.5 to 7.5 t/ha. Practicing farmers were convinced with these varieties and they opined that both varieties withstood up to 10 days in submerged conditions. Besides, quality of grains of MTU 1061 (Indra) was good and fetched higher market price than popular varieties like Swarna and Samba Mashoori. Both the varieties are resistant to biotic stresses like brown plant hopper and blast. Around 30% of total paddy area is now occupied with MTU 1061 and MTU 1064 varieties. The farmers are realising around ₹ 87,000/ ha as gross income with new varieties against ₹ 62,000/ ha with old variety Swarna.



FLD on flood tolerant variety MTU-1064

Source: DARE-ICAR Annual Report 2019-20