Chapter 1

General introduction
In India, out of an estimated 142 million ha (Mha) of net cultivated area, about 86 Mha (60 %) is rainfed. Even after attaining full irrigation potential, nearly 50 % of the cultivated area would remain rainfed (Paroda, 1997). At present about 60 % of India’s population as well as 60 % of livestock depend on agriculture.

Since the productivity in irrigated areas is plateauing consistently, bulk of the rising food demand is met by rainfed areas. Lack of food security in resource poor rural areas makes it difficult for growing population to stay in villages. The human population in rainfed areas is likely to reach 600 million by 2020 AD from the present 410 million. Such an increase in population will shrink the per capita availability of land from 0.15 to about 0.08 ha (Anonymous, 1997b). Thus, the operational holding is likely to be uneconomical to cultivate the conventional cereal crops or to leave fallow. Similarly, the livestock population is likely to exceed 650 million by 2020 AD (presently 509 million heads). This will lead to greater demand for fodder. Further, over-exploitation of natural resources is likely to worsen social disparity and create a host of socio-economic problems, such as unemployment and food and livelihood insecurity. With the enormous urbanization and changing rainfall patterns, the rainfed area is likely to decrease drastically. Therefore, from the significantly reduced area, the productivity needs to be doubled by 2020 (Paroda, 1997). The quality of produce also must be improved. The cost of production needs to be reduced in order to improve farmers’ income.

Thus, in future, maintaining food security will be a challenging task demanding intensive and extensive Research and Development efforts to meet the targets and to make rainfed agriculture viable (Sharma and Singh, 2006). The question currently being asked is “can we meet the new challenges on sustainable rainfed farming which raises the quality of life and is pro-nature”? In the recent past, trends in Indian
agriculture suggest that it can be achieved, provided we adopt land use diversification with multidisciplinary and holistic approach. This must include interactions among climate, soil, water, vegetation, livestock, human and socio-economic dimensions in devising most productive, remunerative, eco-friendly and environmentally sustainable land use (Carter, 2002).

The eastern plateau of India, covering 100, 15 and 23 % of the total geographical area of three eastern states like Jharkhand, West Bengal and Orissa respectively, are almost entirely devoted to rainfed. Topographically, the study area is undulating, with elevation ranging from 150 to 1100 m above the mean sea level. The undulating topography and highly dissected landscape give rise to short-range variations in terrain and soil and water conditions, which influence the kinds of crops that can be grown, the time windows for cropping, and the possible cropping systems in different parts of the toposequence. Undulated toposequences can be roughly divided into low-, medium- and up-lands. Medium and uplands together account for nearly 60 % of the total cultivated area of this region (Banik and Sharma, 2009c; Banik and Sharma, 2008).

In general, the plateau soils are slightly acidic to neutral in reaction, and the soils have low base content, organic matter, available nitrogen and mineralizable phosphorus and medium in potassium, but have high levels of iron and aluminum. Due to dominance of kaolinite clay minerals, soils can be classified as latosols (called tropical red loam), have lower water holding and cation exchange capacity, but exhibit high phosphate fixing capacity. The soil fertility characteristics also vary with landscape position and almost all these parameters increase to some extent from uplands to lowlands (Banik and Sharma, 2008; Banik and Sharma, 2009a).

The climate of the eastern plateau region is humid, sub-humid tropical and is characterized by a hot and dry summer with large winter water deficits. There is a great variation in the amount of total rainfall (ranging from 900 to 1500 mm). Average annual rainfall of eastern plateau region is about 1400 mm, of which 85 to 90 % is received in monsoon months (June to September). Though the average annual rainfall is high, the distribution is lop-sided, making the crops vulnerable to moisture stress due to occasional dry spells even during monsoon season (Banik and Sharma, 2009c).
People living here are mostly dependent on subsistent crop-based agricultural systems to maintain their livelihood. Out of total population of eastern plateau, 75% resides in rural areas and more than 50% of its population lives below poverty line. Mostly, they are small and marginal farmers accounting nearly 90% of the total population. The farmer demography in this region also shows the dominance of small and marginal farmers and they own only 32% of the land. On the other hand, 17% medium and semi medium farmers own 53% of the land. Thus, the landholding is also skewed and is uneconomic in the state.

