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Competition indices used to evaluate the agronomic and monetary advantage in intercropping: A review

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ABSTRACT

With the depletion of land available for agricultural crop cultivation, farmers must take steps to enhance the crop production in order to provide food to the population, improve their livelihood, and generate income. Although there are many methods of cultivation such as greenhouse cultivation and ponic systems to alleviate the problem of land scarcity, those methods may be very expensive. But intercropping can be identified as a method of cultivation to increase the productivity of the land with lower costs, where it involves cultivation of two or more crops together with each other. All the intercropping combinations would not be successful depending on the competition for light, space, time, nutrients and water as well as on the interaction between each. In this context, scientists have identified indices to evaluate the degree of compatibility of each crop combinations. These indices will determine whether any particular crops can be grown in combined to increase the productivity. Authors reviewed the published information and summarized the results. The objective of compiling this review was to gather information of various intercropping researches on intercropping indices and to show the degree of success or unsuccess of each and every crop combination. This paper provides a great idea on the resource use efficiency and advantage of intercropping while giving comparative ideas on selecting crop combinations for intercropping systems. For the compilation, many research articles on various crop combinations were studied and the most important and valuable data were gathered in this paper. This paper would be very much useful for researchers who are going to experiments with the studies related to intercropping.

***Keywords**: Competition, crop combination, cropping indices, intercropping*

INTRODUCTION

Intercropping is an integral part of cropping system which is practiced by farmers in both tropics and sub tropics. It has several advantages over sole cropping. Intercropping efficiently used resources such as light, water, time, space and soil and provides yield advantages and profit compared to monocropping (Gebru, 2015; Ouyang *et al*., 2017). Weeding is one of the major labour consuming activities in sole cropping (Weerarathne *et al*., 2017). Intercropping has crop diversity and reduces the chance to spread weeds through efficient use of land (Rahimi *et al*., 2019). The most important environmental growth resources used by crops are light, space, water, and nutrients. Above ground components of the crops compete for light, radiation and space whereas below ground parts compete for water, rooting space and nutrients. Intercropping conserves soil water with the provision of shade in different levels thereby reduces wind speed and improves infiltration soil physical properties. Different crops with different root system in various levels in intercropping influence the crop demand for water (Mobasser *et al*., 2014). Further, high land use efficiency increases plant productivity than monocropping (Moradi *et al*, 2014). This is very much important for the areas where land is a challenging resource. Industrialization has become a major

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consequence in limiting the land resource. Due to over increasing human population, leading to diminishing land sizes (Dantata, 2014). Hence, intercropping has come into, not a need, but an essential. Intercropping is more likely to result in production increases which will provide better economic security to the farmer (Choudhuri, 2011). Even though agronomic practices such as weeding, watering, fertilizer application and harvesting in monocropping is easy, in addition, the sole cropping provides host for pests and increase the chance for diseases than intercropping (Zhang and Li, 2003). But in intercropping insects have to spend more time and more effort to find their host plants in fields with varieties of crops. Therefore, intercropped fields are subjected to pest and disease incidents rarely (Li *et al*., 2001).

COMPETITIVE INDICES

Competitions among mixtures are assumed as a key aspect affecting production in intercropping (Banik *et al*., 2000). Intercropping utilizes natural resources efficiently compared to sole cropping and there is cooperation when two species grown in a particular place at a time are mutually beneficial and competitive when they are grown in a particular place at a time where it is harmful (Donald, 1963). However, both co-operation and competition are affected by plant density. Co-operation occurs at low density and competition when increase population. Competition may be for water, solar radiation, nutrient and space. In cereals, competition affects the crop yield (Caballero *et al*., 1995). High competition occurs within different crops of same family while low between two different crops from different family (Vandermeer, 1989) for resources such as water, nutrients and light (Buxton and Fales, 1993). Additionally, yield advantages results when intercrop components compete only for the same plant growth resources (Andersen *et al*., 2007). Competition affects the growth of plant in mixtures. Mathematical indices used to study the plant competition trials (Weigelt and Jolliffe, 2003). The beneficial aspects of intercropping can be expressed in terms of indices, in order to get a numerical value about both biological and economic effectiveness of intercropping. There are numerous indices viz; Land Equivalent Ratio (LER), Area – Time Equivalent Ratio (ATER), Relative Crowding Coefficient (K), Competitive Ratio (CR), Aggressivity (A), Actual Yield Loss (AYL) and Monetary Advantages (MA) were developed by scientist to evaluate the intercropping system. Those indices express competition intensity, effects, and its consequence of plant population and aid to interpret the complex data which allows comparison of several combinations with the same index (Esmaeili, *et al*., 2011).

