Introduction
I. INTRODUCTION

With the fast growing population decreasing man to land ratio, soil degradation, poor resource base of the cultivators and direct need for maximization of the productivity, profitability and sustainability of agricultural production, it has become necessary to go for greater use of knowledge based technology with land and marginal lands are brought under cultivation. Further with the increasing income growth and urbanization, lack of remunerative prices for different commodities, it has become imperative for farmers to explore the awareness for other alternate land use systems. This would be possible through diversification of agriculture and efficient land use systems (Shakhela and Jaimini, 2005).

Appraisal of Natural Resources

India is endowed with a vast and rich diversity of natural resources particularly soil, water, climate and agro-biodiversity. To realize the optimum potential of the agricultural production system on a sustained basis, efficient management of natural resources is of paramount importance. India with a geographical area of 329 M ha presently supports 17 per cent of the worlds population on merely 2.5 per cent worlds land area and 4 per cent of worlds fresh water resources.

Moreover, the one billion plus population is expected to reach 1.4 billion by 2025, requiring about 315 mt of food grains (compared to about 210 mt at present) with a protected decrease in per capita land availability to 0.08 ha (0.15 ha t present). As per
estimates of National Bureau of Soil Survey & Land Use Planning (NBSS & LUP). 187.7 M ha land area (57% of the total geographical area) is degraded. Due to water erosion about 5334 mt of top fertile soil is being eroded annually resulting in the loss of total food production of around 30 million tones per year. Soil resource base is also shrinking at an alarming pace of 0.25 m ha/annum due to rapid industrialization and urbanization.

**Soil resources**

Soil is the most vital and precious natural resource for the existence of mankind of the late. The pressure on this vital resource has increased to such an extent that the relationship between the living beings and the soil has become critical. This has resulted in various kind of land degradation, environmental pollution and decline in crop productivity and sustainability. Shrinking resources of prime lands, deforestation and accelerated erosion, deterioration of soil physical properties, increasing water logging and salinity in canal irrigated areas, declining water table in the well irrigated areas, poor management of rain water, lower productivity of dryland area, lower efficiency of inputs such as water, fertilizer and agrochemicals, rapid industrialization coupled with pollution and environmental degradation and hazards have aggravated the problems.

India’s share in land resources of the world is only 2 per cent on which about 17 per cent of world’s human population and 16 per cent of world’s livestock, survive. However, with its diverse agro-climate topography and soil types. India is capable of producing a wide range of crops and vegetation. The land surface
is represented by red and lateritic soils (alfisols, oxisols, ultisols and interceptsols etc., 172.2 m ha) and black soils. Vertisol and their associations (73.5 m ha), alluvial soils (entsisols and inceptisols 58.4 m ha), desert soils (mostly aridisols and entisols 30 m ha) (Velayutham and Battacharya, 2000).

Agroforestry, traditionally is well entrenched in India. In arid and semi-arid areas the degradation of soil and environment are fast taking place due to harsh environment and excessive biotic activity. Arable cropping is extremely risky in arid area of India. Forestry and agroforestry are the natural answer to check this degradation without adversely affecting the productivity. Soil and water conservation and sustainable agriculture are the three components of agroforestry for conserve the soil and water we have to understand what is soil erosion, soil erosion may be defined as the detachment and transportation of soil when natural vegetation and tree are cleared for agricultural purposes, the natural protection of the soil get disturbed and soil detachment and movements occur at a greater speed (Narayan and Ramababu, 1983).

As per National Commission on Agriculture (1976) in India 175 million or about 60 per cent land is under active erosion and degradation contributing to desertification, floods, droughts and has a falling life support system. It has been estimated that about 5333 million tones (16.35 t ha⁻¹) of soil is detached annually due to agriculture and associated activities alone. Out of this about 29 per cent is carried away by river into the sea. Nearly 10 per cent of being deposited in our surface reservoirs resulting with loss of one
to two per cent storage capacity per year (Narayana and Rambabu, 1983) and about 8.4 million tones of the plant nutrients in terms of NPK is lost annually, the cost of which comes out to Rs. 21000 million (Das, 1977).

**Runoff soil and erosion in productivity of Agroforestry**

The productivity is an integral aspect of sustainable land use system. The soil productivity has been related with soil depth. Assuming in deep soil becomes uncultivable with loss of 80 cm depth, it will happen in 200 years period when erosion is as high as @ 60 t ha\(^{-1}\) yr\(^{-1}\) = 4 mm yr\(^{-1}\) if decried in productivity is linear, crop yield will fall by 1/200 i.e., 0.5 per cent each year. Because the figure is not perceptible, farmers usually ignore sheet erosion in the field. The loss in productivity may be more than shown by such simple calculation because important soil properties like water holding capacity may be adversely affected by decrease in soil depth.

