INTRODUCTION

The rice-wheat is the most extensive and traditional cropping system in India which is the main stay of cereal food production in the country. It has been observed that intensive agricultural practices in high yielding rice-wheat cropping system have resulted in numerous problems like deterioration of soil health, pollution hazard and depletion of resources and stagnation in crop production and productivity. This system brings together conflicting and complementary practices. At present this system operates at low yield because of inadequate and imbalanced nutrients and inappropriate soil and water management. In general in India and particular in Himachal Pradesh, these two crops are major food grain crops. The average productivity of rice and wheat crops in India is 2.07 t/ha and 2.71 t/ha, respectively (Anonymous, 2004). In Himachal Pradesh, wheat occupies first position in acreage covering about 361.0 thousand-hectare area, whereas in Kharif season the rice crop is sown on 81.3 thousand hectare area. The average productivity of rice and wheat in Himachal Pradesh is 1.48 t/ha and 1.38 t/ha, respectively (Anonymous, 2004). This indicates a lot of scope for increasing the productivity of these crops. Therefore, technological change is necessary to meet the increasing demand of food for growing population.

Puddling is the most common method of land preparation for low land rice cultivation. Transplanting of rice under puddled conditions (wet tillage) is known to produce higher yields than rice established by direct sowing (Scopongco et al. 1994). Traditional puddling techniques using draught animal traction
produces highest yields (Kirchhof, et al., 2000). Farmers prepare land with animal-drawn countryside ploughs. The number of ploughings and plankings may vary between 3-7. Puddling helps to reduce percolation rates, decreases water consumption and ensures that submerged conditions can be maintained. The puddling increases dispersion of soil particles and helps in retaining water for longer period, because dispersed particles flocculate, settle on the soil surface creating a thin surface and seal pores and capillaries that result in decreased percolation rates with increased time of inundation, whereas this type of soil condition is unfavorable for subsequent arable crop. Wheat requires a well-pulverized soil with a proper balance of moisture, air and thermal regime. Unfavourable environment created during rice crop is considered to be the important factor responsible for the poor yields of wheat following rice. Its negative impacts on land and soil qualities are alarming and should be minimized by adopting more sustainable techno-managerial methods and continuous soil monitoring.

Tilth characteristics such as moisture content may also affect the wheat yield. Increased puddling intensity increases the bulk density and soil penetration resistance (Kukal, and Aggarwal, 2003a). Most of the rice soils produce large size clods due to which it requires frequent tillage to prepare the seed bed for sowing of wheat. Such repeated cultivations require considerable time and energy resulting in delayed sowing of wheat. Due to small clods remaining even after number of tillage operations, proper seed soil contact is not established, this result in poor germination and seedling emergence of succeeding wheat crop. The integrated effect of poor seedling emergence and restricted root growth is ultimately reflected in the poor crop yield (Chenkual and Acharya, 1990). However, what should be the
extent of puddling is not well established. Generally, farmers have a tendency to create a very fine puddle that actually may not be required. Recently Kirchhof and so (1996) reported the puddling could be reduced without affecting the rice yields, except on sandy soils.

Under such conditions, the organic amendment to improve the soil structure in post rice soils is an option to improve wheat yields. Organic amendments are known to improve soil productivity under rice-wheat cropping by way of improving physical conditions and nutrient status of the soil (Sharma et al., 2003). Incorporating organic matter improves structure through increased aggregation, which favourably influences tillage properties, crusting, water infiltration, moisture retention, drainage, aeration, temperature, and root penetration. Greater benefits are obtained by adding organic matter to heavy soils and soils with poor structure than to light-textured soils and soils with good structure (De Datta and Hundal, 1984). But at the same time the availability of farmyard manure in sufficient quantity is not possible. Hence there is a need to find out alternative sources of organic manures. The best bet could be growing of a legume crop in-situ between the harvest of wheat and transplanting of rice crop. It is said, “grow paddy with soil fertility, wheat with fertilizers.” No doubt, the enthusiasm in green manuring has been renewed with the identification of root as well as stem nodulating species like Sesbania which can tolerate both draught and temporary flooding and are able to accumulate substantial quantities of nitrogen and green biomass. Fast growing and short duration green manure crops like Sesbania can be easily grown during the fallow period of 40-70 days after wheat harvest for improving soil physical and chemical properties and sustaining the productivity of cereal crops. Pre rice green manuring by in-situ incorporation of Sesbania can meet a substantial nitrogen
requirement of the rice crop. Therefore it is imperative to study the direct and residual effect of organic manuring in a cropping system as a whole.

It has been reported that bulky organic manures/green manures when used in conjunction with fertilizers, efficiency of both the sources is increased (Larve and Peterson, 1981, Rekhi and Meelu, 1983). This is much more important where there are the chances of washing away or leaching of the nutrients due to continuous flooding of water during the heavy rainy season. Also fertilizer is the key input for increased agricultural production in a well-defined production system.

Nitrogen is one of the primary plant food nutrients, which plays a vital role in plant system for the synthesis of protein and nucleic acid that are responsible for the optimum development of chlorophyll and plant growth. Nitrogen deficiency is widely spread in Kangra soils and it limits rice production considerably. High rainfall coupled with fairly high temperature and over percolating soils, is conducive to nitrogen losses from the rice fields. On the other hand, scientific recommendation on nitrogen application in combination with organic manures for rice are meager. Under such conditions, the economical use of nitrogen assured an added importance in the over all nitrogen management strategy, considering the rising prices of chemical fertilizers.

The combined effect of soil and nutrient management strategies such as reduced tillage, organic and inorganic nutrition may avoid the deleterious effect of puddling on soil structure and fertility, improve water and nutrient efficiencies and increase crop productivity. The extent of this effect depends on soil type and site-specific management, and needs more comprehensive investigation. Keeping in view, the experiment entitled "Studies on rice productivity as influenced by organic
manures and nitrogen levels under different tillage methods and its residual effect on succeeding wheat crop” was conducted during the year 2004-05 to 2005-06 at the experimental farm of Department of Agronomy, CSKHPKV Palampur, with the following objectives:-

I. To find out the suitable source of organic manure and dose of nitrogen for rice crop under different tillage methods.

II. To monitor the effect of organic manures, tillage methods and nitrogen application on soil properties after rice harvest.

III. To study the residual effect of organic manures, tillage methods and nitrogen application on succeeding wheat crop.