Novelty Journals

International Journal of Novel Research in Life Sciences
Vol. 1, Issue 1, pp: (1-7), Month: September-October 2014, Available at: www.noveltyjournals.com

Effect of Maize Variety and Legume, Non Legume Intercropping On Their Yield and Cultivation Cost in Foot Hills of Nepal

S. Dhakal

Assistant Professor, Department of Agronomy, Agriculture and Forestry University (AFU) Chitwan, Nepal

Abstract: **A field experiment was conducted in a local tribal farmer's field of hilly Kavilas VDC of Chitwan, Nepal during the rainy season of 2012 (April to September), on maize intercropping with legumes and non-legumes. 2 Factor Strip Plot Design was used in the experiment with 12 treatments and 3 replications. The treatment comprised of combination of three maize variety of different maturity date [Arun-2 (80-90 DAS), Manakamana-1(120-130 DAS) and Poshilo makai-1(145-155 DAS)] and four intercrops among which Blackgram, Greengram and Cowpea were leguminous intercrop whereas Millet was non leguminous intercrop. Among the used maize varieties, Poshilo Makai-1, a long duration maize, had significantly higher yield (4.72 ton/ha) which was significantly higher than the yield of both medium and short duration maize variety Mankamana-1 (3.52 ton/ha) and Arun-2 (2.82 ton/ha) respectively. Similarly among the intercrops, the yield of non-leguminous component Millet (0.83 ton/ha) was found higher over other leguminous components Blackgram (0.26 ton/ha), Greengram (0.27 ton/ha) and Cowpea (0.52ton/ha). Yield of intercrop was found higher in short duration maize variety but the difference was not found significant. The effect of maize variety and the intercrops along with their combinations were also found significant on the gross return, net return and Benefit cost ratio where medium and long duration maize varieties (Manakamana-1 and Poshilo Makai-1) were significantly superior over the short duration maize variety (Arun-2) whereas in case of intercrops, leguminous intercrop Cowpea was found significantly superior over other intercrops. Intercropping of long duration maize variety with any leguminous intercrop was found profitable over non legume intercrops.**

Keywords: **Intercrops, legumes, maize, yield.**

I. INTRODUCTION

Maize (*Zea mays)* is the world's widely grown cereal and is common in many developing countries as primary staple food crop. It has higher yield potential than any other cereals and thus is popularly known as the 'queen of cereal'. In Nepal, it is the second most staple food crop both in terms of area and production after rice. It is currently grown in 0.87 million hectares land in Nepal with the production of 21 million ton and average productivity of 2.5 ton/ha (MoAD, 2012). It occupies about 28.19% of the total cultivated agricultural land and about 23% of the total cereal production in Nepal. In Nepal, majority of the maize cultivated area i.e. 83% lies in hilly and mountainous region and the rest is in terai region and inner terai region (MoAD, 2012).

Grain legumes are important pulses in Nepal both in terms of their contribution to human nutrition and also as the important component of indigenous cropping systems for improving the soil fertility. The current area under legumes in Nepal is 0.32 million ha (10.81% of the total cultivated area) with the production of 0.31 million tones and productivity of only 0.95 ton/ha (MoAD, 2012).Blackgram (*Vignamungo* L. Hepper) is the third important grain legume of Nepal (summer) in terms of acreage after lentil and soybean. It occupies 8.22% of total area under legume crops. Currently it is grown in an area of 27496 hectare with the production of 22482 ton and productivity of 0.82 ton/ha (MoAD, 2012). Green

gram [*Vignaradiata* (L.) Wilczek] is also the important grain legume of Nepal however area under green gram is still very low in Nepal. It is estimated that 12,000 hectare of cultivated land (4% area of grain legume) is covered by mungbean with average annual production of 6,500 metric tons and average yields of 0.5 ton/ha (Joshi *et al.*, 1997). Cowpea is [*Vignaunguiculata* (L)] known as 'Bodi' is also one of the important grain legumes of Nepal that occupies 0.0042 million hectare of land with the production of 35223 ton and annual productivity of 8 ton/ha (MoAD, 2012).Finger Millet (*Eleusinecorocana*) is also one of the important cereal crops of Nepal widely cultivated in hilly regions. It is the fourth important cereal crops of Nepal after Rice, Maize, Wheat occupying 0.2 million hectare of cultivated land with the production of 0.3 million ton and productivity of 1.12 ton/ha.

