**Paddy Cultivation in Sri Lanka**

Rice is the main cereal crop cultivated in Sri Lanka which act as the main contributor of the rural economy by occupying more than 26.1 percent of the labor force (CBSL, 2018). Sri Lanka is consisting with different ecological regions which contains wide range of climatic conditions most suitable for rice. The cultivation of rice is practiced in all the parts of the country except at higher elevations (Dhanapala, 2000; Henegedara GM, 2002). The land area under rice cultivation acquires about 34 percent of the total land area devoted for cultivation in Sri Lanka which is about 792,000 hectare in 2017, including 543,00 hectare in Maha season and 249,000 hectares in Yala season (CBSL, 2017; “The importance of rice in Sri Lanka | Blue Lanka,” 2018).

According to the Sri Lanka World Bank Group, 2008, the average per capita consumption of rice by the Sri Lankans is 105kg per year. The average yield obtained from the rice cultivation per hectare is 4297 kg which is not sufficient to fulfill the total requirement of the country. The annual rice production in the year 2017 is estimated as 1.7 million metric tons which is sufficient for only 8 months period to fulfill the total requirement in the country. So, on behalf of the food security in the country the deficit amount, 800,000 metric tons is imported (CBSL, 2017).

Rice is the staple food of 20.8 million Sri Lankans which has 0.5 percent contribution on the GDP which is 72,809 million rupees in value (CBSL, 2018). More than 1.8 million farmers in all around the country depends on the rice cultivation from which they earn their livelihood (“The importance of rice in Sri Lanka | Blue Lanka,” 2018). According to the Department of Agriculture rice consumption accounts for 45% of the total calorie requirement and 40% of the total protein requirement of an average Sri Lankan.(Rice Research & Development Institute Bathalagoda, 2017)

**Constrains to the Rice Cultivation in Sri Lanka**

Most of the developing countries situated in the Asia-Pacific Region including Sri Lanka are extremely affected by the yield gap between the potential yield and the actual yield received due to many circumstances (Food and Agriculture Organization of the United Nations, 2000). The demand on the rice is increasing with increase of the population as 1.2% annually (Thiruchelvam, 2005). The total land extent utilized by the paddy cultivation is decreasing rapidly. According to the CBSL, 2017, the land extent cultivated in 2017 is 791,679 hectares which is a 28.9% reduction compared to past few years. The average yield gained per hectare from the past decades including 2015,2016,2017 is respectively 4429kg, 4372kg, 4292kg. It proves that there is no increment in the yield obtained although the population and the demand for the rice increased annually(CBSL, 2017)

The aim of the Asian countries including Sri Lanka to reduce the rice yield gap through increasing the production to confirm the food security and economic stability in the country (FAO Sri Lanka, 2012; Food and Agriculture Organization of the United Nations, 2000). The out put from the rice cultivation can be increased and generate a surplus for the exportation through expanding of the area cultivated, improving the yield or using the both options. The problem with Sri Lanka is that there is no any additional land that can be occupied to improve the production. So the most logical solution to tackle with this problem is to increase the productivity of rice (“Sri Lanka as a Rice Exporting Country: Possibilities and Problems,” 2011). The highest yield potential areas can achieve a high yield which is about 6 metric tons per hectare whereas the average annual yield in Sri Lanka for past few years is around 4.5 metric tons per hectare. So, to achieve the self sufficiency and generate surplus to export, a quantum jump is required in the Rice cultivation sector in the Sri Lanka, otherwise there is no any solution to cope with the increasing demand rather increasing the amount of rice importation proportionally (“Sri Lanka as a Rice Exporting Country: Possibilities and Problems,” 2011).

The major constrains associated with the farmers’ in rice cultivation except the rice yield gap are, invasive weeds, weedy rice, high occurrence of damages from pests and diseases, increased cost on the inputs including labor and the chemicals applied (Akbar et al., 2007; Perera et al., 1990). The aggressive weeds and weedy rice considered as a very common problem found in Sri Lanka. It is serious constraint that reduced the final yield and the occurrence is highly observed in the Direct seeded fields.(Caton et al., 1999; Ratnasekera, 2015; Zhao et al., 2006).

The prevalence of the pest and diseases which adversely make an impact on the yield, also among the major problems associated with Rice cultivation. The root cause for the invasion of pests and diseases is the improper field establishment of plants without maintaining the optimum spacing between the plants. The susceptibility of the plants in the direct seeded field for pest and diseased also high compared to the other methods of establishment (Iqbal et al., 2017). It is a more critical problem in Sri Lanka as more than 90 percent of the farmers choose the direct seeding as a solution to the labor shortage and high cost of production in transplanting method, although the yield gained from the transplanting is high compared to the direct seeding (MoADR, 1989; Weerakoon et al., 2011).

So as the most suitable solution farmers select the application of chemicals to control the pests, diseases, weeds and weedy rice. As it is available at cost effective prices, they tend to use in excessive amounts than the recommendations with the aim of annihilating them from the field. This is the root cause for health risks including kidney diseases which is a most popular sympathetic problem among the rural farmers (“Agrochemical pesticides and kidney related diseases, Sri Lanka | EJAtlas,” 2016; Rajapakse et al., 2016).