Land equivalent ratio (LER)

It is the relative land required in area under mono cropping to get the same yield as produced in the interculture. It is considered as an extensively used index in assessing yield advantages in intercropping. Among competition indices, LER is the most frequently adopting index for comparing intercropping and monocropping (Agegnehu *et al*., 2006). Willey and Osiru (1972) first time used LER to evaluate the yield advantage in *Zea mays* and *Phaseolus vulgaris* intercropping in Uganda. Effective utilization of land and yield advantages was reported by Mashingaidze (2004). Mead and Willey (1980) stated that LER measures the intercropping advantages by environmental resources. Those advantages are attributed with nutrients, light and water. LER has been widely accepted to evaluate the yield advantages in intercropping (Rees, 1986; Pilbeam *et al*., 1994; Mukhala *et al*., 1999).

LER is calculated as follow (Willey and Osiru (1972));

$$LER = Lp + Lq$$

$$LER = \frac{Ypq}{Ypp} + \frac{Yqp}{Yqq}$$

Where,

Ypq -Yield of p in intercropping pq
Yqp -Yield of q in intercropping pq
Ypp -Yield of p in sole cropping p
Yqq -Yield of q in sole cropping q
Lq - Partial LER of q
Lp - Partial LER of p

Comparison of partial LER indicates the relative competition ability between the component crops. The value of one is known as the critical value in LER. Further LER is more than unity intercropping can consider as a yield advantage system while LER less than one denotes intercropping considered as undesirable one in the association (Caballero et al., 1995). Also, Vandermeer (1989) reported that LER was more than 1.0 directs a positive intercropping advantage and interspecific facilitation is higher than interspecific competition. Several researches have been carried out to evaluate the intercropping system by LER (Table 1).

Table 1: LER for best crop combinations

Crop combination	**Remarks**	**LER**	**Reference**
Zea mays + *Vigna radiata* and *Zea mays* + *Amaranthus viridis*	*Zea mays* + *Vigna radiata* had greater LER values	1.236	Aynehband and Behroos (2011)
Abelmoschus esculentus – *Zea mays* – *Piper nigrum*	Strip rows pattern had greater LER values	4.67 and 5.98 in two seasons	Orluchukwu and Udensi (2013)
Common vetch + Cereal (wheat, triticale, barley, common vetch and oat)	*Vicia sativa* + Wheat had higher LER values	1.05	Dhima, *et al.* (2007)
Abelmoschus esculentus + *Amaranthus viridis*, *Abelmoschus esculentus* + *Vigna unguiculata* and *Abelmoschus esculentus* + *Cucumis sativus*	*Abelmoschus esculentus* + *Cucumis sativus* gave the highest LER	1.85	John and Mini (2005)
Sorghum bicolor + *Glycine max*	2:1 pattern had the greater LER	1.42	Homayouni (2004)

Onion + Lentil/Rape seed/Fenugreek/Linseed/Kale/ Dill/Black cumin	LER was maximum in onion + rapeseed system	1.43	Getahun *et al*. (2018)
Sorghum bicolor + *Vigna unguiculata*	1:1 ratio showed greater LER	1.073	Tajudeen *et al*. (2010)
Cotton + *Sorghum bicolor* and Cotton + *Vigna unguiculata*	120/40 cm rows showed greater LER	1.46	Aasim *et al*. (2008)
Sabai grass + *Vigna mungo*	1:2 ratio showed higher LER	2.01 and 1.75 in two seasons	Mahapatra (2011)
Pigeonpea + Pulse (*Glycine max*, urdbean, rajmah and *Vigna radiata*)	Pigeon pea + *Vigna radiata* (1:3) gave the highest LER	1.34	Dudhade *et al*. (2009)
Zea mays + *Vigna unguiculata*	LER was greater in100% maize+ 100% cowpea planting system	2.31 and 2.57 in two seasons	Dahmardeh *et al.* (2010)
Zea mays + *Glycine max*	Rhizobial inoculated plots gave the highest LER. P and K also significantly increased LER over the control	1.73 for grain yield 1.61 for biological yield	Nyoki and Ndakidemi (2017)
Arachis hypogaea + *Eleusine coracana*	1:1 ratio gave higher LER	1.36	Runkulatile *et al*. (1998)
Solanum melongena + Red amaranth, *Solanum melongena* + Leaf amaranth, *Solanum melongena* + Jute, *Solanum melongena* + *Vigna radiata*, *Solanum melongena* + *Vigna mungo*	*Solanum melongena* 100% + *Vigna radiata* 60% intercropping system gave higher LER	1.27	Islam *et al*. (2014)
Letuca sativa + Rocket	LER was highest with smaller row spacing	1.41	Nascimento *et al*. (2018)

