

Could 400 bushels per acre rice yields be achieved by System of Rice Intensification? 24/05/00 Daily New

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A system of rice intensification (SRI) was introduced to Sri Lanka recently to double the rice yields up to 400 bushels per acre. The SRI believes in six culture practices of which a synergistic effect of all would increase the rice yields. They are:

- i. Early transplanting (before 15 days)
- ii. Careful transplanting (horizontally placed roots at 1-2 cm depth)
- iii. Wide spacing (25 cm x 25 cm or even wider, square pattern)
- iv. Soil well drained (no standing water during vegetative phase)
- v. Weed 2-4 times before panicle initiation.
- vi. Apply compost as much as possible.

In the life span of the Department of Agriculture in Sri Lanka, these practices have been tested in the field over the years, conclusions made, and recommendations given to the farmers. Most of them were carried out as single treatments or multiple treatments taking few of them at a time. For example during early research on irrigated rice, the best stage for transplanting was found to be 14-18 day old seedlings and 3-4 seedlings per hill for higher yields and was recommended. If by any chance transplanting gets delayed more number of plants were recommended as the vegetative growth period is shortened and the damage to the transplanting seedlings were comparatively heavy.

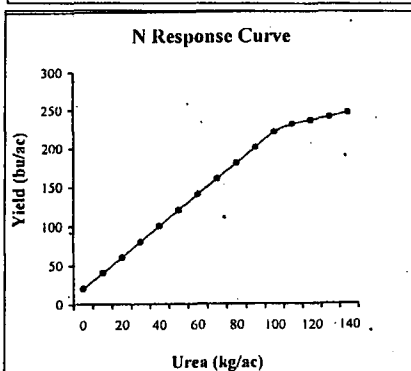
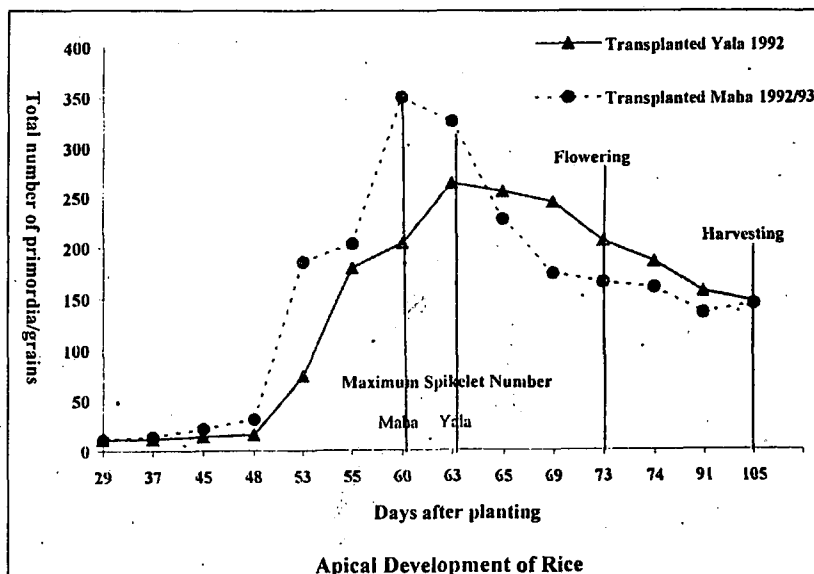
Though SRI had promising results in other parts of the world in doubling yield (which may not solely by the synergy of these practices of SRI but other biotic and/or abiotic factors which are responsible for deciding rice, yields), the vast scientific knowledge gathered by research and field experience in our country up to date in the Department of Agriculture, I am perturbed as to the success of this method. As a senior rice scientist with well over 30 years of research experience in this country who has not got the opportunity to face discussions on this concept, I wish to have it through the media, hence decided to write this article. My arguments against the anticipated success of this concept are based on the facts given hereafter.

Basically rice plant is a source limiting plant unlike wheat which is limiting. In a source limiting plant the net assimilation is low and the demand for assimilate during the reproductive stage for grain development and at maturity stage for grain is hampered leading to spikelet abortion, half filled or unfilled grains in the panicle. Hence early assimilation and storage at early vegetative phase is important to rice so that the increased assimilate demand when the rice plant is at maximum spikelet number stage in reproduction, where cell division takes place at a very high rate (may be several hundreds or more of cell divisions per second) is met.

At this stage of growth production of spikelet are very high and take less than 30 minutes to form one complete spikelet, which will have millions of individual cells per spikelet.

This stage of development will show nitrogen deficiency if adequate nitrogen was not applied which normally refer to as 'mid season yellowing of rice' by the farmers too.

In Sri Lanka since green revolution our breeders were geared to produce high tillering, fertilizer responsive and high yielding varieties. Hence, all our varieties are high yielding and high fertilizer responsive (at least 100kg N/ha). Therefore these varieties



cannot depend solely on organic compost fertilizers alone as the nutrient content of major elements in compost is very low though rich in micronutrient.

Early transplanting

Transplanting practice in Sri Lanka and the department of agriculture recommendation is to transplant seedlings at 14-18 days old. The transplanting in clumps of 3-6 seedlings is practiced because the plants are aged and there is less time for tillering to occur more than the survival of them. Therefore plants will tiller and cover the land area more quickly and reach optimum Leaf Area Index (LAI), than single plant transplanting to harness the incoming radiation at an early age to have excess assimilates for storage in culms and leaves. Further early transplanting will have the advantage of early recovery of the plants too. But the problem is if single seedlings are transplanted and if they die specially when this is done at wide spacing will the plants have the capacity to cover the land area to obtain the optimum LAI to harness the all incoming radiation?

