Controlled Traffic: An Integral part of a New Rice Cropping System for the Dry Tropics.

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Until 1992, rice was a major irrigated crop grown on the clay soils in the Burdekin River and the Mareeba-Dimbulah irrigation areas of north Queensland. The crop was grown using the traditional paddy culture, similar to that used for mechanised rice systems in southern Australia and labour intensive systems throughout the tropics. The rice crop was grown in either the wet or dry season and generally produced good yield and quality, however, because the soil was fallow for the six month period between rice crops, the rice cropping system was not as productive nor as profitable as the competing perennial crop sugarcane.

Cereal or legume crops could be grown instead of the fallow, however, few farmers were successful with the practice of rotating their rice crops with other field crops. A major problem with these rotations was that rainfall often delayed the rice harvest or interrupted the cultivation practices needed to change the soil culture from a paddy to a raised ridge or bed system. The problem occurred most often when farmers tried to harvest a dry-season rice crop during December and plant a wet-season soybean or maize crop during January.

For rice farmers to remain viable, rice production practices had to change. In this paper, a new cropping system for rice that allows year round cropping of rice and soybean is described. Recent research work comparing the growth of a rice crop in either a paddy or the new watertable system is discussed.

Components of the Rice Cropping System

Research components of the new rice-based cropping system that would promote the continuous production of rice and soybean crops in rotation were outlined by Garside *et al.* (1992). The new system involved growing crops on permanent, raised beds with either continuous or intermittent irrigation in the furrows between the beds. Potentially, the new system would increase the opportunity for cropping, increase yield, reduce water use, improve nitrogen use and reduce energy use.

Since the components were developed separately in previous research projects, they needed to be combined into a single crop production system. The system could then be assessed on-farm with the general purposes: (a) to confirm that the system was relevant to farming in the tropics; (b) to ascertain what changes in farming culture were required; and (c) to encourage farmers to consider and use the new technologies to promote a better farming system.

Commercial Application of the Rice System

When the new system was trialed on a farm each of the new technologies was applied in a different way, and with different constraints, to how it was tested during the research phase. Some interesting technical problems were encountered. What soil type? We used a Barratta Clay (2Ug). What size block should be used? What slope? We used a 3 ha field with 300 m long irrigation runs and a slope of 0.47%. Farmers considered this to be the minimum irrigation row length for easy management. What size should the soil beds be? Bed size was determined by the size of our gear and was 1.5 m wide and 0.2 m high. In practice, the bed size will be determined by the hydraulic conductivity of the soil because it is essential to form a watertable. Would a water table form? Yes. Should rice be grown in the furrows? Yes, but it grows with different nitrogen fertility. How should nitrogen be applied to the rice crop? Don't know but nitrogen movement in the irrigation water and rainfall will probably influence the transport, forms, uses and loses of N. How much water needed to be recycled? Not much, since the flow rate in each furrow could be controlled to minimise tail water. Could weeds be controlled. Yes and no. Some weeds like phasey bean were well adapted to the new system. Would establishing soybeans in the rice residue be a problem? No, but mulching the rice residue probably helped. Would rice be a weed in the soybean crop? No, rice growth seemed to be limited by N stress.

Benefits of the Rice System

The trial produced a successful rice crop yielding a mean of 6.7 t ha^{-1} (8.0 t ha^{-1} on the bed and 6.1 t ha^{-1} in the furrow) and a successful soybean crop yielding 3.2 t ha^{-1}. These yields were equivalent to the best commercial yields for the district.

Other benefits were more difficult to quantify but are worthy of mention. Birdlife did not affect the establishment phase of the rice crop in the new system, however, in the paddy system birds frequently puddle the soil and cause the loss of many seedlings. The laser graded furrows provided good irrigation water flow and drainage. For example, when the trial was drained at rice maturity, there was no surface water left after four days and after eight days the trial was harvested and the rice residue was mulched. Within a week a large rainfall event flooded the site. The soybean crop was subsequently planted into stored soil moisture, whereas the harvest of an adjacent commercial rice crop was still delayed due to the wet weather.

