Conclusions
VI CONCLUSION

Enormous increasing demand for food in most of the countries is due to its fast growing population. Cost-benefit ratio for bringing new land under cultivation is smaller than that of increasing production of already cultivated land. Increase of food production in the available cultivated land is depending upon the maintenance of the soil health.

Continuously growing of a same crop over years in the same cultivated area leads to ill health of the soil and increase in various pest and diseases, which, causes decline in food productivity.

From the reported records it could be noticed that, maize cultivation area has been increased to an extent of 32.5 per cent, where as its increase in production is not appreciable i.e., to the extent of 4.2 per cent. This slow increase in production is might be due to continuous growth of the same crop.

To overcome the problem of ill health one can use alternate methods like intercropping, relay cropping, mixed cropping and so on. Many researchers have indicated that sole (say maize) crop will be problematic in the long run, further they have advocated going for intercropping which are beneficial, preferably by having legume as component crop.

Cereal-legume intercropping plays an important role in food production, especially in situations of limited water resources. Intercropping improves the utilization of available resources and cause yield advantages and increases yield stability. Yield advantages occur when intercrop components compete only partly for the same plant growth resources.
Existing intercropping pattern, mainly with red gram or field bean are not confirming with the plant population. Green gram and black gram are short duration crops (maximum of 70-75 days) where as maize is 120-130 days crop. Initially both are sown at the same date with defined row ratio. Pulses such as green gram or black gram will come for harvest by the time maize will come to flowering stage, till that time maize consumption for its nutrition was limited. After certain period nutrition requirement by maize will be more and waste materials of pulses remains can become manure for maize.

Since no information is available on recommendable row ratio of intercropping with proper weed control technology in the Bhadra command area of Karnataka, the study of Statistical and Economic evaluation of intercropping of maize with urd bean- a study in Bhadra command area of Karnataka is attempted to assess the influence of different row ratio of intercropping along with effectiveness of weed control methods on significance in yield, economically advantageous, well performing, adaptable and dominant crop of the intercropping system.

With the intention for evaluating the intercropping row ratio, present investigation has been proposed with the following objectives.

1. To study statistically and economically optimum/viable row ratio of the maize-urdbean intercropping in Bhadra command area of Karnataka
2. To study association of yield attributing parameters with the yield under different row ratios of intercropping
3. To evaluate the energy use efficiency under different row ratio
4. To evaluate sustainability of the intercropping
5. Statistical and economic evaluation of crop weed interaction
Normally, non statistician will conclude about the technology without in depth of statistical analysis of the data. In this study an attempt has been made by subjecting the data to preliminary test such as normality and test of homogeneity before application of the suitable statistical analysis.

Evaluation of intercropping data is not complete without a comparison between the performances of the intercrops to that of the component sole crop. This has been made by using various biological or economic or statistical indices such as Analysis of variance (ANOVA), Cost benefit ratio (B:C ratio ), Land equivalent ratio (LER), Area time equivalent ratio (ATER), Energy equivalent ratio, Crop performance ratio (CPR), period based crop performance ratio, Correlation analysis, Response surface methodology (RSM), Stability and Sustainability analysis etc.

Three year data generated during kharif seasons of 2003 to 2005 under rain fed situation at Agricultural Research Station, Kathalagere under the jurisdiction of the University of Agricultural Sciences, Bengalooru has been considered. Designed five objectives have been evaluated to identify suitable geometry of intercrop of Maize and Urdbean which can provide maximum productivity and to ascertain appropriate weed control measure which could minimize weed by giving optimum productivity.

