5. SUMMARY AND CONCLUSIONS

A field investigation entitled, “Effect of integrated nutrient management on productivity, profitability and seed quality in okra-pea cropping system” was carried out at the Experimental Farm of Department of Seed Science and Technology, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur during kharif, 2012 to rabi, 2013-14. The experiment was conducted with the following objectives:

i. To study the effect of integrated nutrient management on growth, development, seed yield and quality in okra and pea

ii. to study the residual effect of nutrients applied through organics and chemical fertilizers in okra-pea crop, and

iii. to work out the overall economics of treatments in okra-pea cropping system

Experiment consisted of seven integrated nitrogen treatments in okra viz. 25% nitrogen through FYM + 75% nitrogen through fertilizer; 25% nitrogen through fortified vermicompost + 75% nitrogen through fertilizer; 25% nitrogen through vermicompost + 75% nitrogen through fertilizer; 50% nitrogen through FYM + 50% nitrogen through fertilizer; 50% nitrogen through fortified vermicompost + 50% nitrogen through fertilizer; 50% nitrogen through vermicompost + 50% nitrogen through fertilizer and recommended dose of fertilizer. These seven treatments were tested in randomized block design with 3 replications in kharif and three treatments viz; 50% recommended dose of fertilizer, 75% recommended dose of fertilizer and 100% recommended dose of fertilizer constituting 21 treatment combinations, in following pea crop in rabi were evaluated in split plot design with 3 replications.

The salient findings emerged from the field as well as laboratory studies have been summarized in this chapter as here under:
Okra

i) Organic and inorganic sources of nutrients in combination could not exhibit any significant effect on days taken to emergence during the years 2012 and 2013, respectively. Use of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) combination recorded significantly higher number of plants and were found significantly at par with the treatment 50% N applied through vermicompost + 50% N through fertilizer (M₆) combination and minimum number of plants were recorded in RDF (M₇) during both the years.

ii) Application of 50% N through fortified vermicompost + 50% N through fertilizer in combination remaining at par with 50% N through vermicompost + 50% N through fertilizer at 60, 90 DAS and at harvest during 2012, produced significantly taller plants over other treatments. During 2013, application of 50% N through vermicompost + 50% N through fertilizer (M₆) at 60 and 90 DAS produced significantly taller plants and were found statistically similar with the treatment 50% N through fortified vermicompost + 50% N through inorganic fertilizer (M₅).

iii) Dry matter accumulation was significantly observed highest with the combined application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) remaining at par with 50% N through vermicompost + 50% N through fertilizer (M₆) during both the years of experimentation.

iv) The combined application of organic and inorganic sources of nutrients did not influence the number of days taken to 50% flowering during both the years. However, application of treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) resulted in attaining significantly more number of days to 50% capsule formation and 80% maturity and were observed significantly at par with M₆ treatment (50% N through vermicompost + 50% N through fertilizer) during both the years.

v) The combined application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) produced significantly higher plant population per unit
area compared to control plots during both the years, remaining at par with 50% N through vermicompost + 50% N through fertilizer (M₆) in 2013 followed by combined application of 50% N through FYM + 50% N (M₄) through fertilizer. Significantly, lower plant population was found in control treatment (M₇) receiving recommended dose of fertilizers only.

vi) Significantly highest number of capsules per plant and seeds per capsule were found with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅). The 1000 seed weight of okra was not influenced significantly with different treatments during both the years.

vii) Application of 50% N through vermicompost + 50% N through fertilizer (M₆) recorded significantly higher capsule length of okra during 2012 and was found statistically alike to M₅, M₂ and M₁ whereas during 2013, significantly higher capsule length was recorded with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) and was statistically similar to M₆ treatment.

viii) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) resulted in significantly higher shelling percentage of okra and was found at par with application of 50% N through vermicompost + 50% N through fertilizer (M₆) during 2012 only whereas M₇ i.e. RDF was the inferior most treatment in this regard.