Rice Growth and Yield on a Watertable

Probably the most important question that was raised by the trial was whether rice growth and yield was limited, unchanged or promoted by the watertable system compared with the flooded paddy system. To provide some replicated data on this comparison, an experiment was conducted at Walkamin Research Station on the Atherton Tablelands during the dry season of 1994. The soil type was a grey clay (Ug5.22) with a slope of 1.5%.

The experiment compared the growth, nitrogen fertility and yield of five contrasting lines of rice grown with either a paddy or watertable irrigation system. The data presented are for treatments that received a total of 28 g N m^{-2} applied as urea in four split applications. The urea was either cultivated into the soil before planting, applied onto the soil surface and watered in, or applied into the floodwater.

The grain biomass at maturity and the whole grain millout was similar for the paddy and watertable systems (Table 1). In both treatments the line J26 produced more grain than the other varieties although the percentage of whole grains for this line was smaller. J26 was a very interesting line because in both irrigation treatments it exhibited visual symptoms of leaf rolling usually associated with water stress.

Table 1. Grain biomass and wholegrain millout of rice lines grown either in a paddy or with a watertable system.

	Grain biomass (g m^{-2})		Wholegrain millout (%)	
Rice lines	Paddy	Watertable	Paddy	Watertable
Starbonnet	998	856	-	67
Lemont	1043	848	61	63
Amaroo	993	904	59	63
YL39	912	1190	62	65
J26	1248	1368	-	50
s.e. mean	52	122	-	3
l.s.d. (P=0.05)	205	351ns	-	9

The growth of the variety Lemont varied between the paddy and watertable systems before and after anthesis (Table 2). The time to anthesis was longer and there was more leaf area and vegetative growth for the watertable treatment, however, the grain biomass was bigger in the paddy. Kernel biomass was much greater for the paddy treatment and resulted in a bigger harvest index. The N fertility of the two systems may have been different with more N taken up after anthesis by the rice crop in the paddy. Reduced growth before anthesis in the paddy treatment may also be due to an attack of Rice Leaf Miner when the paddy was permanently flooded. The rice seedlings in the watertable treatment were not affected.

The total N content of the rice crop in each treatment was 27 g m^{-2}. It is unlikely that this amount of crop N was limiting to yield since in the Burdekin River Irrigation Area paddy rice crops yielding 1000 g grain m^{-2} have contained less than 25 g N m^{-2} (Ockerby 1994).

In general, the experiment found no evidence of differences in the growth of rice on a watertable compared with the traditional paddy culture that could be directly attributable to the irrigation system.

Table 2. Effects of paddy and watertable irrigation systems on the growth of Lemont.

	Data for Lemont (mean and s.e.)	
Components of rice growth	Paddy	Watertable
Time to anthesis (d)	105 (1.0)	111 (3.0)
LAI at anthesis	4.7 (0.3)	8.6 (1.1)
Tiller number at anthesis	555 (24)	938 (103)
Grain biomass (g m^{-2})	1043 (52)	848 (122)
Kernel biomass (mg)	24 (0.3)	20 (0.6)
Harvest index	0.51 (0.02)	0.39 (0.03)
N content at anthesis (g m^{-2})	23.7 (3.2)	25.3 (1.5)
N content at maturity (g m^{-2})	27.2 (3.4)	27.1 (0.4)

The work with the watertable system of rice production is still in its infancy. The indications at his time are that rice will produce a good yield and quality when grown on permanent beds using continuous furrow irrigation to form a watertable about 0.2 m below the soil surface. The benefits of the new culture to the cropping system are large since it allows rice to be grown in rotation with other irrigated field crops and, as such, promotes the efficient use of irrigated environments in north Queensland where year-round crop production is possible.

References

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