Grain yield of direct seeded and transplanted rice in rainfed lowlands of South East Asia

Jaquie Mitchell, Shu Fukai and Jayampathi Basnayake

School of Land and Food Sciences, The University of Queensland, St.Lucia, Qld. 4072, www.uq.edu.au
Email jaquie.mitchell@uq.edu.au

Abstract

The mean grain yield of 81 direct seeded (DS) and 91 transplanted (TP) environments that were conducted as part of 3 ACIAR projects over 11 years, from 1992-2002, in Laos, Thailand and Cambodia were examined. The average yield of TP rice was 6% greater than DS rice. A subset of 27 pairs of DS and TP environments was examined and results indicated a significant positive correlation between the DS and TP establishment methods for mean grain yield with only a 3% difference in overall performance. The performance of 3 genotypes in 3 locations in Laos in 1996 was also examined. Results indicated a highly significant positive correlation between the performance of genotypes in DS and TP experiments in which TP rice had a 30% yield advantage over DS rice. This particular experiment highlights the need for good management practices when DS establishment methods are utilised. Results of this paper indicate that DS and TP rice will produce a similar yield for a given environment provided that they are grown utilising good management practices.

Media summary

Good management practices lead to similar grain yield between direct seeded and transplanted rice in rainfed lowlands of South East Asia

Key words

Rice (*Oryza sativa* L.), water scarcity, labour costs

Introduction

Unpredictable water supply is a common feature of rainfed lowland rice ecosystems. A large portion of the worlds rice production comes from these areas. The rainfed lowlands occupy 74, 65 and 75% of the total rice production area in Thailand, PDR Laos and Cambodia respectively (IRRI 2001). In the rainfed lowlands, areas of rice established via DS methods has increased in recent years (eg OAE data Thailand) and this trend is likely to continue in this region. This is mostly due to the development of DS technology packages suitable for particular agroecological zones and the labour saving cost associated with DS techniques. The economics and production system advantages and disadvantages of both establishment methods (DS and TP) have been widely reported (Fukai 2002; Pandey and Velasco, 2002). Summarising this literature, some authors report that TP establishment out performs (in terms of yield) DS establishment (Naklang et al 1996: Pandey and Velasco 2002). Pandey and Valasco (2002) reported that the technical efficiency of rice production is lower and more variable for DS rice than for TP rice. However, Reddy and Panda (1988), suggested that DS crops perform better than TP crops. A large number of grain yield data sets have been generated as a result of 3 Australian Centre for International Agricultural Research (ACIAR) projects conducted over an 11 year period in Thailand, Cambodia and Laos. Some of these are published (eg. Jearakongman et al 1995; Naklang et al 1996; Sipaseuth et al 2002) while others are unpublished. Included are a number of data sets from experiments that were specifically designed to compare DS and TP methods. The aim of this paper was to collate and analyse data to obtain an overview of the relationship, if any, between DS and TP establishment methods within these environments.

Methods

Data was compiled from a number of locations over a number of years in Thailand, Laos and Cambodia (Table 1). In Thailand data from 5 locations in the North Eastern region was utilised between 1992-1998, data from 3 locations in Laos between 1998-2002, and 3 locations in Cambodia between 2000-2002. In total, grain yield results from 81 DS and 91 TP environments were examined. This data was obtained from experiments that examined various treatments (eg planting date, fertiliser levels, weed control) consequently a treatment mean in a location was considered as an environment. Experiments consisted of between 1 and 72 genotypes, with some having a wide range in phenology. Direct seeded rice experiments included dibbling, broadcast and row seeded establishment methods that were compared to the traditional methods for transplanting rice from nursery seedbeds. Data investigated was from both research stations and on-farm trials. All data sets were from replicated experiments except for one demonstration trial that consisted of large plots of DS and TP at 3 Lao locations.

Table 1. Location and years data collected on direct seeded and transplanted experiments

Country	Location	Year
Thailand (1992-1998)	Khon Kaen (KKN)	1992, 1995, 1996, 1998
	Ta Pra (TPR)	1992,1993,1997,1998
	Phimai (PMI)	1992-4, 1996-1998
	Ubon Ratchathani (UBN)	1993, 1997
	Surin (SRN)	1992-1994
Laos (1996-2002)	Vientiane (VTN)	1996-2002
	Savanaket (SVK)	1996-2001
	Champasak (CPK)	1996-1999
Cambodia (2000-2002)	CARDI	2000-2002
	Battambang (BTB)	2001-2002
	Kamphongthong (KAM)	2002

To examine the relationship between mean grain yield obtained from the 2 establishment methods a subset of 27 pairs of DS and TP environments was identified. This data originated from experiments that were either designed to compare DS vs TP, or sown within a few days of each other at the same location, utilising the same genotypes. The grain yield response of 3 genotypes sown in 3 locations in 1996 in Laos was examined. In these experiments direct seeding was achieved using the dibbling method. The genotypes were from different phenology groups: short duration (PN1, photoperiod insensitive), medium (TDK1, photoperiod insensitive, semi-dwarf) and long duration (RD6, photoperiod sensitive) types.