ix) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) remaining at par with 50% N through vermicompost + 50% N through fertilizer (M₆) resulted in significantly higher seed yield during both the years, 2012 and 2013. There was an increase of 213.8 kg and 268.5 kg ha⁻¹ seed due to application of treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) over control treatment during 2012 and 2013, respectively. The magnitude of increase in the seed yield due to this treatment was to the tune of 30.8 % during 2012 and 36.1 % during 2013. The straw yield of okra was produced significantly highest due to the application of treatment M₆ (50% N through vermicompost + 50% N through fertilizer) followed by treatment (M₃) during 2012 and application of treatment M₅ (50%
N through fortified vermicompost + 50% N through fertilizer) followed by treatment (M₆) during 2013.

x) M₅ (50% N through fortified vermicompost + 50% N through fertilizer) being statistically at par with treatment M₆ resulted in significantly higher harvest index during 2012. During 2013, application of treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) resulted in significantly higher harvest index followed by treatment M₆ (50% N through vermicompost + 50% N through fertilizer) during both the years.

xi) The treatment, M₅ (50% N through fortified vermicompost + 50% N through fertilizer) resulted in significantly higher N, P and K uptake in okra followed by application of treatment M₆ (50% N through vermicompost + 50% N through fertilizer).

xii) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) recorded significantly highest soil pH, organic carbon, available N, P and K in soil over rest of the treatment combinations during both the years.

xiii) Micronutrient cations viz. Fe, Mn, Zn and Cu were recorded significantly higher with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) over rest of the treatment combinations. RDF (M₇) was rated as inferior most in respect of available micronutrient cations compared to rest of the treatment combinations during both the years.

xiv) Gross returns, net returns and net returns per rupee invested were found highest with the combined application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) and were statistically similar to application of 50% N through vermicompost + 50% N through fertilizer (M₆) during both the years and minimum gross returns, net returns and net return per rupee invested were recorded in RDF treatment.

xv) Germination percentage of okra during 2012 was not significantly influenced by all the treatment combinations but during 2013, application of 50% N
through fortified vermicompost + 50% N through fertilizer (M₅) recorded significantly highest germination percentage over rest of the treatments.

xvi) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) recorded significantly higher shoot and root length followed by application of 50% N through vermicompost + 50% N through fertilizer (M₆) during 2012. Significantly lower shoot and root length was found in plots with RDF (M₇) during both the years.

xvii) Seedling dry weight of okra was recorded significantly higher with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) closely followed by application of 50% N through vermicompost + 50% N through fertilizer (M₆) and lowest seedling dry weight was observed in treatment applied with RDF (M₇) during both the years.

xviii) The lowest electrical conductivity was recorded with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) followed by 50% N through vermicompost + 50% N through fertilizer (M₆) and significantly highest electrical conductivity was found with the application of recommended dose of fertilizers (M₇) during both the years of experimentation.

xix) Higher vigour index and field emergence was recorded with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) followed by 50% N through vermicompost + 50% N through fertilizer (M₆) treatment and significantly lower vigour index and field emergence was registered with recommended dose of fertilizers (M₇) during both the years of experimentation.

Peas (Residual effects)

i) There was no significant difference between the treatments applied in okra on days taken to emergence in peas during both the years of experimentation.

ii) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) remaining at par with the treatment 50% N through
vermicompost + 50% N through fertilizer (M₆) recorded significantly higher number of plants as compared to other treatments. The minimum number of plants were recorded with recommended dose of fertilizers (M₇) during both the years.

iii) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) in combination and treatment 50% N through vermicompost + 50% N through fertilizer (M₆) produced significantly taller plants at all the stages of observation during both the years.

iv) Dry matter accumulation in pea was found significantly higher with the combined application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) followed by 50% N through vermicompost + 50% N through fertilizer (M₆), M₄, M₂, M₃ and M₁ at all the crop growth stages during both the years.

v) The residual effect of organic and inorganic sources in combination did not influence the number of days taken to 50% flowering during both the years of experimentation.

vi) The data revealed that M₄ treatment (50% N through fortified vermicompost + 50% N through fertilizer) took significantly more number of days to 50% pod formation over treatment M₄ and M₂ during 2012-13 and over treatment M₄ and M₃ during 2013-14, respectively.