Agriculturally the plateau region is one of the most backward in the country. Rainfed monocropped rice is the predominant crop; other crops are pulses, maize, wheat and oilseeds. Crop and livestocks productivity and cropping intensity are much lower than the national average due to undulating topography, lower irrigation facilities, resource poor farmers etc. For example, average rice productivity of the state is around 0.96 Mg ha\(^{-1}\), which is half the national average. The state has only 11% irrigated area of the net sown area (against the national average of 40%), thus reducing the gross cultivable area and the cropping intensity (114%).

Maize \((Zea\ mays\ L.)\), 'queen of cereal' is also known as corn, belongs to the family Poaceae. In India, maize grown in all the seasons - \textit{kharif}, \textit{rabi} and \textit{zaid} contributes nearly 90%, 7-8% and 1-2% of total production of the season respectively. For the diversification and value addition of maize as well as growth of food processing industries, an interesting recent development is of growing maize for vegetable purpose, which is known as 'baby corn'. The change in food habit from non-vegetarian to vegetarian has aggravated the consumption of vegetables (Thavaprakaash et al., 2005). Baby corn, a new vegetable not so popular yet, is an emerging potential crop among the progressive farmers around big cities. Baby corn production has proved an enormously successful venture in countries like Thailand and Taiwan. Today Thailand is a world leader in the export of canned and fresh baby corn. Attention is now being paid to explore its potential in India. Baby corn being short duration crop terminates its life cycle within 75 days; as it enters into reproductive phase during 50-55 days after sowing (DAS) [Thavaprakaash et al., 2005]. Thus, farmers can grow four crops in a year and the production of baby corn
can generate year round higher income and employment for them and can also raise foreign exchange earnings *per se*.

Though, the baby corn provides benefits to people from every walk of life to the growers. Its every part has economic value. After harvesting baby ears shoots, the green plant of maize is used as fodder for livestock. Its fodder can safely be fed to almost every class of livestock at all stages of growth without any danger of oxalic acid, prussic acid; it can also be used as hay and silage (Chaudhary, 1983). The fodder is relished by animals due to its succulency and palatability (Chaudhary and Hussain, 1985).

Kernels in baby corn ears should be uniform in shape and petite in size (2–4 inches long and 1/3–2/3 inch in diameter at the base, or butt end), with rows neatly aligned and ends evenly tapered (Chutkaew and Paroda 1994). To meet these criteria, harvesting unfertilized young ears, especially before or just after the silks have emerged is preferable (Bar-Zur and Saadi, 1990). Baby corn is free from pesticide and its nutritional value is comparable to cauliflower, cabbage, tomato, eggplant and cucumber (Chutkaew and Paroda 1994). It would produce an attractive low-calorie vegetable with high fiber content and no cholesterol.

Again, providing two meals a day to ever growing people of India will always remain one of the major concerns of the Government. This poses not only a matter of great concern but also a formidable challenge. A simple regression analysis between the food grain production and fertilizer consumption during 1960-61 to 1999-00 showed that the partial factor productivity of fertilizers has been continuously declining (NAAS, 2006). The same has also been endorsed by the PDCSR (Project Directorate of Cropping System Research) and farmers from several pockets of India. The efficiency of fertilizer nitrogen is only 30-40 % in rice and 50-60 % in other cereals, while the efficiency of fertilizer phosphorus is 15-20 % in most crops. The efficiency of potassium is 60-80 %, while that for sulphur is 8-12 %. As regards the micro-nutrients, the efficiency of most of them is below 5 %. It was vividly brought out in the deliberations that the major factor responsible for the low and declining crop response to the fertilizers was the continuous nutrient mining of the Indian soils without adequate replenishment to the desired extent (NAAS, 2006). It is estimated
that about 28 Mt of primary plant nutrients are removed annually by crops in India, while only 18 Mt or even less are applied as fertilizer, leaving a net negative balance of about 10 Mt of primary plant nutrients (NPK). Furthermore, the soils are also getting continuously depleted of secondary plant nutrient sulphur and micronutrients. The marked deficiencies of sulphur and zinc are widespread in the country and significant responses to application of these nutrients are well documented (NAAS, 2006). The deficiencies of boron, iron and manganese are also being reported from some parts of the country. Thus, inadequate and imbalanced fertilization is a major causative factor for low and declining crop response to fertilizers (NAAS, 2006). The need for integrated nutrient management including the use of organic sources such as farmyard manure, rural and urban compost, vermicompost, green manures, inclusion of legumes in the crop rotations, and bio-fertilizers was emphasized for meeting a part of the plant nutrient needs of crops (NAAS, 2006).

