BIOLOGICAL AND LAND-USE EFFICIENCY OF DIFFERENT BARLEY-BASED INTERCROPPING SYSTEMS

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INTRODUCTION
The population of Pakistan is increasing at an alarming rate but the rate of increase in food production is too slow to meet the rapidly increasing demand for food. Thus the farmers and agronomists are faced with the task of increasing food production. This necessitates the development of new crop management practices to enhance crop productivity per unit area and time. Raising productivity through a more effective use of natural (e.g., light) and added (e.g., water, fertilizer, etc.) resources is possible through intercropping, provided component crops' demands for resources are well understood (Kalrab and Gangwar, 1980; Riaz et al., 1993). Recent research has shown substantial yield advantage of intercropping over monocropping or different crops (Manda and Mahapatra, 1990 and Patrick et al., 1995).

Barley (Hordeum vulgare L.) has a distinction of being the first grain crop to be cultivated and used as food by mankind. It is very rich in protein (7.5 to 15%) and starch (50-60%). Thus barley is considered to be as valuable as the same weight of maize grain for livestock feeding. It has a wide range of adaptation to soil and climatic conditions. Even it can withstand adverse agro-environment.

At present there is a great need for increased production of food grains, pulses and oilseeds because of their ever increasing use in the daily human diet. Area under these crops, however, cannot be increased due to their competition with wheat in rabi season. So, the best way to increase the production of barley, lentil (Lens culinaris Medic), gram (Cicer arietinum L.), methra (Trigonella foenumgraecum), linseed (Linum usitatissimum L.) and wheat (Triticum aestivum L.) may be through intercropping. The present study was, therefore, designed to determine the bio-economic efficiency of different barley-based intercropping systems under the irrigated conditions at Faisalabad.

MATERIALS AND METHODS
The investigations were carried out on a sandy clay loam soil at the University of Agriculture, Faisalabad during the year 1991-92. The intercropping systems comprised barley alone, barley + lentil, barley + gram, barley + Fenugreek (methra), barley + linseed and barley + wheat. Barley was sown in 100 cm spaced 4-row strips with 20 cm space between the rows of each strip. Three rows of each intercrop were sown between the barley strips.

Although all the intercrops reduced grain yield of barley significantly compared to its monocropping, yet the additional yield obtained from each intercrop compensated more than the losses in barley production. The land equivalent ratio showed 28 to 45% yield advantage of different intercropping systems over sole cropping. The highest yield advantage (45%) was recorded in barley + lentil followed by barley + gram (38%) against the minimum of 28% in barley + methra and barley + wheat. Similarly, all the intercropping systems gave substantially higher net income per ha than pure stand of barley. The maximum net income of Rs. 10367 ha-1 was obtained from barley + lentil intercropping system against the minimum of Rs. 6641 ha-1 from sole cropping. The results suggest that barley + lentil is the best intercropping system in all respects.

Key words: barley, biological efficiency, intercropping systems
the following formula of Willey (1979):

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\text{LER} = \frac{\text{Intercrop yield}}{\text{Sole crop yield}}
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The data obtained were analysed by using the Fisher's analysis of variance and DMR test was applied at \( P = 0.05 \) to compare differences among the treatment means (Steel and Torrie, 1984).

**RESULTS AND DISCUSSION**

**Biological Yield:** All the intercrops reduced biomass yield ha\(^{-1}\) of barley compared to that of the sole barley crop (Table 1) because of simultaneous competition among the component crops. Among the intercrops, lentil, gram and methra had significantly less effect on biomass yield of barley than linseed and wheat which were at par with each other. This was attributed to the continuous exhaustive competition of linseed and wheat with barley. The biomass yield of intercrops also varied significantly. Wheat produced significantly higher biomass yield ha\(^{-1}\) than all other intercrops, followed by lentil and linseed, which gave equal biomass. The minimum biomass was produced by gram. Reduction in biomass yield of base crop due to competitive effect of different intercrops was also reported by Rehman (1984) and Mandal and Mahapatra (1990).

**Grain Yield:** Different intercrops decreased the grain yield ha\(^{-1}\) of barley significantly compared to its pure stand (Table 1). The reduction was significantly higher in linseed and wheat intercropping than that of lentil, gram and methra. However, lentil and gram had a similar suppressive effect on grain yield or barley. These results are supported by those of Prasad et al. (1988), Tareen et al. (1988), Abo-Shelaia (1990), Bajwa et al. (1992) and Riaz et al. (1993) who reported differential suppressive effect of intercrops on the yield of the base crop. There were significant differences in grain yield ha\(^{-1}\) of the intercrops. Wheat produced the maximum grain yield of 1051 kg ha\(^{-1}\) against the lowest of 262 kg ha\(^{-1}\) for gram. However, lentil and linseed did not significantly differ from each other.

**Spikes m\(^{-2}\) of Barley:** Significant differences in number of spikes m\(^{-2}\) of barley were recorded among different intercropping systems (Table 1). Barley alone produced significantly greater number of spikes m\(^{-2}\) than that grown in association with different crops. Among the intercrops, linseed and wheat significantly decreased the spikes m\(^{-2}\) of barley than other intercrops but were at par with each other. However, gram had the least effect on spikes m\(^{-2}\) of barley. These differences were attributed to the variable, intercrop competition among the component crops of different intercropping systems. Similar suppressive effect of intercrops on number of spikes...
m – of the main crop was reported by Prasad et al. (1988).

Number of Grains per Spike of Barley: Various intercrops had significant effect on grains per spike of barley (Table I). Wheat caused significantly more reduction in the grains per spike of barley than linseed and methra which were statistically equal to each other. The minimum reduction in grains per spike was, however, noted in lentil and gram intercropping systems.

1000-Grain Weight of Barley: Intercropping decreased 1000-grain weight of barley significantly (Table I). Wheat and linseed caused the maximum reduction in 1000-grain weight of barley due to their continuous exhaustive competition with barley. Legume intercrops had relatively less effect on 1000-grain weight probably due to mild competitive effects. These results are in consonance with those of Khan (1984) who reported that 1000-grain weight of wheat was adversely affected in different intercropping systems.

Land Equivalent Ratio and Net Income: Land equivalent ratio (LER) indicates the yield advantages of intercropping over monocropping. LER values showed 28 to 45 % yield advantage of different intercropping systems over sole cropping of barley (Table I). The maximum yield advantage (45 %) was recorded in barley + lentil, followed by barley + gram (38 %), while the minimum (28 %) was in barley + methra and barley + wheat intercropping systems.

In terms of monetary gain, all the intercropping systems gave substantially more net income ha⁻¹ than that of the pure stand of barley. The maximum net income of Rs. 10367 ha⁻¹ was obtained from barley + lentil against the minimum of Rs. 6641 ha⁻¹ from the sole crop of barley. The results suggest that barley + lentil is the best intercropping system in all respects. Higher yield advantage and net income ha⁻¹ in different intercropping systems has also been reported by Nazir et al. (1988). Mandal and Mahapatra (1989) and Abo-Shetaia (1990).

REFERENCES