LER is sometimes known as Relative Yield Total (RYT). In considering mathematical theories, LER is the sum of the intercrop yield divided by the sole crop yield of each of the component crops in the specific intercropping system. It is the expression of sum of the relative yield values of each crop in intercropping. The relative yield value is used when both crops were sown on the basis of the same plant density, and it can directly represent the benefits of intercultures (Soleymani *et al*., 2012).

Area-Time Equivalency Ratio (ATER)

This index was proposed by Hiebsch and Collum (1987) as a modification for LER. It incorporates the duration of the crop also. ATER is calculated by,

$$ATER = \left(\frac{Lp \times tp + Lq \times tq}{T}\right)$$

Where,

Lp, Lq – Partial LER of p and q crops respectively

tp, tq – Duration of crop p and q, respectively

T – Duration of the whole intercrop system

The ATER includes growth duration of various crops and it provides more accurate comparison compared with monocropping. ATER value is similar to LER, when components of crops are same in their duration (Ofori and Stern, 1987). ATER corrects the conceptual inadequacy of LER as time duration of various crops also effect on success or unsuccess of intercropping. ATER used to evaluate barley-lentil, barley-flax intercropping (Mandal and Mahapatra, 1990). In roselle and cowpea intercropping the highest ATER values were significantly recorded with row ratio 2:3 and 1:1 system without significant difference between both of them during both seasons. The lowest ATER value was produced with 1:3 system (Gendy *et al*., 2017). According to the findings of Dhandayuthapani and Latha (2015) it was found that, sowing pigeon pea with greengram at 120cm X 30 cm with 1:3 row proportions provided greater ATER of 1.15. Metwally *et al*. (2016) cited that intercropping cotton with wheat had higher ATER compared to sequential double cropping system. Also, intercropping cotton with faba bean had higher values of ATER compared to sequential double cropping system. ATER were below 1.00 in intercropping of bottle gourd and cassava combinations except morphotypes of bottle gourd with cassava cultivar *six mois* planting at 6:24 ratios (Doubi *et al*., 2016). In maize potato intercropping ATER provides 75 % advantage over monocropping (Bantie, 2014). Maize-pea intercropping, single row maize followed by single row pea showed higher ATER of 1.33 which was 17% and 85% respectively higher than ATER from maize and pea partners (Dhar *et al*., 2013). ATER values were high in corn – peanut intercropping system (1.58), followed by maize– soybean system (1.52) and corn – mung bean system (0.96) (Polthanee and Trelo-ges, 2003).

Relative crowding coefficient (K)

It is an index used to determine the completion effect and advantages of intercropping. In a mixture, the crop with the highest K value is regarded as having a greater relative dominance of one species over the other.

The K was calculated as:

$$Kpq = \frac{(Ypq \times Xqp)}{(Ypp - Ypq)} Xpq$$

$$Kqp = \frac{(Yqp \times Xpq)}{(Yqq - Yqp)} Xqp$$

$$Kqp = Kpq \times Kqp$$

Where,

Xpq - sown proportion of ‘p’ in mixture of ‘q’
Xqp - sown proportion of ‘q’ in mixture of ‘p’
Xqp - sown proportion of ‘q’ in mixture of ‘p’
Xpq - sown proportion of ‘p’ in mixture of ‘q’
Ypq – yield of p in intercropping pq
Yqp- yield of q in intercropping pq

If K = 1, interspecific and intraspecific competition have been equal. If Kp, Kq differs from 1, crop which shows higher K can be considered as dominant crop.

If the K is more than unity, it can be considered as a yield advantage whereas equals to unity and less than 1 indicate that no yield advantage and a yield disadvantage respectively (Ghosh, 2004).