Another problem associated with the rice cultivation is high cost of production. The most expenditure of Manual transplanting is occupied by the labor charges which accounts for about 40% - 50% of the total expenditure (Clayton, 2010; Vidanapathirana, 2003). And also, improper nursery management practices, delayed transplanting of seedlings, careless transplanting by the labors with increased missing hill percentage and reduced plant density are commonly observed consequences between the Sri Lankan farmers which reduced the rice yield obtained (Columbia and Division, 2013; Das, 2012; Farooq et al., 2001; Illangakoon et al., 2017).

The most feasible solution to reduced the problems associated with rice cultivation in Sri Lanka is to find out the possible substitutes to avoid these constraints with the help of new technological changes. For that the research efforts are very important because the evaluation of each modern technology considering their suitability for Sri Lankan conditions and make adjustments accordingly before introducing to the farmers is very essential. The problem is only a marginal proportion of the GDP is allocated for Agricultural Research and Extension in Sri Lanka during the past decades (“Sri Lanka as a Rice Exporting Country: Possibilities and Problems,” 2011).

## **.4 Constrains with Rice Cultivation in Sri Lanka**

low yield of transplanted rice, poor nursery management seems to be a major cause due to which seedlings cannot perform well after transplanting in the main fiel

Influence of Nursery Management and Seedling Age on Growth and Economic Performance of Fine Rice

rice cultivation is a labor-intensive task that could not be accomplished easily. Land preparation, transplanting and harvesting are the expensive and time- consuming operations for successful rice cultivation. Tray soil

Labor cost accounts the biggest input cost for rice production (Clayton, 2010).

There is a need to explore establishment methods (EM) that require less labour but still allow the crop to be transplanted on time since labour scarcity has emerged as a serious problem in rice cultivation in Sri Lanka. Direct seeding (DS) is practiced as a solution but, apart from irregular stand establishment, the most disastrous constraint in DS is the invasion of weeds and weedy rice (Marambe 2009; Gunawardana et al., 2013). Use of herbicide in controlling weeds in DS is effective but excessive use is costly and causes problems such as ground water contamination, development of herbicide- resistant weed populations. Optimizing plant density and timeliness of operation is considered essential for optimizing yield in rice cultivation (Chaudhary et al., 2005). Hence, mechanical transplanting (MT) is one of the feasible alternatives in eliminating weed problem in DS and huge labour use in transplanting while facilitating the timeliness crop establishment.

Impact of varieties, spacing and seedling management on growth and yield of mechanicaly transplanted rice

Industrialization, migration of agricultural labor to other job and high labor wage are the threat for sustainable rice production as well as food security. Labor crisis and high wage is particularly critical during peak labor-need periods, which typically occur during rice transplanting and harvesting. Tray soil

To overcome these, farm mechanization has been considered as an important remedial measure. In recent time, transplanting and harvesting machinery are considered top priority for sustainable rice production.

Agricultural machines have replaced human force in many rice cultivation practices such as land preparation, transplanting, harvest, and post-harvest process in many developed countries. Though land is Prepared mechanically but seedling raising and transplanting is still done traditionally in Bangladesh. About 156 man-days per hectare are required for producing rice. Forty five man-days are consumed for seedling raising and transplanting which is about 29% of the total labor requirement. Tray soil

Mechanisation of small holding will play an important role in increasing rice production.status and prostpectus

Manual paddy transplanting is the tedious, laborious and time consuming operations requiring about 250-300 man h ha-1 which is roughly 25% of total labor requirement of rice production [11]. Mufti AI, Khan AS. 1995. Performance evaluation of Yanmar paddy transplanter in Pakistan. Agricultural mechanization in Asia, Africa and Latin America. 26 (1): 31-36. status and prostpectus

At transplanting time, there is acute shortage of labour. This results in increased labour wages and a delayed transplanting operation. In some cases, a proper crop stand is not maintained by the hired labour. Hence there is an urgent need to have mechanization in rice production which will result in reducing the labour work and time consumed. Mechanical transplanting to release the work force and to reduce the cost of paddy production.

development and performance evaluation

basis. Manual transplanting takes longer period to complete transplanting operation. Therefore, major constraints are the high cost of manual transplanting and uneven plant population. Singh et al. (1985)studied the response of rice to different planting methods. development and performance evaluation

Timeliness of transplanting is essential for optimizing the yield and this can only be achieved through mechanical transplanting. A delay in transplanting reduces the yield. development and performance evaluation

t was reported that a delay in transplanting by one month reduces the yield by 25% and a delay of two month reduced the yield by 70% (Rao and Pradhan, 1973). There Techno-economic performance of 4-row self-propelled mechanical rice transplanter at farmers field in Bangladesh

crisis of labour

Crisis of labor has created an unusual situation. The farm owners have to find the labors going door to door or they have to wait for the labors to finish the work in the nearby fields. Sometimes, they have to hire labor offering extra wages with additional facilities. As a result, the scheduled time of transplanting paddy expires in many places. Under such circumstances a less expensive and labor saving method of rice transplanting without yield loss is the urgent need of the hour (Tripathi et.al., 2004). Techno-economic performance of 4-row self-propelled mechanical rice transplanter at farmers field in Bangladesh