**Evaluation of the Objective 1** “To study statistically and economically optimum/viable row ratio of the maize-urdbean intercropping in Bhadra command area of Karnataka” has been done using statistical analysis/ economical/biological indices. Based on the results following inferences have been drawn.
a. **Analysis of variance** revealed that, productivity is significantly superior in the combination of intercropping row ratios with integrated weed control treatment of Alachlor @ 1.5kg/ha + *Hand weeding at 40 DAS*. The productivity is particularly more in the paired row of maize with two rows of urdbean (80.30 q/ha) in combination with Alachlor @ 1.5kg/ha + *Hand weeding at 40 DAS*. This higher productivity is found to be significantly superior over the productivity of the remaining combinations.

b. Intercropping are more remunerative compared to sole maize. Among the intercropping treatments paired row of maize with two row of urd bean (2:2) has provided higher gross return of Rs36347.14/ha, net returns of Rs.24219.59/ha and **Cost benefit ratio** B: C ratio of 1.987 (for one rupee investment 1.987 rupees in the return) indicating superiority of having wider ratio of intercropping. It implies that farming community can have better monetary returns by having the intercropping of 2:2 row ratio compared to other intercropping and sole maize. This row ratio is economically viable and intercropping are economically advantageous.

c. Paired row of maize with two rows of maize (2:2) recorded higher value of **land equivalent ratio** (1.545). Its (2:2 intercropping row ratio) superiority has been of reflected by recording highest productivity (maize equivalent yield) of 69.848 q/ha, it could be inferred that, Paired row of maize with two rows of urd bean (2:2) realized significantly superior productivity with optimum and efficient utilization of natural resources such as radiant energy, available moisture, water, air and so on.

d. Highest **Area time equivalent ratio** value of 1.355 realized for the intercropping treatment of maize and urd bean (2:2) intercropping
are more productive with the utilization of the natural resources. Among the intercropping row ratios, Paired row of maize with two rows of maize (2:2) realized more productivity with its optimum utilization of natural resources such as solar radiant, available moisture, water, air and so on. Maize equivalent yield realized is 69.85 q/ha in 2:2 row ratio which is significantly superior compared to other row ratios.

e. Highest crop performance ratio value of 1.950 is recorded for the intercropping treatment of maize and urd bean (2:2) compared to other row ratios. This indicated that among the different intercropping row ratios evaluated for the performance, paired row of maize with two rows (2:2) is noticed to be performing well. Same row ratio intercropping crop performance is reflects with significantly higher values for MEY, B: C ratio, LER and ATER. Similar inferences can be drawn for the evaluation of intercropping using period based crop performance ratio which as considered duration of the crop also.

f. Dominance of the main crop (maize) in the intercropping of maize against urd bean can be realized from the aggressivity results. This hints that it has a greater ability to produce as compared to component crop (urd bean).

**Evaluation of the objective 2** “To study association of yield attributing parameters with the yield under different row ratios of intercropping” has been done by having the suitable methodologies of Correlation analysis and Response surface analysis. Based on the results following inferences have been drawn.

a. Hand weeding at 25 days after sowing, chemical weeding by Alachlor @ 2 kg/ha and integrated weed control practice of
Alachlor @ 1.5kg/ha + hand weeding at 40 days after sowing minimized the weeds to a greater extent, providing of wider row ratio and remains of the companion crop (Urd bean) after its harvest caused for substantial increase in values of yield and its attributing characters compared to sole crop. This helps in having better positive relation (table 4.2.2) of maize yield with more of its attributing characters in the intercropping row ratios. Weed control treatment of 2:2 exhibited positive correlation of yield with all the yield attributing characters. This may be due to wider row spacing provided in that row ratio intercropping.

b. Responses realized by the quadratic polynomial are near to the observed yield. This is confirmed by the $R^2 (0.989)$. From the results of the response surface methodology it could be observed that quadratic polynomial found to be the most appropriate fit and the fitted model revealed optimum productivity in the 2:2 row ratio of intercropping.