Table 2: Relative crowing coefficient for crop combination

Crop Combination	Relative crowding coefficient (K)	Reference
Mustard + Gram and Mustard + Lentil	Mustard + Gram was better in K	Jana *et al*. (1995)
Sorghum bicolor + *Vigna unguiculata*	Sorghum had higher K value	Tajudeen *et al.* (2010)
Cotton + *Sorghum bicolor* and Cotton + *Vigna unguiculata*	Cotton had higher K value	Aasim *et al.* (2008)
Barley + Faba bean	K was high at 100:37.5(%) barley: faba bean	Agegnehu *et al*. (2006)
Common vetch + wheat, triticale, barley and oat	Common vetch + Oat had higher K	Dhima *et al.* (2007)
Zea mays + *Vigna unguiculata* and *Zea mays* + *Glycine max*	*Zea mays* had higher K value	Khonde *et al*. (2018)
Safflower + Bitter vetch	Safflower had greater K in 2:2, 2:3 and 2:4 planting patterns, but in 5:2 planting pattern bitter vetch had greater K	Jalilian *et al*. (2017)
Canola + Wheat, Canola + Lentil and Canola + Linseed	Higher value of K (4.08) in canola + one row of wheat intercropping system	Tahir *et al*. (2003)
Sesame + Legume (*Vigna radiata*, mash bean, *Vigna unguiculata* and *Glycine max*)	Sesame was dominated crop and Sesame + *Vigna radiata* system had maximum K	Bhatti *et al*. (2006)
Barley + Lentil, Barley + Gram, Barley + Methra, Barley + Linseed and Barley + Canola	Except in Barley + Canola, in other planting systems barley had higher K values	Wahla *et al*. (2009)

Competitive ratio (CR)

It is an index used to measure the competition effect in intercropping. Willey and Rao, (1980) suggested that competitive ratio used to measure of better competitiveness of the crops over relative crowding coefficient and aggressivity. Competitive ratio can be calculated by using the following formula.

$$CRq = \left(\frac{LERq}{LERp}\right) \times \left(\frac{Zp}{Zq}\right)$$

$$CRp = \left(\frac{LERp}{LERq}\right) \times \left(\frac{Zq}{Zp}\right)$$

Where,
LERp = Land Equivalent Ratio of crop p
LERq = Land Equivalent Ratio of crop q
Zp = sown proportion of crop p in intercropping
Zq = sown proportion of crop q in intercropping

If CRp value is less than 1, it can be considered to grow crops in association while CRp is greater than 1 indicating there is negative compatibility and growing crops in intercropping is not suitable. The opposite is matching for crop q.

Rice based intercropping, intercrops maize, sesbania, mung bean, rice bean, cowpea and pigeon pea recorded higher CR values than base crop indicates that intercrops are more competitive than rice when in association. CR value of sesbania (2.14) followed by maize (1.82) while minimum in cowpea and pigeon pea (1.75) and another tested intercrop have CR of 1.78 (Jabbar *et al*., 2009). In vetch intercropped with wheat, barley, oat and triticale, higher CR values were noted in barley and oat than wheat and triticale while CR value for vetch was inferior in mixtures with barley and oat than in wheat and triticale (Dhima *et al*., 2007). When barley is intercropped with grass pea and vetch, intercropped grass pea and vetch had greater CR indicated that grass pea and vetch is more competitive when compared with barley (Javanmard *et al*., 2014). Competitive ratio (CR) of intercropping of annual medic with barley revealed that, barley was the dominant species in the cropping patterns. Barley: annual medic in the ratio of 6:2 cropping pattern was the one and only exclusion where barley was not the dominant (Sadeghpour *et al*., 2013). In maize - potato intercropping, maize had positive CR, specifying that maize was the crop with more competitiveness than potato (Bantie, 2014).

Aggressivity

Aggressivity is the index which used to show the degree of yield rise relatively in ‘p’ crop is higher than that of ‘q’ crop in an intercropping (McGilchrist, 1965). It indicates different tendency of cropping system. It mentioned only completive effect is larger or lesser.

The aggressivity is equation is,

$$Ap = \left(\frac{Ypi}{Yp \times Ppi}\right) - \left(\frac{Yqi}{Yq \times Pqi}\right)$$

$$Aq = \left(\frac{Yqi}{Yq \times Pqi}\right) - \left(\frac{Ypi}{Yp \times Ppi}\right)$$

Where,
Ap – Aggressivity of crop p
Aq – Aggressivity of crop q
Ypi and Yqi – Actual yield of p and q in intercropping
Yp and Yq – Yield of p and q in mono cropping
Ppi - sown proportion of p in mixture with q

If Ap is over zero, the competitiveness of crop p exceeds that of crop q in intercropping. It means, the crop q offers greater competitiveness.