Because of the good off-farm employment opportunities available in the area and the prevailing hot season, the persons already engaged in non-farm jobs are generally reluctant to perform rice transplantation.Therefore, frequent shortage of labour always has been reported during the season. The other common problems associated with the rice transplantation by hired labour are lower plant population per unit area, improper fixation of nursery plants in the soil, a higher percentage of missing plantation and un-even transplantation in paddy fields, i.e. dense and thin planted patches in the field. Diffusion Possibilities of Mechanical Rice Transplanters

The important reasons for low rice yield include water shortage, weed infestation, prevalence of insect pests and diseases and inappropriate sowing method leading to low plant population. Low plant population can be optimized using a proper sowing method.

Direct seeded rice: purely a site specific technology

Though a contract system for undertaking transplanting evolved during this period, the careless attitude of contract labourers (aggressive pulling of seedlings from the nursery, clipping seedlings and transplanting at more depth with insufficient plant density, etc) to complete the work in the shortest possible time has been affecting the productivity of rice in Bangladesh. Though the work standards have been declining, these contract labourers have started demanding higher wages every year.

Transplanting Rice Seedling Using Machine Transplanter : a Potential Step

The shifting agronomy to direct-seeded rice, necessitated by the

unavailability of labour for transplanting, has exacerbated weed problems such as Echinochloa spp. (Marambe and Amarasinghe, 2002), the sedges (Marambe, 2006) and weedy rice (Marambe and Amarasinghe, 2000; Marambe, 2005). In

WEEDY RICE: EVOLUTION, THREATS, AND MANAGEMENT B. Marambe Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka.

In rice, the planting methods have an impact on

the growth and yield besides cultivation cost and labour requirements

(Sanjitha

Rani and Jayakiran, 2010). “ DIGANG ” RICE ( Oryza sativa L .) UNDER UPLAND CONDITION OF BAWKU , UPPER EAST REGION , GHANA

**Rice cultivation in the world**

The task of producing the additional rice to meet the expected demands of the year 2025 poses a major challenge. The danger is that stability in rice production is linked to social and political stability of the countries in the Asia-Pacific Region (Hossain, 1996). The scope of area expansion in some countries is offset by the reduction in rice lands in major rice producing countries. So

The question turns more problematic when we think that production increases have to be realized annually using less land, less people, less water and less pesticides. T

The research scientists should understand well the farmers’ constraints to high rice productivity and provide them with appropriate technological packages for specific locations to bridge the gap under participatory approaches (IRRI, 1998; Price and Balasubramanian, 1998). The extension service should ensure that farmers use correctly and systematically recommended technological packages (ICMPs) in the rice fields, through effective training and demonstrations. For

Bridging the rice yield gap in the Asia-Pacific Region

Crops can be established using dry seed, pre‐germinated seed and seedlings. The most suitable planting technique depends on locality, soil type, and crop ecosystem. Crops can be direct seeded by hand broadcast, dibbling, line sowing or drilled using a machine in both wet and dry soil. Transplanted crops can be established manually, either in rows or randomly, or by machine. Direct seeded crops tend to mature faster than transplanted crops but often face more competition from weeds.

Rice Production Manual

The important reasons for low rice yield include water shortage, weed infestation, prevalence of insect pests and diseases and inappropriate sowing method leading to low plant population. Low plant population can be optimized using a proper sowing method.COMPARISON OF DIFFERENT PLANTING METHODS FOR OPTIMIZATION OF PLANT POPULATION OF FINE RICE ( Oryza sativa L .) IN PUNJAB ( PAKISTAN )

## **2.2** **Rice cultivation in Sri Lanka**

Agriculture can be named as the backbone of Sri Lankan economy on which one third of the rural population depends on (Dushani and Sandika, 2009). Among the agricultural crops rice, is the main contributor for the rural economy which occupies more than 72% contribution on livelihood of them (Henegedara GM, 2002).

Rice is the principle con- tributor of the rural economy as the majority (72%) of rural households is engaged in production of rice as their main and supplementary source of live- hood (Henegedara 2002). Rice is the main crop cul- tivated by the majority of farmers in rural areas and it is the staple food of the 18.6 million inhabitants of Sri Lanka. Further, it is the livelihood of more than 1.8 million farmers. Rice contributes 1.8 % of country’s GDP (Central Bank 2008). Rice is culti- vated in almost all parts of the country, except at very high altitudes, as a wetland crop (Henegedara 2002). The annual per capita consumption of rice was

around 92 kg in 1998 and it was dependent on the paddy production in the country and the price of imported wheat flour.

The main difference between the two methods are direct seedling method, the seeds are sown directly in wet or dry field, whereas in transplanting method, seedling are first raised in seedbed in the nursery and uprooted for transplanting manually or mechanically. Development and performance

Over 75% of the world supply is consumed by people in Asian countries and thus rice is of immense importance to food security of Asia. The demand for rice is expected to increase further in view of expected increase in the population.

Biology of Rice.Pdf