In early 1960s we practiced this early transplanting using Dapog Paper nurseries where seeds are sown on a paper fold woven with thread. Farmer had only to pull the thread (as the paper is easy to break when wet, decay easily) and lay it on the field with the seedlings after about 10 days when the plants are at 2 leaf stage. This is somewhat the same practice as suggested by the SRI. However our results were not attractive hence was never popular though the labour requirement for transplanting is very low. Further more it had the following practical problems.

- i. High wind movement tends to desiccate rice plants.
- ii. Since the plants were just laid on the field without planting wind movement tend to

uproot them (may be few plants or the whole row as the plants were tied to each other).

- iii. Due to intense rainfall receive after transplanting they also tend dislodge them and/or bury them in the mud.

In this method too the roots are placed horizontally as in SRI because the transplanting personnel did not plunge in the rice plants to the soil and therefore will have the same practical problems listed above.

Spacing and tillering

SRI also recommends wide spacing expecting to tiller heavily (50-100 per hill) and cover the land area. However, wider spacing has the disadvantage of lower efficiency of harnessing incoming radiation at an early stage for assimilate production as it takes longer time to cover the land surface by tillering in order to intercept all incoming radiation. It is one of the reasons that this system had to rely on 2-4 weeding rounds during vegetative stage since the soil is exposed and no standing water to control weed growth.

Rice plant tillering is divided into two phases. Productive tillering phase is the phase where tillers can grow and mature at the same time with the mother tiller and the unproductive tillering phase, at which the tillers produced are late and will not mature along with the mother tiller. However our varieties are bred and selected so that they will carry less unproductive tillers. Even with our varieties if we give a wider spacing tillering will continue but there was no guarantee that they will flower and mature at the same time. Therefore the age of the rice plant is increased. If one has to wait till all panicles are mature and also the mother plant panicles which are the biggest of all will be over mature and tend even to drop seeds. Further our recent varieties are highly responsive for fertilizer as we select varieties with this character while breeding, without high fertilization, objectives of SRI is hard to achieve.

Wide spacing always goes hand in hand with high tillering. But to obtain high yields one should not go higher than the optimum leaf area index (LAI) after which the maintenance respiration exceed the assimilation rate of the rice plant as a result of mutual shading of leaves. If a plant bears 50-100 tillers it invariably cause heavy mutual shading and pass this optimum LAI limit and therefore the net assimilation is decreased and storage will be less. Further, 24-27% of the assimilates in the rice panicle is from the stored assimilates

during the vegetative stage which gets translocate to the panicle. Thus at the time of PI to flowering, there will be shortage of assimilates for the development of panicles.

Spikelets or flowers in rice plant abort in two stages one while within the plant known as pre flowering spikelet abortion and after heading which is termed as post flowering abortion. If there is assimilate deficiencies there will be high pre-flowering spikelet abortion, which no one will see, unless plants were dissected and see through a microscope. Therefore the sink size reduces. One advantage in this respect is that if the sink size is reduced there will be less post flowering spikelet abortion which normally occurs as a result of source limitations and/or early senescence curtailing assimilate translocation to the panicle.

Research results have also shown that an additional application of N at milking stage increase the number of high density grains which is due to dense packed starch molecules. Further as the number of tillers increases the vegetative growth period of later born tillers become less and less hence panicles tends to become shorter and shorter as they reach 4th or 5th order tillers which under normal circumstances are termed as unproductive tillers.

It is a known fact that the world renowned rice scientists at the International Rice Research Institute, Manila, Philippines, at its inception or more appropriately since green revolution, worked heavily during the last 3 to 4 decades on high fertilizer responsive high tillering varieties and reached a yield ceiling. The present day varieties released from IRRI are high or moderate tillering types. Since last 2-3 years they also have given up this idea and conceptualize a programme on 'uniculm rice plant' to break this yield ceiling.

We in Sri Lanka also feel the pulse of this new concept where the first rice variety which gave 200 or more bushels per acre yield in the farmers fields is a variety with low and erect tillering, namely At 354, which was recommended by the Department of Agriculture for saline environments. This variety has its advantage of having more main culms than tillers by transplanting closely because of its plant stature where tillers are well compact with very low tillering angle.

Wetting and drying

SRI also recommends well drain soils during vegetative growth to aerate the soil. Alternatively it recommends wet fields and drains them even letting them dry occasionally. This has very bad effects on mobilization of major nutrients, namely Nitrogen (N), Phosphorous (p) and Potassium (K). The idea of SRI to have well drained conditions may be to have high mineralization of organic matter and applied compost because of high temperature. But the bad effect is, that the nutrients which become available through mineralization will tend to volatilize, especially nitrogen which is the most wanted for high rice yields.

For lowland rice, field is prepared puddle under saturated conditions and once transplanted if they allow to well drain or wet and dry conditions will enhance heavy weed growth. Further under well drained conditions it may be extremely difficult to use a mechanical weeder, as the use of a mechanical weeder is to berry the weeds but not to remove as manual weeding. Manual weeding is going to be very expensive and also face the problem of resource availability for weeding.

(To be continued)