Groundnut – cereal intercropping cereal recorded positive aggressivity and confirmed as the dominant crop (Ghosh, 2004). In mustard –l egume intercropping, mustard recorded higher aggressivity compared to legume (Banik *et al*., 2000). When eight maize varieties were intercropped with cowpea and soybean, positive aggressivity values in all mixtures showed that maize was the dominant species (Khonde *et al*., 2018). When safflower and bitter vetch grown in intercropping, the results showed that the aggressivity index of safflower was positive in all intercropping patterns in related to bitter vetch. As well, the aggressivity values were significantly greater than zero ($P \leq 0.05$), dominating safflower and showed much higher competitiveness in the intercropping system of safflower with bitter vetch (Jalilian *et al*., 2017). When canola intercropped with wheat, gram, lentil and linseed in different ratio, the positive signs of aggressivity values of canola showed that canola is the dominating crop compared to other intercrops with negative aggressivity values. Low aggressivity values was found in canola with one and two rows of wheat (-0.03, -0.06 respectively), showing that wheat was the crop which is mostly compete with canola (Tahir *et al*., 2003). In the intercropping systems of barley and annual medic, the aggressivity values confirmed barley was the dominant one in the experiment (Esmaeili *et al*., 2011). Cui *et al*. (2017) stated that, the aggressivity values of maize were positive in 2 maize: 2 soybean and 1 maize: 1 soybean row ratio. When groundnut and millet are planted in combined in two different locations, aggressivity of groundnut was significantly lowered (-0.53) at 2:4 system at first place and at the other place, in the same arrangement of 2:4, aggressivity value was higher (-0.19) than 2:2 ratio (Aliyu *et al*., 2016). In intercropping of cowpea and multi-cut sorghum at row ratio of 2:2 rose the aggressivity index compared to 1:1, 1:2 and 2:1 row ratio (Sharma *et al*., 2009). Irrespective of the system used in the intercropping of maize and garden pea, maize showed a positive relationship and garden pea showed a negative relationship signifying that maize was dominant crop whereas garden pea seemed as dominated crop. Higher aggressivity value of 0.426 was noted in maize with broadcast garden pea in between maize rows (Khan *et al*., 2018). Aasim *et al.* (2008) revealed that, aggressivity of cotton was positive and considered as the dominant species in the intercropping systems compared to cowpea and sorghum which had negative values.

Actual yield loss (AYL)

Actual yield loss index based on yield per plant and provides the details of competition than the other indices (Banik *et al*., 2000). AYL is the proportionate yield loss of intercrops relatively to the mono crop which is indicate by sign.

AYL calculates by using the following equation (Banik 1996).

$$AYL = AYLp + AYLq$$

$$AYLp = \left[\frac{Ypq/Xpq}{Yp/Xp}\right] - 1$$

$$AYLq = \left[\frac{Yqp/Xqp}{Yq/Xq}\right] - 1$$

Where,
Ypq – yield of p and q as intercrops
Yqp – yield of q and p as intercrops
Xpq – sown proportion of intercrop p with q
Xqp – sown proportion of intercrop q with p
Yp – yield of p in mono crop
Yq – yield of q in mono crop
Xp – sown proportion of p in mono crop
Xq – sown proportion of q in mono crop

Table 3: Actual yield loss for crop combination

Crop combination	Remarks	AYL	Reference
Sorghum bicolor + *Vigna radiate*	Highest AYL was obtained in treatment 1:3 ratio	4.61	Shaker-Koohi and Nasrollahzadeh (2014)
Zea mays + *Vigna unguiculata* and *Zea mays* + *Glycine max*	AYL was negative in all intercrops with cowpea and soybean. Lowest negative value was with maize + soybean systems	-0.34	Khonde *et al*. (2018)
Wheat varieties in intercropping (Zarrin + Gaspard)	The total AYL was positive in the all mixtures. Highest was with 1:2 ratio (33% Zarrin + 67% Gaspard)	2.15	Jamshidi (2011)
Zea mays with French bean, *Vigna unguiculata* and *Vigna mungo*	*Zea mays* had negative and intercrops had positive values for AYL. French bean recorded more yield loss in 1:1 ratio	0.57	Choudhary (2014)
Zea mays + Legume (*Vigna unguiculata* and Common bean)	AYL value was highest in maize + cowpea system of 1:1 ratio (50%:50%)	1.36	Yilmaz *et al*. (2008)
Zea mays + *Glycine max* (with different N levels)	2:2 cropping pattern with highest nitrogen fertilizer level had highest total AYL values	0.299 and 0.077 in two seasons	Rashwan and Zeneldein (2017)
Zea mays + *Arachis hypogaea*	Total AYL value was greater in 3:1 ratio	0.08	Dwomon and Quainoo (2012)
Zea mays + *Vigna unguiculata*	All combinations had negative values, giving lowest in 100:100 (both crops in same row)	-0.30	Takim (2012)
Cotton + *Sorghum bicolor* and Cotton + *Vigna unguiculata*	Total AYL value was greater in cotton with sorghum at 120/40 cm rows	1.160	Aasim *et al*. (2008)
Common vetch + cereal such as wheat, triticale, barley and oat	AYL was greater in common vetch + oat in 65:35 ratio	0.134	Dhima et al. (2007)