**Evaluation of the objective 3** “To evaluate the energy use efficiency under different row ratio” has been made using the energy use efficiency. Based on the results following inferences have been drawn.

a. Increasing of the energy-use efficiency in the agricultural sector will become more vital in the future, as producers attempt to increase their output without increasing the size of their crop land. Row ratio of 2:2 and 2:1 noticed more energy use efficient than others, it is due to lesser inputs used in case of these treatments. The results indicated that, because of the available natural resources usage of the input components is less for the maximum output. This has resulted in higher productivity realized in them.
Evaluation of the objective 4 “To evaluate sustainability of the intercropping” has been attempted by Stability analysis and Yield Sustainability index. Based on the results following inferences have been drawn.

a. Normally analysis of variance will be performed to identify a significant treatment. When the data is generated over years, analysis of variance may not provide justifiable conclusion about a treatment tried over years. Results using stability analysis revealed that the intercrop treatments consisting of maize-urdbean (1:1) and maize-urdbean(2:2) has regression coefficient (b_i) not significantly deviating from unity and has mean yield greater than population mean yield. This indicated that these two are well adapted to all environments (all periods).

b. System of agriculture will not be sustainable unless the productivity and quality of the soil are continuously maintained. One of the practices to enhance the soil productivity is to have intercropping with legumes. Paired row of maize with two rows of Urd bean (2:2) is more sustainable since it has recorded higher SYI values compared to other sole/intercropping treatments. This sustainability has been reflected productivity of 69.85 q/ha. The sustainability of the treatment has been noticed in the consistent increase performance in all the year of experimentation. Sustainability in productivity may be due to the growing of legume crop as a component of the intercropping. This indicated minimum guaranteed yield.

Evaluation of the objective 5 “Statistical and economic evaluation of crop weed interaction” has been attempted by considering some of the suitable tools which are used in the evaluation of
intercropping in objective 1 to 4. Based on the results following inferences have been drawn.

a. Combination of the integrated weed control practice with 2:2 intercropping row ratio has realized higher productivity of 80.30 q/ha (table 4.1.4) which is superior over rest of the combinations. This indicated that, integrated weed management with Alachlor @ 1.5kg/ha + Hand weeding at 40 DAS is more beneficial compare to the rest of the practices imposed.

b. Wider row intercropping tried with the combination of chemical or integrated weed control practices are economically feasible as perceived by the B : C ratio ( 2.070 and 1.705 B: C ratio : table 4.5.2).

c. Combination of Hand weeding at 25 DAS, Alachlor @2kg/ha and Alachlor @ 1.5kg/ha + Hand weeding at 40.DAS with the intercropping treatments of Maize and Urd bean (2:1) and Maize and Urd bean (2:2) recorded higher LER values

d. Second degree polynomial has higher $R^2$ of 0.962 compare to 0.796 of linear and is found to be significant, it has been considered as the appropriate polynomial to estimate the optimum responses for the different treatments.

Based on the results of the above findings and abstract of each objective findings it can be concluded that, Paired row of maize with two rows of urdbean in combination with integrated weed control treatment of Alachlor @ 1.5kg/ha + Hand weeding at 40 DAS is statistically significant, economically viable, effectively natural resources utilizing and well performing combination. Maize crop which is main crop in the
system has noticed to be dominant in the system: in the sense that it has the capacity to provide higher productivity.

Presence of the remains of companion crop (urd bean) caused for the better values for the yield attributing characters of maze. These have significant influence (correlation) for the increase in productivity of maize crop in the intercrop. This is noticed to be more in Paired row of maize with two rows of urdbean in combination with integrated weed control treatment of Alachlor @ 1.5kg/ha + Hand weeding at 40.DAS.

The high productivity realized by the Paired row of maize with two rows of urdbean has been confirmed by the appropriate quadratic polynomial. Similarly, high productivity realized by having integrated weed control treatment of Alachlor @ 1.5kg/ha + Hand weeding at 40.DAS is confirmed by the appropriate quadratic polynomial.

Paired row of maize with two rows of urdbean can said to be best intercropping ratio which could provide higher energy use efficiency: in the sense that, it will provide higher productivity by having minimum input (in put energy). This is possible only by having the legume (black gram) as an intercrop, since remains of legume after harvest become manure to the main crop (maize). This has caused least usage of fertilizer.

Paired row of maize with two rows of urdbean intercropping system as been identified has an intercropping system which can be cultivated in any period. In the sense it will provide stable productivity in all years. Further it is identified as the system which can give minimum guaranteed yield over years.