Results and discussion

The frequency distribution of grain yield for DS and TP rice were not significantly different from one another (Figure 1). Mean grain yield response was 6% higher in TP rice over DS, with a mean grain yield of 2102 (sd. 965) and 2244 kg/ha (sd. 883) for DS and TP environments respectively. In 20% of the TP and 14% of DS environments grain yield was greater than 3000 kg/ha. However, the highest yielding trial was a DS environment, this was due to a very high plant density establishment. There was not a large difference in frequency of failures (0-499 kg/ha) between the DS and TP methods. However, it is likely that the number of failures might be underestimated, particularly for DS environments, as establishment failures may have been unreported if experiments were replanted. Establishment failures were usually due to flooding and drought. Production data from Thailand's northeast region indicated that 10% of the area sown to rice using DS failed to produce a yield, while only 5% of TP rice failed (OAE 2002).

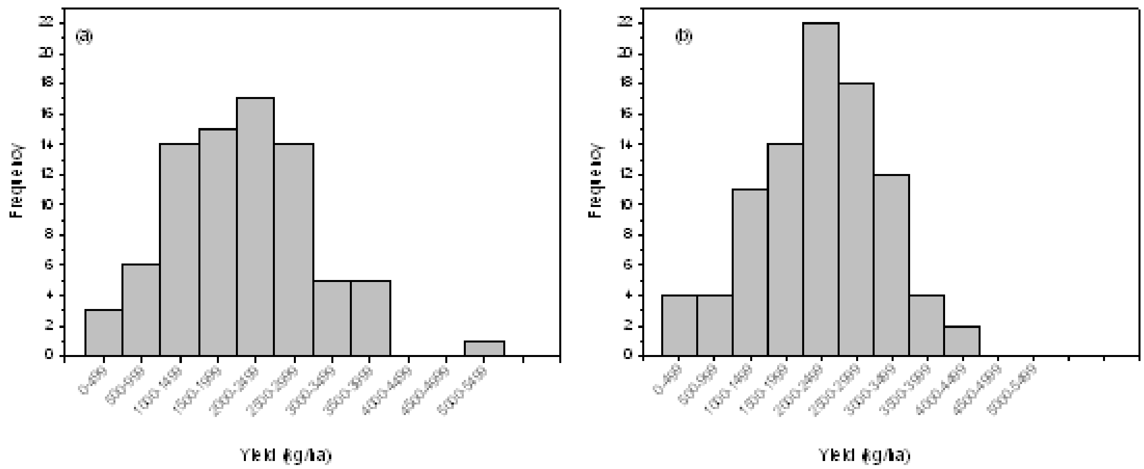

Figure 1 Frequency distribution of grain yield (kg/ha) of (a) 81 DS environments and (b) 91 TP environments conducted in Thailand, Laos and Cambodia.

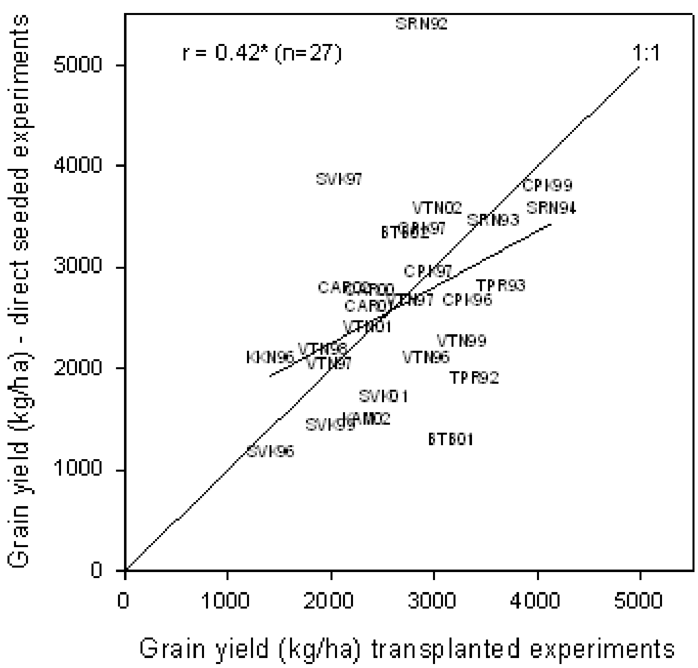

Figure 2 Relationship between mean grain yield (kg/ha) of 27 DS and TP experiments conducted in Thailand, Laos and Cambodia.