Maize based cropping pattern is crucial for food security in the mid hills of Nepal where agriculture is the mainstay for livelihood. There is immediate need to conserve the inherent soil properties to sustain the maize production in these regions. At the same time maximum utilization of the land in a logical way might be beneficial to increase the income of the farmers in this region.

Over the past few years intercropping has been recognizing as a potentially beneficial system of crop production in tropical agricultural systems and the evidences suggest that intercropping can provide yield advantage over sole crops not because of high external inputs but rather due to more efficient utilization of resources (Chaudhary and Rosario, 1992).In cereal/legume intercropping system, inclusion of legume component, which has usually short stature growth habit, utilizes space and time more efficiently than a sole cereal crop because legume has ability to fix atmospheric nitrogen to the soil (Heibsh and McCullumn, 1987) and does not effectively compete with cereals plants for nutrients so the complement with each other.

II. MATERIALS AND METHODS

The field experiment was conducted at Kavilas, Chitwan in a farmer's field of tribal society (Chepang) from January 2012 to October 2012. The experimental site is located in sub-tropical climatic region of central Nepal, 30 kilometer north east of Bharatpur, headquarter of Chitwan district. Geographically it is situated at 27^{o} 77' N latitude and 84^{o} 47' E longitude with an elevation of 332 meter above mean sea level with a slope of 5^{o}. The soil of the experimental site was slightly acidic in reaction with clayey texture. The total rainfall received by the crop was 1546.6 mm during its season.

The experiment was laid out in 2 Factor Strip Plot Design with 12 treatments and 3 replications. The treatment comprised of combination of three maize variety of different maturity date [Arun-2 (80-90 DAS), Manakamana-1(120-130 DAS) and Poshilo makai-1(145-155 DAS)] and four intercrops among which three were leguminous intercrop and one was non leguminous intercrop (Blackgram, Greengram, Cowpea and Millet). Maize varieties were planted in similar pattern with spacing of 70 cm between the rows and 20 cm between the plants and the intercrops were tried on 1:1 basis i.e. in between the two maize rows, the intercrops were sown/ transplanted. Statistical package MSTAT-C was used for the analysis of the observed data. Intercrops being completely different crop species no statistical analysis was done among them regarding their yield however they were checked in terms of their suitability and profitability in the intercropping system with various maize varieties.

III. RESULTS AND DISCUSSION

Grain yield of Maize

Average grain yield of all maize varieties was observed 3.7 t/ha and ranged from 2.86 t/ha to 4.72 t/ha. The collected and analyzed data showed significant difference between the maize varieties (Arun-2, Manakamana-1 and Poshilo makai-1) regarding the grain yield (Table 1). Regarding the grain yield, the long duration variety emerged as significantly superior variety with grain yield of 4.72 t/ha which was distinctly higher than the grain yield of short duration maize variety Arun-2 (2.82 t/ha) whereas the medium duration variety Manakamana-1 (3.52 t/ha) was intermediate between the other two varieties. Long duration varieties compared to short duration varieties tended to be taller and to produce a larger number of leaves, larger LAI, larger TDW and higher grain yield (Yamaguchi, 1973).Thus, it can be well understood that even in the similar condition of soil and weather, varieties differ in respect of grain yield. Pandey and Agrawal, 1991 also

mentioned that the suitability of varieties to a particular agro-climate is the most important factor in realizing their yield potential.

Furthermore, the intercrop had also significant effect on the grain yield of the base maize crop. Significantly higher grain yield was achieved from the maize crop intercropped with any of the legumes as compared to that of maize crop intercropped with non-leguminous component. The maize grain yield was significantly high in case of maize intercropped with cowpea (3.97 t/ha) as compared to that of maize intercropped with millet (2.98 t/ha). Yield of grains in case of maize intercropped with green gram (3.83 t/ha) and black gram (3.96 t/ha) were at par with that of the grain yield from the maize crop intercropped with cowpea.

Thus, based on above facts it can be illustrated that intercropping of Poshilo makai-1 with any of the legumes gave significantly higher grain yield (4.72 t/ha) as compared to Manakamana-1 (3.52 t/ha) and Arun-2 (2.82 t/ha) (Figure 1). Grain yield of Manakamana-1 maize intercropped with any of the legume resulted in intermediate yield (3.52 t/ha) between Arun-2 (2.82 t/ha) and Poshilo makai-1 (4.72 t/ha). Hence, for the mid hill region of Chitwan, Poshilo makai-1 variety of maize was more productive over other two varieties and in intercropping with any of the legume (Black gram, Green gram and Cowpea) its yield was distinctly higher than those of other two varieties used. Thus, both the maize varieties and the intercrops have significant effect on the grain yield of maize.