In conclusion, fertilizer has been and will continue to be the key input for achieving the estimated food grain production goals of the country. Since increase in food grain production is possible only through the increased productivity per unit land, an all out effort is needed to increase the crop response to fertilizers (NAAS, 2006). Some of the suggested measures are balanced and adequate N, P, K, S, Zn, B and Fe (and any other deficient nutrient) fertilization, integrated plant nutrient supply system (IPNS), timely availability of desired fertilizer materials, availability of good quality seeds of the recommended crop varieties and implementation of recommended agronomic practices. Customized soil and crop specific fertilizer materials need to be developed for major cropping and farming systems in different agro-eco regions (NAAS, 2006).

Again, people living here are mostly dependent on subsistent crop-based agricultural systems. Rice dominated monocropping system is overwhelmingly prevalent in this region, although, the annual rainfall is quite high ranging between 1100 -1400 mm. Under such condition we are confronted with the situation where diversified crops and cropping systems, suitable to the ecosystem are gradually being replaced by monocropped rice based systems giving very low productivity hovering around 1.5 - 1.8 t/ha. Less return from agricultural sector compels the farmers to migrate seasonally to adjoining coalmines or to other places for maintaining their livelihood. So, the challenges are to establish situation specific, ecofriendly and socially...
acceptable as well as economically viable technologies on a sustainable basis while utilizing all the natural resources. Under these circumstances, introduction of baby corn vis-à-vis development of its package of practices in the eastern plateau region of India has a potentiality to uplift the socio-economic status of the farming community, thereby, help to generate additional employment by setting up baby corn oriented small scale industries. Above all, sequential as well as intercropping of baby corn with pulses can bestow the opportunity to the local people to fulfill their day to day needs of cereals, pulses and vegetables under low input subsistence farming system.

Under the aforesaid situation, a study entitled “PRODUCTIVITY OF BABY CORN (ZEA MAYS L.) – UNDER DIFFERENT AGRONOMICAL PRACTICES IN EASTERN PLATEAU REGION” was designed and investigated at Agricultural Experimental Farm of Indian Statistical Institute, Giridih, Jharkhand, India with the following objectives:

1. To identify the suitable baby corn genotype(s) for eastern plateau region,
2. To assess the effect of integrated nutrient management (INM) practices on productivity and nutritional quality of baby corn genotypes,
3. To study the effect of INM practices on soil health,
4. To evaluate the baby corn-legumes complementarities in intercropping systems,
5. To determine the effect of intercropping systems on weed smothering and weed community structure,
6. To estimate sole/interactive effect of *Azospirillum* and arbuscular mycorrhizae (AM) in absence and presence of different doses of chemical fertilizers on productivity of the baby corn, and
7. To determine soil quality and cost effectiveness of application of biofertilizer(s) with and without chemical fertilizers.

To execute the above mentioned objectives, four distinct experiments had been planned and carried out during the years of 2007-08 and 2008-09. The findings of these experiments have been presented in a separate chapter with their specific, introduction, objectives, experimental setup, results, discussion and summary. Finally, a conclusion has been drawn from all the four separate experiments.