vii) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) took significantly more number of days to 80% maturity over M₆, M₄, M₂, M₃ and M₁ during both the years of experimentation.

viii) Number of nodules, fresh weight and their dry weight was noticed significantly higher with the application of treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) followed by treatment M₆, M₄, M₂, M₃ and M₁ during both the years 2012-13 and 2013-14, respectively.

ix) Treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) remaining at par with M₆, M₄, M₃ during 2012-13 and M₅ during
2013-14, respectively produced significantly higher plant population per unit area as compared to other treatments.

**x)** Significantly highest number of pods per plant and seeds per pod were registered with the application of M₅ treatment as compared to other treatments. The minimum number of pods per plant and number of seeds per pod were recorded with M₇ treatment.

**xi)** The residual effect of M₅ treatment applied in okra produced significantly higher weight per pod and 100 seed weight of pea during both the years. M₇ (RDF) treatment recorded significantly lower weight per pod as well as 1000 seed weight during both the years.

**xii)** Application of treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) resulted in significantly higher seed yield of peas followed by application of treatment M₆ (50% N through vermicompost + 50% N through fertilizer) and M₆ (50% N through FYM + 50% N through fertilizer) during both the years of experimentation. The increase in seed yield recorded to the tune of 36.9% during 2012-13 and 39.5% during 2013-14 over RDF, respectively.

**xiii)** The straw yield of peas was also recorded significantly highest due to the residual effect of treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) followed by treatments M₆ and M₂.

**xiv)** The harvest index was also significantly highest with the treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) followed by M₆ and significantly lower harvest index was recorded with (M₇) treatment during both the years.

**xv)** Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) remaining at par with M₆ resulted in significantly higher shelling percentage and protein content of peas during both the years except for shelling percentage during 2013-14.
N, P and K uptake in pea was observed significantly higher with treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) which was closely followed by the application of treatment M₆ during both the years. The control plots (RDF) removed significantly lower N, P and K.

Soil pH was found highest with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) over rest of the treatment combinations. Significantly lower pH was recorded with application of recommended dose of fertilizers (M₇) during both the years of study.

Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) remaining statistically at par with M₆, M₄ and M₃ treatments recorded significantly highest organic carbon content during both the years of experimentation.

Available N, P and K in soil was recorded significantly higher with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) over rest of the treatment combinations during both the years.

During 2012-13 and 2013-14, treatment M₅ remaining at par M₆ recorded significantly higher available micronutrient cations (Fe, Mn, Zn and Cu) over rest of the treatment combinations. Similar results were obtained with respect to soil microbial population (bacteria, actinomycetes, Azotobacter and PSB).

Significantly higher gross returns, net returns and net returns per rupee invested were obtained from the crop sown with treatment M₅ (50% N through fortified vermicompost + 50% N through fertilizer) followed by treatment M₆ and significantly lower gross, net returns and net returns per rupee invested were obtained with the application of treatment M₇ (RDF) during both the years.

Among the treatment combinations, application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅) resulted in significantly higher germination percentage followed by M₄ and M₆ and these treatments were significantly at par with each other during both the years. Significantly lower
germination percentage was found with RDF (M₇) treatment during 2012-13 and 25% N through FYM + 75% N through fertilizer (M₁) during 2013-14 as compared to other treatment combinations.

xxiii) Application of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) recorded significantly higher shoot and root length, seedling dry weight and vigour index followed by application of 50% N through vermicompost + 50% N through fertilizer (M₆) during both the years except for root length being recorded highest in M₆ treatment.

xxiv) The lowest electrical conductivity was recorded with the application of 50% N through fortified vermicompost + 50% N through fertilizer (M₃) followed by M₆ treatment and significantly highest electrical conductivity was found with the application of recommended dose of fertilizers (M₇) during both the years.