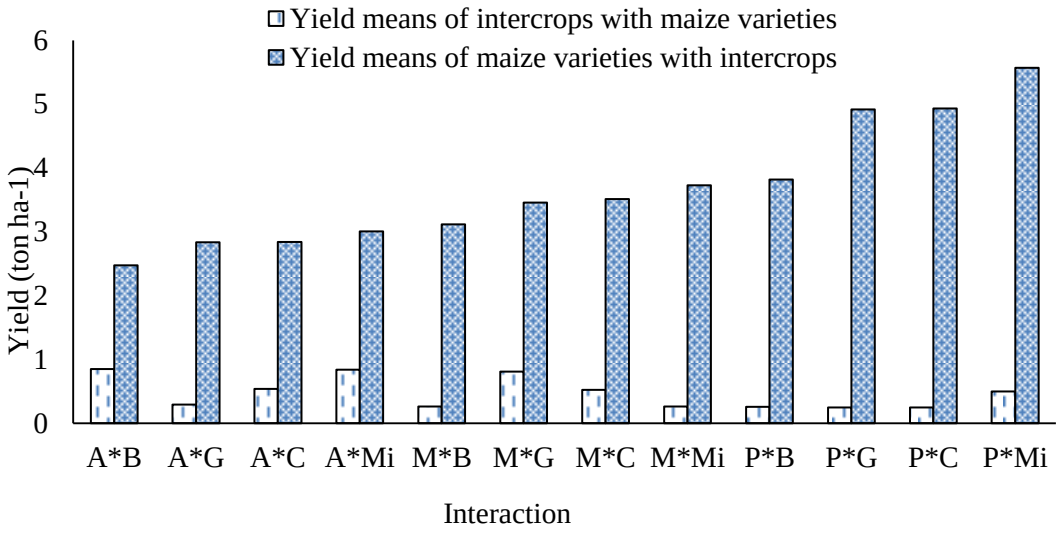

Figure 1: Performance of maize and intercrops during various combinations

Grain yield of intercrops and maize equivalent yield

The average intercrop grain yield was observed to be 0.47 t/ha ranging from 0.49 t/ha to 0.45 t/ha. No significant effect of maize variety was observed in case of grain yield from the intercrops however slightly higher grain yield was obtained in case of short duration maize variety Arun-2 (0.49 t/ha) as compared to that of medium duration maize variety Manakamana-1 (0.47 t/ha) and long duration maize variety Poshilo makai-1 (0.45 t/ha) (Table 1). Slightly higher yield of intercrops in short duration variety might have been resulted from better growth and development of intercrops in short duration variety and due to higher number of yield attributing characters of intercrops in case of short duration maize variety. There was negative correlation between the height of maize varieties and yield of intercrops (r = 0.95). Short cereals offer less competition to intercropped crops for solar radiation than tall cultivars (Tarhalkar and Rao, 1975; Vorasoot*et al.*, 1976; Wahua and Miller, 1978).

Regarding the maize grain equivalent yield too, the maize varieties do not have significant effect. However, slightly higher maize equivalent yield is obtained in case of Poshilo Makai-1 due to higher maize grain price for this highly nutritious variety of maize. Poshilo Makai-1 is a maize variety of QPM series (Quality Protein Maize) and contain more

protein and amino acids as compared to the other maize varieties so it has good market value (NMRP, 2010). However, the maize equivalent yield varied significantly among the intercrops, where significantly higher maize grain equivalent yield was obtained in case of cowpea (6.23) as compared to that of Blackgram (5.01) and Greengram (5.10). This was due to higher yield and market price of cowpea as compared to other intercrops. The non-legume intercrop millet produced least maize grain equivalent yield (4.06). The equivalent yield of Blackgram and Greengram were found at par.