Cultivated Land Utilization Index (CLUI)

CLUI is a ratio between summation of products of crop cultivated area and crop duration, and the product of total crop cultivated area and the total number of days in a year. This index reflects the usage of available solar energy with a supposition that the solar flux density in a region is uniform throughout the year. However, it does not reflect the intensity of cropping practices and resource use. Hence, the combination of CLUI, and cropping intensity, may represent the actual land resource use in a better way than sole CLUI or cropping intensity.

CLUI is calculated by the following formula.

$$CLUI = \left[\frac{\sum_{i=1}^{n} a_i d_i}{A \times 365}\right]$$

where,
i = 1, 2, 3, …., n
n=the total number of crops
ai=the area occupied by the ith crop (ha)
di= the duration of the ith crop (days)
A = the total cultivated land area available for 365 days (ha) (Brahmanand *et al*, 2021)

Brahmanand *et al*, (2021) mentioned that when cultivating rice, other cereals, pulses, oilseeds, vegetables, fibres, spices, sugarcane, tobacco and fruit crops in different planting patterns during 2013–14, the average cropping intensity and CLUI values for the state were 167% and 0.585 respectively. This indicates that though 67% of the net cultivated area is sown twice in a year, only 58.5% of total available solar energy is harnessed. It reflects the scope of improving productivity through better utilization of available solar energy even at the same cropping intensity in the state.

Monetary Advantage Index (MAI)

Competition indices not always provide information about economic advantages. Monetary Advantage Index (MAI) was developed to calculate economic advantages and it was calculated by the following equation.

$$MAI = \left(\frac{(Value\ of\ combined\ intercrops) \times (LER - 1)}{LER}\right)$$

The greater the MAI value indicates the cropping system is more profitable (Ghosh 2004).

Positive MAI values revealed that intercropping systems outperformed monocropping in terms of yield. According to Ghosh (2004), when the LER and K were higher, the MAI value was also higher. The MAI noted significantly higher values in groundnut with maize combination compared groundnut/sorghum and groundnut/pearl millet combinations. The low monetary benefit was found in groundnut/pearl millet one cut (Ghosh, 2004). The MAI values in 2 maize: 2 soybean row ratio was greater than MAI in 1 maize: 1 soybean (Cui *et al*., 2017). MAI from the intercropping systems of annual medic and barley was positive in all of the cropping patterns but not in cropping ratio of barley: annual medic 4:4 and 6:6. In those cropping ratios, the negative values indicated that the intercropping systems are not good to combine in economic aspects. The highest MAI was observed in cropping ratio of barley: annual medic 1:1 (24.90) followed by 4:2 ratio (15.96) (Sadeghpour *et al*., 2013). In turmeric and mung bean intercropping, MAI values calculated showed positive in all the intercropping systems.

The positive value in yield and economic advantages of the intercropping system showed an advantage compared to mono cropping. Turmeric with three row mung beans in intercropping system gave highest MAI implied that the combination was more economical and advantageous in several aspects (Islam *et al*., 2018).

In a maize – soybean intercropping with integrated soil fertility management practices, among all the tested treatments, integrated soil fertility management resulted in higher monetary advantage index values for maize/soybean mixture relative to other treatments (Muyayabantu *et al*., 2013).

CONCLUSION

There are many competitive indices used to evaluate the agronomic and monetary advantages of intercropping system. However, right choice of indices for specific need is vital in making accurate interpretations and adoption of intercropping.

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