Introduction
I INTRODUCTION

Modern agriculture, no doubt, has paved the way for “Green Revolution”, but it has been achieved mainly with the application of chemical fertilizers and pesticides to high yielding varieties with the sole objective of maximizing the yield. India has made indiscriminate consumption of fertilizers during the last four decades. However, during the last few years in many parts of the country, the yield potentials of many crops are either stagnating or declining. The fertilizer application as in the past is not bringing forth the desired output. As a result, the growth rate in agriculture does not seem to be keeping pace with the requirement vis-à-vis growth in population.

Moreover, the imbalanced and inadequate use of chemical fertilizers in intensive cropping systems is the main cause for stagnation in productivity, insecurity in food and environmental hazards. These problems became a big challenge to the scientific community and this necessitating for new research agenda. The fertilizer usage mostly depends on its availability, cost, subsidy and is rarely decided by local recommendations. The current NPK fertilizer consumption ratio is 10:2.9:1 as against optimal ratio of 4:2:1. This imbalance in nutrient application by farming community resulted in emergence of multi-nutrient deficiencies and their management at the farm level is a real challenge at present and in future, the neglected nutrient deficiencies would only aggravate the situation by jeopardizing the productivity as well as sustainability.

The NPK recommendations being advocated to farmers and included in the package of practice were developed over 40 years ago by the scientists of agricultural universities in collaboration with ICAR institutions and development departments. These recommendations may
not be relevant in the present day context as there is appreciable decline in the organic matter level and fertility of soils all over the country. The present farming condition warrants the need for revalidation of the package of practice recommendations for different crops. So several fertilizer recommendation approaches have been used based on soil test to tackle above mentioned problems with respect to fertilizer application and to attain maximum yield per unit of fertilizer use. However, these fertilizer recommendations are not well suited when the cropping systems followed in different places and different soils are considered. In order to overcome these, system based nutrient management approach is more appropriate for managing the nutrient needs of different crops in intensive production systems and to reduce nutrient wastages, besides preventing environmental pollution. For such precision management of nutrients as required by crops in different cropping sequence based on soil test provides the strategy for nutrient management considering the soil chemical and biological properties.

The Site specific nutrient management (SSNM) approach involves three steps. The first step is to establish an attainable yield target, which is location and season specific depending upon climate, cultivar and crop management. The yield target reflects the total amount of nutrients that must be taken up by the crop to produce unit quantity of economic produce. The second step is to ensure effective use of native nutrients from soil and application from external sources. The third step is to apply fertilizer to fill the deficit between crop needs and indigenous supply and to maintain soil fertility. In case of soil test crop response (STCR), required amount of fertilizers are added based on soil test and crop response to achieve targeted yield.

Maize is an important cereal crop of India, stands 3rd in area and production after rice and wheat. Currently it is cultivated over an area of
8.49 m. ha with a production of 21.28 million tonnes. The productivity in India is much lower (2.51 t ha\(^{-1}\)) than world average productivity of 4.34 t ha\(^{-1}\) (Anon., 2011). In Karnataka, maize is grown over an area of 1.2 m. ha with a production of 3.6 million tonnes and productivity of 3.0 t ha\(^{-1}\) (Anon., 2011). Maize is called “Queen of cereals” because of its productive potential compared to any other cereal crop. Being an exhaustive crop, it has very high nutrient requirement and its productivity depends closely on nutrient management. During the last ten years, the area under maize in Karnataka has increased by 41 per cent.

In the agricultural economy of India, oilseeds are important next only to food grains in terms of area, production and value. The per capita consumption of vegetable oil has increased from 3 kg per year in 1950 to 14.2 kg per year during 2010. Increase in per capita income pushes the demand for oil significantly. However, oilseeds in India have a low profile in productivity. Intensive agriculture without any matching replenishment of nutrients has left the soils in a poor status in respect of carbon, major nutrients and micronutrients like zinc and boron. Oilseed crops responses have been so far considered as directly related to deficiency or sufficiency status of these nutrients in the soils and on corrective doses supplied to them. The Indian soils are depleted of organic matter and there is an urgent need for higher use of balanced fertilizers (Anon., 2012).

Among the oilseed crops, groundnut (Arachis hypogaea L.) is an important crop commonly called as poor man’s almond. It is the world’s fourth most important source of edible oil and third most important source of vegetable protein. Groundnut occupies an area of 20.9 million hectares in the world with a total production of 35.4 million tonnes. India occupies the first place in acreage but stands second in production with
cultivated area under 6 m ha with production of 5.5 million tonnes. Gujarat, Andhra Pradesh, Tamilnadu and Karnataka are the leading producers and contribute about 70 per cent of the area and account for 75 per cent of the total production (Anon., 2011).

Sunflower (*Helianthus annus* L.) is one of the important annual vegetable oil seed crops and its oil is generally considered as premium oil because of its light colour and high level of unsaturated fatty acids which is good for health. Sunflower is also a crop of choice for farmers due to its wider adaptability, high yield potential, shorter duration and profitability. However, area in sunflower has declined in recent years. In India, sunflower crop is cultivated in an area of 0.9 m. ha with total annual production of 0.63 million tonnes and productivity of 696 kg ha\(^{-1}\). Karnataka is called as sunflower state by having largest share in area (53%). While its productivity in the state is as low as 391 kg ha\(^{-1}\) (Anon., 2011). One of the reasons for its low productivity in Karnataka is non-adoption of scientific management practices in respect of nutrient application (Anon., 2012).

At present in Eastern Dry Zone of Karnataka, maize-maize and maize-sunflower sequential cropping systems are gaining importance as dominant cropping systems under both rainfed and irrigated situations by replacing groundnut and finger millet based cropping systems because of profitability and demand in the market. Since both maize and sunflower crops are exhaustive crops, maintaining of both crop and soil productivity is one of the crucial factors for attaining higher yield. Keeping all these aspects in view, the work reported herein forms a part of the collaborative RKVY project on “System based nutrient management for maize and groundnut cropping sequences” with the following objectives,
1. To study the effect of system based nutrient management practices on the productivity of maize, sunflower and groundnut.

2. To study the soil chemical and biological changes due to system based nutrient management in maize and groundnut based cropping sequences.

3. To work out nutrient balance sheet in different cropping sequences.

4. To work out economics for system based nutrient management practices over recommended levels of fertilizer in maize and groundnut based cropping sequences.