Above findings suggest that, the maize variety has got little but not significant effect on the grain yield of the intercrops. The reduction in grain yield of intercrop was due to significant reduction in number of pods per plant resulting from the increased number of branches without pods and reduced number of seeds per pod which showed that maize depressed intercropped cowpea yield (Agboola and Fayemi, 1971; Haziel, 1974; Francis *et. al.*, 1978; David and Garcia, 1983). However, little high grain yield was achieved in case of intercrops grown in short duration maize variety Arun-2 as compared to that of intercrops grown in medium duration maize variety Manakamana-1 and long duration maize variety Poshilo makai-1. The depression of intercropped cowpea yield in intercrop with cereals has been attributed to the percentage of incoming radiation that reached cowpea due to shedding by tall cereal plants (IITA, 1976). But, the effect of intercrop species on the grain yield was found significant. Higher grain yield was obtained in case of non-legume component millet than in other leguminous intercrops. Also the maize equivalent yield was not found to be significantly affected by maize varieties however among the intercrop, cowpea produced significantly higher maize equivalent yield where millet produced significantly lower equivalent yield.

Table 1: Dynamics of intercrop yield and maize equivalent yield as affected by maize variety and intercrop species in Kavilas VDC, Chitwan during rainy season, 2012

Treatments	Yield of Intercrops (ton/ha)	Maize Equivalent Yield (ton/ha)
Factor A, Maize Varieties		
Arun-2	0.49	4.52
Manakamana-1	0.47	4.82
Posilo Makai-1	0.45	5.97
SEm±	0.13	0.31
LSD	NS	NS
Factor B, Intercrops		
Black gram	0.26	5.01[b]
Green gram	0.27	5.10[b]
Cowpea	0.52	6.23[a]
Millet	0.83	4.06[c]
SEm±		0.14
LSD		0.50
CV %	13.02	17.10

NS- Non significant. Means followed by common letter (s) within column are non – significantly different based on DMRT at P = 0.05. SEm-Standard Error of Mean. CV-Coefficient of Variation

Economic evaluation

Along with the biological suitability cropping system should be economically viable and profitable. So in order to judge the profitability of the intercropping system some of the economic indices are used.

International Journal of Novel Research in Life Sciences
Vol. 1, Issue 1, pp: (1-7), Month: September-October 2014, Available at: www.noveltyjournals.com

Gross return

The mean gross return was found to be 120.03 thousand per hectare ranging from 90.35 thousand to 149.16 thousand per hectare. The treatments varied significantly in context of gross return. Significantly higher gross return was obtained in case of long duration maize variety Poshilo makai-1 (149.16 thousands/ha) as compared to that of short duration variety Arun-2 (90.35 thousands/ha) however the medium duration variety Manakamana-1 (120.59 thousands/ha) was found intermediate between the other two varieties.

Similarly, there was significant effect of intercrops in the gross return from the intercropping system. Intercropping of maize varieties with cowpea showed significantly higher (146.58 thousands/ha) gross return than that of maize varieties with green gram (120.27 thousands/ha), black gram (117.96 thousands/ha) and millet (95.33 thousands/ha). Maize intercropped with black gram and green gram has also significantly higher gross return that that of maize intercropped with millet. The maize intercropped with millet showed the lowest gross return from the combination.

Net return

The maize varieties showed clear and distinct difference regarding the net income from the system. The average net income from the varieties was found to be 73.09 thousands/ha whereas the range lied in between 43.41 thousands/ha to 102.22 thousands/ha. The maize variety Poshilo makai-1(102.22 thousands/ha) was found significantly superior regarding the net return as compared to Arun-2 variety (43.41 thousands/ha). The net return from the variety Manakamana-1 (73.65 thousands/ha) was found to be at par with net return from Poshilo makai-1 (Table 2).

The role of intercrop in determining the net return from the system was also found significant. Clearly, maize intercropped with cowpea (98.08 thousands/ha) emerged as the best intercrop combination with significantly higher net return than that of maize combination with Green gram (71.57 thousands/ha), Black gram (69.56 thousands/ha) and millet (53.18 thousands/ha). The net return from the maize and millet combination was found to be significantly lower (53.18 thousands/ha) as compared to that with other combination.

Above discussion clearly signifies that, the combination of the long duration variety Poshilo makai-1 with cowpea was the best practice during the research. The gross and net return from this combination was higher because of the high yield (0.52 t/ha) and high market price (Rs 100/kg) for cowpea than that of black gram (Rs 95/kg), green gram (Rs110/kg) and millet (Rs 30/kg). Yield of other intercrops black gram (0.26 t/ha), green gram (0.27 t/ha) were found lower than that of cowpea so in spite of good market value they failed to give higher gross and net return. For millet, the production was found higher (0.83 t/ha) but the market value of the product was low resulting into low gross and net return. Both maize variety and intercrops played a crucial role in determination of the gross and net return of the system.

