INTRODUCTION
The radiatively active trace gases of the atmosphere such as water vapour, carbon dioxide, nitrous oxide, carbon monoxide and methane (CH₄) absorb the outgoing thermal radiation, emitted by the cooling of earth surface, in infrared range of electromagnetic spectrum and thereby retain a favourable temperature in the atmosphere. But, increase in the emission of these anthropologically emitted gases due to population pressure, intensive agriculture, profound industrialization and other human related activities have resulted in a steady increase in global warming. It has been projected that if the present state of industrialization, dairy farming, rice cultivation and other agricultural activities continues or is further intensified, the atmospheric concentration of greenhouse gases will double by 2035 AD. Current researches worldwide are, therefore, directed towards understanding the source-sink relationship of different greenhouse gases in order to stabilize or lower the concentration of these gases in the earth's atmosphere.

CH₄, the most abundant hydrocarbon in the atmosphere has both a direct and an indirect warming potential. Although CH₄ represents about 1% of the total atmospheric carbon, it exerts a strong influence over the earth's climate, and the chemistry of the troposphere and stratosphere (Whitman, 1985). As a major regulator of OH radicals and primary sink for Cl, CH₄ affects tropospheric ozone, OH radicals and carbon monoxide concentrations, stratospheric Cl and ozone chemistry (Cicerone and Oremland, 1988). Because of its interaction with infrared radiation, CH₄ also plays a direct role in climatic change, as an effective greenhouse gas. Contribution of CH₄ to greenhouse warming is considerable, despite its concentration being considerably lower than that of carbon dioxide (Tyler, 1991). Global CH₄ emission is currently estimated at 500 Tg yr⁻¹. As the total sink capacity is somewhat less than the current total emissions, CH₄ is at present accumulating in the atmosphere at a rate of 0.7% per annum. CH₄ is a major end product of anaerobic decomposition of organic matter and about 75% of atmospheric CH₄ originates from anoxic ecosystems (Ferry, 1992). However, a distinction should be made between natural CH₄ emissions to which substantial sources such as wetlands, moors, swamps, shallow lakes, tundras and temporarily flooded regions contribute and anthropogenic emissions, which largely stem from agricultural activities. Thus, at the
global scale, agriculture accounts for more than 40% of the total and for more than 60% of anthropogenic CH$_4$ emission (Ahlgrimm, 1996).

Flooded rice paddies, characterized by predominantly anaerobic conditions, are considered as one of the major anthropogenic sources of atmospheric CH$_4$. Global emission from this source is around 60 Tg yr$^{-1}$ with a range of 20-100 Tg yr$^{-1}$ (Houghton et al., 1996). World’s population is expected to reach 6.3 billion in 2000 AD and 8.6 billion in 2025 AD (IRRI, 1993). Such population pressure would necessitate an increase in rice production in 2020, by almost 50% over the current levels, through expansion of cultivated area and/or increase in productivity. The projected increase in the intensity of rice cultivation is, however, anticipated to result in a higher CH$_4$ emission, as much as 20% during the next decade (Anastasi et al., 1992).

More than 90% of world’s rice is produced in Asia. India and China, account for 60% of world’s rice growing area (DeDatta, 1981). India, with 42.3 m ha of world’s rice paddy and 19.5% of rice grain yield, is considered as one of the major contributors to atmospheric CH$_4$ (Bachelet and Neue, 1993). However, the estimates of CH$_4$ emissions from rice fields in India are still debatable. According to IPCC, estimate based on the extrapolation of the data generated in advanced countries (USA, Europe and Japan) to tropical Asia, rice fields in India contribute about 37 Tg CH$_4$ yr$^{-1}$. But, based on CH$_4$ emission data for 46 integrated seasons from 20 locations (mostly experimental farms of Agricultural Universities and National Institutes) under National CH$_4$ Campaign (organized by Dr. A.P. Mitra, FRS and Dr. D.C. Parashar of National Physical Laboratory, New Delhi) upto 1995 and 44 integrated (1993-1998) seasons from 4 centres under ICAR-AP Cess Fund project, coordinated by the Central Rice Research Institute, Cuttack, the mean CH$_4$ emission from irrigated and rainfed lowland rice systems in India is estimated to be about 4.1 Tg with a range of 2.8 to 5.3 Tg (Adhya et al., 1994; Mitra, 1992; Parashar et al., 1997). Estimates of CH$_4$ emission from flooded rice fields in India have been repeatedly scaled down from their initial high values, the low estimates being strongly influenced by low emissions measured in Indian rice fields (Crutzen, 1995). There are still uncertainties on the precise estimates of contributions of rice ecosystem to global CH$_4$ budget, because of incomplete measurements, high local variations and seasonal fluctuations. Thus, there is a need for reducing uncertainties of current and future emissions to eventually provide a reliable basis for mitigation.
CH$_4$ emission from rice paddy is governed by a complex set of parameters, viz. soil type, pH, redox potential, temperature, water regime, fertilizer, sulphate content, rice cultivars and cultural practices used in rice cultivation (Neue et al., 1997). Both organic and inorganic fertilizers can influence CH$_4$ production and emission (Minami, 1995). However, the effects of urea and other N fertilizers on methanogenesis are not clearly understood and are often contradictory. Thus, urea fertilization promoted CH$_4$ emission in some soils and inhibited it in others, depending upon the soil physical characteristics (Wang et al., 1993b). In a rice-based cropping system, lowland rice is normally rotated with upland crops such as wheat, oilseeds, pulses and vegetables. Such crop rotation with an upland crop preceding rice, reduces not only phytotoxic effects of continuous flooding, but also CH$_4$ emission from rice fields besides increasing overall productivity (Neue et al., 1991). Rice cultivars differ in their ability to transport CH$_4$ from the subsurface soil to the atmosphere (Adhya et al., 1994). A single mid-season drainage may reduce CH$_4$ emission rates by about 50% over that from continuously flooded regime (Minami, 1996). Mid-season drainage is often considered as a good strategy for abatement of CH$_4$ emissions especially from flooded rice fields. Like wise, salinity is one of the important parameters influencing microbial activities in the soil including CH$_4$ production (Bachelet and Neue, 1993; Denier van der Gon and Neue, 1995b).

Technologies suggested for mitigation of CH$_4$ emission from rice fields include crop diversification, improved water management practices to reduce the duration of flooding, introduction of rice cultivars with low CH$_4$ emission rates, and the form, amount and mode of fertilizer application. However, there is an urgent need to generate more information about the various farmer-friendly, eco-friendly and economically viable mitigation technologies that are in accord with higher rice production.

The present study is therefore concerned with:

- CH$_4$ emission from upland crops preceding a lowland rice crop and from a rice-rice cropping system;
- effect of water regime on CH$_4$ efflux in an alluvial soil planted to rice under greenhouse conditions;
- CH$_4$ emission from rice fields as affected by split application of N fertilizers;
• CH$_4$ production in laboratory incubated flooded rice soils amended with different forms of chemical N fertilizers;
• cultivar variations in CH$_4$ emission from flooded rice fields;
• effect of salts, added to increase soil salinity, on CH$_4$ production in flooded rice soils; and
• CH$_4$ production in flooded soils amended with heavy metals.