Peas (Direct effects)

i) Different fertility treatments could not exhibit any significant influence on days taken to emergence during both the years 2012-13 and 2013-14, respectively. Significantly higher plant stand was recorded with 100% RDF over 75% and 50% RDF during both the years of experimentation.

ii) Plant height was consistently and significantly increased with increasing fertilizer levels from 50 to 100% RDF at all the stages of crop growth and at harvest during both the years.

iii) Dry matter accumulation was recorded significantly highest with 100% RDF at all the crop growth stages followed by 75% RDF and significantly lowest dry matter yield was found with 50% RDF during 2012-13 and 2013-14, respectively.

iv) Different fertility levels applied to peas did not influence the number of days taken to 50% flowering during both the years whereas application of 100% RDF to peas resulted in maximum days taken to 50% pod formation stage and 80% maturity followed by 75% RDF and 50% RDF during both the years.
v) Number of nodules, fresh weight and their dry weight increased consistently and significantly with increase in fertility levels from 50 to 100 per cent application and significantly highest nodule number, fresh weight and dry weight was recorded with application of 100% RDF.

vi) There was no significant influence of treatments applied in peas on final plant stand during 2012-13 whereas during 2013-14, application of 100% RDF produced significantly higher number of plants over 75% RDF and lower plant stand was recorded with 50% RDF.

vii) Application of RDF increased the number of pods per plant, number of seeds per pod, weight per pod and 1000 seed weight significantly which further increased successively and significantly with the increasing level of fertilizer N up to 100% RDF. However, 100% RDF (F3) was found at par with 75% RDF (F2) in influencing number of seeds per pod in 2013-14.

viii) Application of 100% RDF remaining at par with 75% RDF recorded higher shelling percentage of peas during both the years. Similar was the trend in respect of protein content.

ix) Application of recommended dose of fertilizers (100% RDF) resulted in significantly highest seed yield followed by 75% RDF during both the years of experimentation. Increase in grain yield due to 100 % RDF and 75% RDF was 8.93% and 6.14% over 50% RDF during 2012-13 and 8.98% and 4.78% during 2013-14, respectively.

x) Application of recommended dose of fertilizers (100 % RDF) resulted in significantly highest straw yield and harvest index of peas followed by 75% RDF and significantly lowest straw yield and harvest index was registered with 50% RDF.

xi) Application of recommended dose of fertilizer (100% RDF) resulted in significantly higher N, P and K uptake followed by 75% RDF and significantly lower N, P and K uptake was recorded with application of 50% RDF during both the years of experimentation.
xii) Recommended dose of fertilizers (100% RDF) resulted in significantly higher pH, organic carbon (%) and available N, P, K followed by 75% RDF and significantly lower values were recorded with 50% RDF during both the years.

xiii) Significantly higher Fe, Mn, Zn and Cu content in soil was recorded with 100% RDF and compared to other fertility levels.

xiv) Recommended dose of fertilizers (100% RDF) resulted in significantly higher soil microbial population (bacteria, actinomycetes, *Azotobacter* and PSB) in soil followed by 75% RDF and significantly lower microbial population with 50% RDF.

xv) Significantly higher gross and net returns were recorded with the application of 100% RDF followed by 75% RDF and significantly lower gross and net returns were recorded with 50% RDF during 2012-13 and 2013-14.

xvi) Significantly higher germination percentage, shoot length, root length and seedling dry weight of peas was recorded significantly higher with 100% RDF followed by 75% RDF and significantly lower values were recorded with application of 50% RDF during both the years of experimentation.

xvii) Significantly lower electrical conductivity during both the years was recorded with 100% RDF than 75% RDF whereas significantly higher electrical conductivity was found with the application of 50% RDF.

xviii) Application of 100% fertility level to peas resulted in significantly higher seedling vigour index and field emergence of peas followed by 75% RDF during both the years of experimentation.

**Cropping system studies**

Significantly, higher okra equivalent yield, gross returns, net returns and net returns per rupee invested per annum per ha were obtained with the combined application of 50% N through fortified vermicompost + 50% N through fertilizer (M₅ treatment) followed by treatment M₆ (50% N through vermicompost + 50% N through fertilizer).