Benefit cost ratio

Mean B:C ratio in the research trail was found to be 1.55 with the range of 0.92 to 2.16. There was significant role of maize varieties in determination of B:C ratio of the system. Clearly Poshilo makai-1(2.16), a long duration maize with yield of 4.72 t/ha gave significantly higher B:C ratio than that of Arun-2 (0.92), a short duration maize with yield of 2.86 t/ha. The B:C ratio from Manakamana-1(1.56), a medium duration maize with yield of 3.52 t/ha was at par with that of Poshilo makai-1 variety of maize. Higher B:C ratio in Poshilo makai-1 variety was achieved due to significantly higher yield of the variety than the other two variety (Table 2).

Similarly, effect of intercrop was also found significant in case of B:C ratio. The maize intercropped with cowpea (2.02) was found significantly higher B:C ratio than that of maize intercropped with Green gram (1.47), Black gram (1.44) and Millet (1.26). B:C ratio of the maize crop intercropped with green gram, black gram and millet was found at par. Higher B:C ratio in case of maize intercropped with cowpea was because of higher yield of cowpea and good market value than that of other intercrops.

In conclusion, it can be stated that the combination of long duration maize Poshilo makai-1 and Cowpea can come out with best B:C ratio than that of other combinations (Figure 2). This combination had higher B:C ratio because of the higher grain yield of maize variety, higher intercrop yield and good market price of the intercrop. Other combination of maize and intercrops generally had B:C ratio lower than 1.5 so they cannot be put forward as a economic combination for the farmers.

International Journal of Novel Research in Life Sciences
Vol. 1, Issue 1, pp: (1-7), Month: September-October 2014, Available at: www.noveltyjournals.com

Table 2: Effect maize varieties and intercrops on gross return, cultivation cost, net return and benefit cost ratio at Kavilas, Chitwan during rainy season 2012

Treatments	Gross Return (Rs'000/ha)	Net Return(Rs'000/ha)	B:C Ratio
Factor A, Maize Varieties			
Arun-2	90.35[b]	43.41[b]	0.92[b]
Manakamana-1	120.59[a]	73.65[a]	1.56[a]
Posilo Makai-1	149.16[a]	102.22[a]	2.16[a]
SEm±	7.38	7.38	0.16
LSD	28.99	28.99	0.61
Factor B, Intercrops			
Blackgram	117.96[b]	69.56[b]	1.44[b]
Greengram	120.27[b]	71.57[b]	1.47[b]
Cowpea	146.58[a]	98.08[a]	2.02[a]
Millet	95.33[c]	53.18[c]	1.26[b]
SEm±	3.58	3.58	0.07
LSD	12.4	12.40	0.25
CV %	17.76	29.17	28.75

NS- non significant, Means followed by common letter (s) within column are non – significantly different based on DMRT at P = 0.05. SEm-Standard Error of Mean. CV-Coefficient of Variation

