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Bio-Economics of different Upland Rice-Based Intercropping Systems under Strip Plantation

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ABSTRACT

Bio-economic efficiency of some rice-based intercropping systems was evaluated in an experiment and the results showed that intercropping of maize, sesbania, mung bean, rice bean, cowpea and pigeonpea decreased the paddy yield to the extent of 1.20, 1.11, 0.72, 0.63, 0.74 and 0.76 t ha^{-1}, respectively compared to rice alone. However, this much reduction in rice yield was compensated by additional harvests of 41.77, 28.60, 21.40, 24.90 and 21.60 t ha^{-1} of maize, sesbania, mung bean, rice bean, cowpea and pigeonpea fodders, respectively. The maximum net income of Rs. 56454.18 ha^{-1} with BCR of 3.71 was obtained from rice-maize intercropping system compared to a minimum net income of Rs. 32519.93 ha^{-1} and BCR of 2.74 in case of rice alone.

Key Words: Biological and economic assessment; Rice-based intercropping

INTRODUCTION

Drastic increase in world population has increased the demand for food to an unprecedented level and the present system of sole cropping has failed to meet the diversified domestic needs of our small farmers from the dwindling supply of new lands for cultivation and other limited resources. These conditions necessitate a shift from mono/sole cropping to multiple cropping (intercropping), which is being considered to be an excellent strategy for intensifying land use, absorbing excess labour and increasing income and production per unit area and time both in the irrigated and rainfed areas.

Beyond its importance as a farming practice, intercropping often, offers the possibility of yield advantages relative to sole cropping through yield stability and improved yield (Willey, 1979). Contributors to yield advantages include; better use of growth resources (Trenbath, 1986) and better control of weeds, pests and diseases (Willey, 1979). It also helps maintaining the soil fertility (Patra *et al.,* 1986), making efficient use of nutrients (Ahmad & Saeed, 1998) and ensuring economic utilization of land, labour and capital resources (Singh *et al.*, 1996). Intercropping may be practised for a number of yield goals, not limited just to the production of dry matter (Willey, 1979). Morris and Garrity (1993) stated that water use efficiency in intercropping was 18.99% higher than that in sole cropping. Thus, it is imperative to look for such intercropping systems which have the potential of raising crops such as different legume and non-legume forages, which are in chronic shortage during hot summer months, successfully in association with major food crops of Pakistan such as rice.

Conventional method of planting rice does not permit intercropping and a new method of planting upland rice in widely spaced multi-row strips has been developed (Saeed *et al.,* 1999).

Not much information on the possibility of intercropping of different legume and non-legume fodder crops in the upland rice was available and it was planned to develop a sustainable and economically viable intercropping system involving rice as a base crop.

MATERIALS AND METHODS

Investigations were carried out at the University of Agriculture, Faisalabad, during 'kharif' season of 1999-2000. The experiment was laid out in a randomized complete block design using three replicates having a plot size of 3.6 m x 10.5 m. The intercropping systems comprised no intercropping (i.e sole rice), rice + maize, rice + sesbania, rice + mung bean, rice + rice bean, rice + cowpea and rice + pigeonpea. Rice cultivar Basmati-385 was direct seeded on June 15, 1999 in 75 cm spaced four row strips with 15 cm space between the rows of each strip and simultaneously three rows of each of the intercrops were also sown between the rice strips. A seeding rate of 40 kg ha^{-1} for rice and 50, 40, 25, 15, 25 and 30 kg ha^{-1} for maize, sesbania, mung bean, rice bean, cowpea and pigeonpea, respectively was used. A basal dose of 100 kg N + 100 kg P_2O_5 was applied at sowing, while remaining 50 kg N was top-dressed immediately after harvest of intercrops.

All intercrops were harvested, as fodders, 50 days after sowing while rice crop was harvested, as base crop, at its physiological maturity on Oct. 30, 1999. Observations on the desired parameters of the main crop grown in association with intercrops were recorded by using standard procedures. Paddy yield equivalent was computed by converting the fodder yield of intercrops into paddy yield, based on existing market prices. The data collected were analysed statistically using the prescribed procedures and the treatments' means were compared at 0.05 probability level (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Data given in Table I show that all the intercrops significantly reduced rice paddy yield ha^{-1}. Sesbania caused maximum reduction in paddy yield of associated rice crop compared to sole crop, preceded by rice + pigeonpea intercropping system which was statistically at par with rice + cowpea, rice + rice bean and rice + mung bean intercropping systems. While maize caused least reduction in paddy yield which was also statistically at par with rice + rice bean and rice + mung bean intercropping systems. This reduction in paddy yield is attributed to significantly less number of fertile tillers m^{-2}, kernels per panicle and 1000-kernel weight in all the intercropping systems. Singh *et al.* (1996) and Saeed *et al.* (1999) also reported similar reduction in paddy yield by intercropping. All intercrops caused significant reduction in rice biomass ha^{-1}. Minimum rice biomass was obtained from rice intercropped with sesbania, preceded by that of rice intercroped with pigeonpea, which was statistically at par with rice + cowpea, rice + rice bean and rice + mung bean intercropping systems while maize caused least reduction in associated rice crop biomass. Low biological yield of rice intercropped with sesbania was due to less vegetative growth of rice plants in this treatment because of severe competition between component crops. Reduction in biological yield of wheat by different intercrops has also been reported by Tareen *et al.* (1988).

