CHAPTER-I

INTRODUCTION

India nurtures 16 percent of world’s human population with 2.5 per cent of the geographical area. Though the country could produce a record yield of 230 million tonnes of food grain in the agricultural year 2009-10, the target is fixed around 264 million tonnes by 2030 AD to feed a burgeoning population of 1.37 billion. This stupendous task has to be accomplished with shrinking natural resource base of land and water.

In many developing countries with increasing population pressure, the scope for expansion of cultivable area is limited. Moreover, there is a growing competition for land from non-agricultural sectors like industrialization and rapid urbanization Buringh (1982) estimated that approximately 25 million hectares of agricultural land worldwide is lost annually because of rapid increase of non agricultural use. The per capita availability of land in India is 0.14 hectare at present which is likely to go down to 0.09 hectare by 2030. Thus, increase in agricultural production must be achieved through ensuring higher productivity from each hectare of land by increasing cropping intensity and inclusion of high yielding as well as high value cash crops.

Important considerations for developing sustainable cropping systems depend upon several factors like soil, climate, available technologies, irrigation facilities, socio economic constraints of the farm community, infrastructure facility, food habit and market demand and thus, needs to be suitably maneuvered.

Rice (Oryza sativa) is the staple food crop of 63 to 65 percent people of India. The crop at present is grown in 43 million hectares of land with production of 96.7 million tonnes, which contributes to 41 percent to the
national food basket (Economic Survey, 2009-10). But its production has to be raised to 130 million tonnes by 2015 and further to 160 million tonnes by 2030 with a minimum annual growth rate of 2.35 percent (Venkatramani, 2005). Eastern India only occupies about 43 percent of country’s rice area. Evidently rice is synonymous with life of the people of Eastern India and any system without rice will not be accepted by the farmers. Therefore, though upland rice is subjected to vagaries of nature, ‘thriving with rice’ concept as given by Nguyen et al. (1994) is highly appropriate for eastern states of the country.

In Eastern India uplands predominate the plateau regions of Chhotanagpur and the higher slopes of Orissa and Assam (Singh and Palsingh, 1991). In Orissa 44.54 lakh hectares area is under rice out of which 37 % land is irrigated where rabi rice, pulses and vegetables are taken up during winter season after harvest of kharif rice. These irrigated tracts offer ample opportunity to harness desired production and productivity through inclusion of winter vegetables and other high value cash crops with better agronomic manipulation.

Potato (*Solanum tuberosum*) which is one of the most important vegetable crop of India is grown in an area of 1.6 million hectares with 28.5 million tonnes of production (Economic Survey, 2009-10). It is the most preferred vegetable of the people all over the state but the area (7.32’000 hectares), production (75.58 thousand tonnes) and productivity (10.3 t/ha) is very low as compared to the national level and thus can be successfully taken up as winter crop after harvest of *kharif* rice in the irrigated medium lands of the state.

Potato being a fast growing, short duration winter crop is very flexible to fit into different multiple cropping systems. Several profitable multiple cropping systems based on potato have been identified for different regions. The cropping systems have improved fertilizer economy, increased cropping intensity from 200 to 400, improved the maintenance of soil fertility and
reduced the incidence of disease and pests (Kumar and Sharma, 1999). Among them some of the potato based crop rotations for Eastern Gangetic plains (eastern U.P, Bihar, West Bengal and Orissa) are potato-greengram-rice/maize, potato - maize - rice, rice- potato- sesame and potato - vegetable-maize. In order to maintain the fertility status of soil, it is highly essential to follow a judicious fertilizer schedule for a cropping system as a whole, instead of component crop. Potato being an exhaustive crop requires high dose of fertilizers which may in turn have deleterious effect on soil health. So to maintain the soil fertility and to sustain the productivity, appropriate combination of organics and inorganic sources of fertilizer has to be worked out.

This can prove to be a boon to the farmers as potato produces abundant food (17.81 t/ha) within a short spell of time and fetches a high market price with little value addition and can give higher monetary return to the small and marginal farmers.