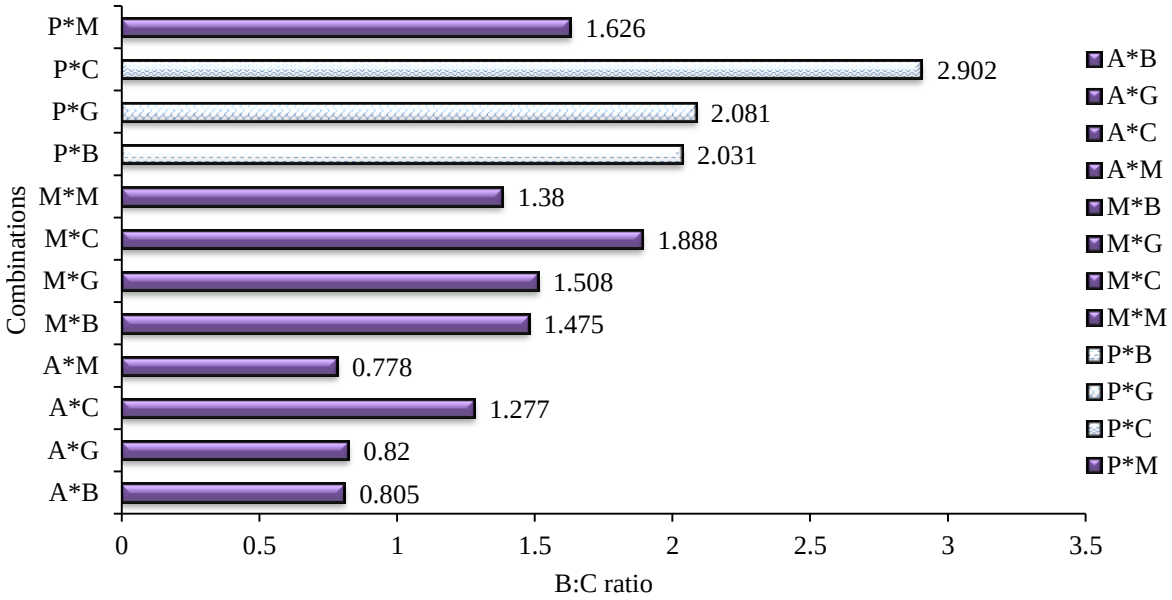

Figure 2: Benefit cost ratio of maize and intercrop combinations in Kavilas, Chitwan, 2012

IV. CONCLUSION

Maize varieties varied significantly on their yield and their combination with intercrops also differed significantly over the profitability of intercropping system. Among the maize varieties, long duration maize varieties were found superior over the mid and short duration variety however the yield of intercrops on various maize varieties were not found significant. Non legume intercrop i.e. Millet produced considerably higher amount of yield as compared to leguminous intercrops. While comparing the maize equivalent yield, the yield was found to be superior in case of leguminous intercrops because of their higher market price. The intercropping system also varied significantly in gross, net return from the system and the Benefit cost ratio where the combination of long duration variety with leguminous intercrop was

found superior over the rest combination. Higher yield of long duration maize variety and higher market value of leguminous intercrop provided the ground for profitability of their intercropping system.

ACKNOWLEDGEMENT

I would like to lay my sincere acknowledge to my advisory committee for their continuous and inspiring support. I would also like to pass on my words of credentials to SMARTS team under SANREM/USAID project for the availability of fund for my research. Also all the helping hands and my family members deserve very special acknowledgement for their endless effort and support during the entire study period.

REFERENCES

[1] Agboola, A.A. and Fayemi, A.A. 1971. Preliminary trails on intercropping of maize with different tropical legumes in western Nigeria. J. Agric. Sci. 77(2): 210-225.

[2] Choudhary, M.K., and E.L. Rosario. 1992. Utilization of efficiency of applied nitrogen as relayed to yield advantage in maize/mung bean intercropping. Field Crop Research 30: 41-51.

[3] Davis, J.H. and S. Garcia. 1983. Competitive ability and growth habit of indeterminate beans and maize for intercropping. Fd. Crops Res. 6: 59-75.

[4] Francis, C.A., F.A. Flow and M. Prager. 1978. Effect of bean association on yield and yield components of maize. Crop Sci. 18: 760-764.

[5] Haziel, K.A. 1974. The agronomic significance of mixed cropping 1. Maize intercropped with cowpea. Ghana, J. Agric. Sci. 7: 169-178.

[6] Heibsh, C.K. and R.E. McCullumn, 1987.Area × time equivalency ratio. A method for evaluating the productivity of intercrop. Agronomy Journal. 79: 15-22.

[7] International Institute of Tropical Agriculture (IITA). 1976. Annual Report, Ibadan, Nigeria.

[8] MoAD. 2012. Krishi Diary. 2012/13. Ministry of Agriculture Development, Nepal.

[9] NMRP. 2010. Introduction about the varieties of maize. Leaflets. National Maize Research Program Rampur.

[10] Tarhalkar, P.P. and N.G.P. Rao. 1975. Changing concepts and practices of cropping systems. Indian Farming 25: 3-15.

[11] Vorasoot, N., A. Patanothai, K. Wougpichet, A. Chintavate and K. Boontop. 1976. Crop production and cropping systems for sorghum. In Thailand National corn and sorghum program, 1976 Annual Report, Kasetsart University, Thailand.

[12] Wahua, T.A.T and D.A. Miller. 1978. Relative yield totals and yield components of intercropped sorghum and soybeans. Agron. J. 70: 287-291.

[13] Yamaguchi. J. 1973. Varietal traits limiting the grain yield of tropical maize 4. Plant traits and productivity of tropical varieties, Soil Science and Plant Nutrition 20 (3): 287-304.