Examination of 27 pairs of DS and TP environments (Figure 2) indicated a significant positive correlation between the DS and TP establishment methods for mean grain yield with only a 3% difference in overall performance (DS = 2655 and TP = 2737 kg/ha). The relatively poor performance of a number of DS environments can be explained by weed problems in which all genotypes were affected similarly (eg BTB 2001,) and drought both early and late in the season as occurred in KAM 2002 in which genotypes perform differently depending on phenology in relation to the timing of the drought event. Lodging was a problem in some DS environments (eg. VTN96). The highest yielding DS environment (SRN92) was due to a high plant density. Savanaket tended to produce low yields due to its low soil water holding capacity and consequently lack of standing water for both establishment methods.

The 3% yield difference obtained under experimental conditions was similar to that observed in Thailand's northeast region production data in 2001 based on area harvested (DS = 1869 kg/ha, TP = 1931 kg/ha). Given the small reduction in yield and provided farmers can achieve a good plant establishment the DS method may provide distinct economic and production advantages. For example, a scenario observed in the region under study is that rain events may occur early in the season which are followed by periodic dry conditions around the time

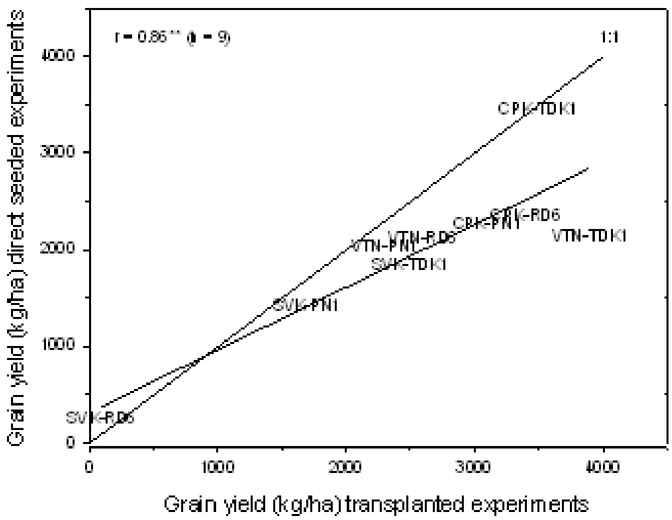

Figure 3 Grain yield (kg/ha) of 3 genotypes grown in DS and TP experiments in 3 locations in Laos in the 1996 wet season.

of transplanting and this can result in delayed transplanting and consequently reduced yield. Under these circumstances there is an advantage in utilizing the DS method when there is sufficient soil moisture early in the season. This enables good crop establishment and consequently crops avoid late season drought and high yield can be achieved.

The performance of 3 genotypes within 3 locations was examined in Laos in 1996 (Figure 3). Results indicated a highly significant positive correlation between the performance of genotypes in DS and TP experiments. Savanaket is generally a low yielding environment as discussed earlier and RD6 a long duration phenology type was badly affected by drought late in the season. Selecting the appropriate phenology type is important, particularly in DS environments, and must be done in conjunction with environment characterisation. In VTN there was lodging and rat damage (PN1) and the DS experiment was also affected by brown plant hopper while the TP experiment was not. This may explain the relatively poor performance of TDK1 in VTN DS. Overall yield performance of genotypes was 30% greater in the TP compared with DS environments (2567 and 1982 kg/ha respectively). These results illustrate the importance of improving management when DS methods are utilised, and the selection of appropriate genotypes.

Conclusion

Farmers in the rainfed lowlands tend to use DS methods when TP can not be conducted due to labour or water constraints. As noted by Fukai (2002) DS rice in farmers' fields is often established under more difficult environmental conditions and this may lead to a higher risk of poor establishment. The data examined in this paper and farm production data in Northeast Thailand indicate that under good management practices there is very little difference in yield between the two establishment methods. However, the 1996 Lao experiment, highlighted some of the DS production problems (lodging, pest and weed problems) and these need to be considered against the advantages (eg high density, early seeding, quick maturity) of DS. In order to maximize the potential advantages of the DS method, farmers need to engage a high level of management, particularly in the rainfed lowlands compared with irrigated environments. Furthermore, if the management levels/skills can be raised by those farmers using the DS establishment methods then there is likely to be a yield and economic advantage in using the DS method.

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