On the other hand, rice-potato cropping system depletes large amount of nutrients from the soil which needs to be replenished through heavy doses of chemical fertilization. Generally, high analysis chemical fertilizers are used due to ready availability and quick yield response. Indiscriminate and continuous usage of high levels of such chemical fertilizers, mostly N, P & K, apart from their high cost often leads to nutritional imbalance particularly for micronutrients which ultimately cause deterioration in physicochemical properties of soil and steadily decrease crop yield (Nambiar and Abrol, 1989; Gupta et al., 2000). This calls for development of integrated nutrient management systems (INMS) where chemical fertilizer is supplemented through organic source of plant nutrients, green manures and biofertilizers for improvement and maintenance of soil fertility leading to sustained crop production.

It is universally accepted that chemical fertilizers are not a substitute for organic materials and vice versa, rather their role is complementary. The
The underlying principle behind INMS concept is to use organic and inorganic sources of plant nutrients in the most efficient manner because of the limited availability of organic matters and high cost of chemical fertilizers. A major difference between chemical fertilizers and organic materials is that the nutrients contained in chemical fertilizers are used up rapidly but incompletely. On the other hand, nutrients supplied through organic sources are used slowly and stored in soil for a longer time. Therefore, integrated use of organic and inorganic sources of plant nutrients has been found to be promising in obtaining sustainable crop productivity (Chettri et al., 2004) on a long-term basis under modern intensive cropping, besides meeting the nutrient turn-over in soil plant systems. It is also believed that integrated nutrient management would improve soil fertility for sustained increased productivity through optimizing availability of all possible organic, inorganic sources of plant nutrients as required for crop growth in an integrated manner, appropriate to each cropping system (Hegde, 1992). Balanced inorganic fertilization and integrated nutrient management have sustained crop yields on long-term basis (Dwivedi et al., 2002).

Integrated nutrient supply which involves the conjunctive use of chemical fertilizers and organic manures assumes great significance in recent years for sustained productivity (Singh et al., 2001). Randhwa and Tandon (1989) while reviewing the long term fertilizer experiments conducted all over the country observed that neither the organic matter alone nor the mineral NPK fertilizer can sustain high productivity to meet the food requirement of the burgeoning population. Organic manure alone may supplement the lower nutrient demand under low to medium intensity cropping systems lent for intensive farming, combination of organic manure and chemical fertilizer become imperative to sustain productivity.

Characteristically acid lateritic soils of Orissa are low in organic matter, nitrogen and phosphorous. Hence, in the management of these type of soils,
addition of organic matter known to be an excellent storehouse of plant nutrients becomes essential (Dager, 1995). Therefore, to obtain a higher crop yield on sustained basis it becomes imperative to integrate both organic and chemical sources of plant nutrients in suitable proportions. This can be achieved most effectively if; optimum combination of organic and inorganic source of plant nutrients can be identified for rice - potato system.

Use of green manure along with inorganic fertilizer in rice crop not only increases the yield and yield attributing characters but improve the soil physico chemical properties to a great extent (Pushpanathan et al., 2004). Reportedly Azolla can substitute almost 50% of N requirement of rice (Saravanan et al., 1987).

Potato is highly responsive to application of organic manures (Mondal et al. 2005). Application of vermicompost and neem cake was also found to positively influence the tuber yield (Singh and Rai, 2007). Urkurkar et al. (2010) reported that maximum potato tuber yield was obtained with 100% application of chemical fertilizers followed by 50% RDF + 50% N 1/3 each as cow dung manure, neem cake and composted crop residue.

Therefore keeping the above issues in view the present field investigation was undertaken with the following objectives:

1. To study the system productivity of rice- potato sequence under partial substitution of chemical nitrogen through various organic sources of nitrogen.
2. To study the quality parameters of each crop for nutritional security.
3. To study the NPK uptake by each crop in the system.
4. To study the soil fertility of the system and
5. To study the economics of the system.