Also, it transpires from Table I that different intercropping systems caused significant reduction in number of fertile tillers m^{-2}, one of the major yield components, of associated rice compared to sole crop of rice. Rice grown in pure stand produced the maximum number of fertile tillers m^{-2} (261.8). By contrast, the minimum number of fertile tillers m^{-2} (226.5) was produced by the rice intercropped with sesbania. The minimum number of fertile tillers m^{-2} recorded for rice intercropped with sesbania is attributed to overshading of rice crop by the sesbania crop and severe competition between two associated crops for various growth factors, both of which might adversely affect the pollination in rice. These results are in line with findings of Khan (1984) and Ahmad (1990) in case of wheat-based intercropping systems. Both the legume and non-legume intercrops reduced significantly the kernels per panicle compared to monocropped rice. Maximum reduction was caused by sesbania intercrop. Probably, reduction in grains per panicle of intercropped rice be due to cessation of grain development at early stage as a result of overshading of the rice by sesbania and maize plants. Suppressive effect of other intercrops i.e. mung bean, rice bean, cowpea and pigeonpea on kernels per panicle of rice was probably due to competition for different growth factors during early rice development and inability of rice to recover this competitive loss at later stages. Similarly, 1000-kernel weight of rice was decreased significantly by all the intercrops under study, which might again be attributed to the competitive effects of the respective associated crops. Khan (1984) also reported similar suppressive effect of intercropping on 1000-grain weight of wheat.

In terms of total paddy yield equivalent, all the intercropping treatments yielded higher (5.06 t ha^{-1} to 6.76 t ha^{-1}) than sole rice (4.30 t ha^{-1}), being the highest for rice + maize (6.76 t ha^{-1}) followed by rice + cowpea (5.32 t ha^{-1}), rice + sesbania (5.21 t ha^{-1}), rice + mung bean (5.12 t ha^{-1}), rice + rice bean (5.11 t ha^{-1}) and rice + pigeonpea (5.06 t ha^{-1}). These results are in corroborate with Saud (1999) who reported that intercropping gave higher rice grain-equivalent yield compared to sole cropping.

Table I. Growth and yield components of rice as well as total paddy yield equivalent and economic analysis of different rice-based intercropping systems.

Treatments	Yield (t ha^{-1}) Paddy	Biomass	Intercrops (fodder)	Fertile tillers m^{-2}	Kernels per panicle	1000-kernel weight (g)	Total paddy yield equivalent (t ha^{-1})	Net income (Rs. ha^{-1})	Benefit-cost ratio (BCR)
Rice alone	4.30 a	13.14 a	---	261.8 a	172.0 a	20.51 a	4.30	32519.93	2.74
Rice + Maize	3.81 b	12.57 ab	41.77	245.5 b	163.7 b	19.39 b	6.76	56454.18	3.71
Rice + Sesbania	3.19 d	9.73 c	28.60	226.5 c	152.7 c	19.11 b	5.21	38725.43	2.87
Rice + Mung bean	3.58 bc	11.65 b	21.80	238.4 b	160.3 b	19.20 b	5.12	38520.43	2.84
Rice + Rice bean	3.67 bc	11.90 b	20.40	238.1 b	160.0 b	19.32 b	5.11	38751.68	2.87
Rice + Cowpea	3.56 c	11.53 b	24.90	240.5 b	159.1 b	19.20 b	5.32	40220.43	2.89
Rice + Pigeonpea	3.54 c	11.43b	21.60	240.9 b	159.0 b	19.19 b	5.06	38057.93	2.84

Any two means in a column not sharing the same letter differ significantly at 0.05 P (LSD); Paddy yield equivalent of intercrops was calculated at the ratio given below; 1 kg paddy = 14.17 kg fodder

In monetary terms, it was evaluated that highest net income of Rs. 56454.18 ha^{-1} and benefit-cost ratio (BCR) of 3.71 was obtained from an intercropping system of wheat + maize against the minimum net income of Rs. 32519.93 ha^{-1} and BCR of 2.74 in case of sole cropping (Table 1). These results are in line with those of Mandal *et al.* (1990), Jha *et al.* (1991) and Chandra (1992) who also reported higher net monetary returns from intercropping over monocropping of rice.

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