Erosion leads to removal of top fertile soil affecting loss of organic carbon nutrients. Hence decrease in productivity imposed by root zone limitations. Yield reduction is mulch higher than show by artificial desurfacing the top soil because as say or eroded sediments may be several folds (2.5 times) as compared to that of matrix called enrichment ratio and removal of organic carbon affects soil structure, water holding capacity infiltration porosity, increase in bulk density which causes sustained reduction in crop yields particularly in dry regions.
Agroforestry practices in which erosion control is combined with improvement of soil fertility are likely to be of great value in designing a sustainable land use system.

Agroforestry and soil conservation together prevent soil erosion while maintaining soil fertility. The production under the system may not be the highest but it is sustainable at an optimum level. Therefore, the natural resources of production are not allowed to degrade at the cost of profit/production level. Production could be adjusted to sustain the entire system for a long period of time. This is possible through adoption of agroforestry and soil conservation as a sustainable land use system (Patel et al., 2005).

**Erosion control through agroforestry**

Soil and water are two basic resource of agriculture production, there conservation has got direct bearing on sustainable land use system. Conservation of soil and water could be effectively brought about by adopting soil conservation and agroforestry. Soil conservation in broader sense should encompass both control of soil erosion as well as maintenance of fertility. Agroforestry practices in which erosion control is combined with improvement of soil fertility are likely to be of great value in designing a sustainable land use system.

Erosion control reduces losses of soil organic matter and nutrients. Eroded sediments normally contain high levels of carbon and nutrients. In addition dissolved nutrients are removed in runoff water. An order of magnitude calculation shows that
severe erosion such as 50 t/ha/yr can remove one ton of soil carbon, 100 kg of nitrogen and corresponding of other nutrients. Reducing erosion to 10 t/ha/yr will save of these amounts, equivalent to application of several tons of fertilizers (Tikka and Jaimini, 2005).

**Agroforestry land use systems helps for poors in fulfilling the following needs**

- It creates an alternate food source in ecologically disadvantaged situation such as dry/arid lands.

- It utilizes the available farm resources efficiently and judiciously.

- It maximizes the per unit production of food, fodder, livestock and the other forest products. Besides, it helps in optimizing the productivity of biological and physical resource viz., land, labour, livestock, soil moisture, solar radiation etc.

- It reduces pressure on protective and productive forests for meeting the local demands of fuel wood, fodder, building material, industrial timber etc., so that the existing forests can fully be spread for their protective and productive roles.

- It maintains the ecological balance by mitigating green house effects and sequestering atmospheric carbon dioxide.

- It checks soil erosion, conserve soil moisture and increase the soil fertility.
It provides on alternate option for reclamation of degraded lands such as salt affected mine spoils etc. (Goyal, 2005).

**Horti-silvi pasture systems**

Drought hardy fruit crops can survive and provide income to the farmers even under severe drought, silvicultural plantations would check the drift of sand, provide forage, fuel and timber wood and would help in increasing favourable microclimatic conditions. To manage the arid lands in judicious way a combination of horticultural crops, silvicultural plantations and fodder crops should be maintained. This gave rise to the concept of horti-silvi pasture systems of farming. Selection of fruit plants tree / bush plants / grass legume species should be ideal for based on rainfall, soil and local conditions (Vashistha and Prasad, 1997).

**Environmental benefits of agroforestry land use system**

Agroforestry is an efficient land use system where trees / shrubs are grown with arable crops seeking positive interactions in enhancing the productivity on a sustainable basis.

Combining trees with food crops on crop land farms yield certain important environmental benefits, both general ecological benefits and specific on site benefits.

The general ecological benefits are:

- Reduction of pressure on forest
- More efficient recycling of nutrients by deep rooted trees on the site
Better protection of ecological system

Reduction of surface runoff, nutrient leaching and soil erosion through impending effects of tree roots and stems on these processes

Improvement of microclimate, balance such as lowering of soil surface temperature and reduction of evaporation of soil moisture through a combination of mulching and shading

Increment in soil nutrients through addition and decomposition of litterfall

Improvement of soil structure through the continuous addition of organic matter from decomposed litter

**Economic benefits**

Agroforestry land use system on croplands / farm lands bring significant economic benefits to the farmer, the community, the region or the nation, such benefits may include:

- Increment in an maintenance of outputs of food, fuelwood fodder fertilizer and timber
- Reduction in incidence of crop failure common to single cropping or monoculture systems, and
- Increase in levels of farm incomes due to improved and sustained productivity

In the long run agroforestry system, have been found to be more productive and profitable than sole cropping (Debo Roy,
In this the scientific approach for qualitative and quantitative assessment of resource degradation in now and informative stage of development. Hence an attempt has been made in the present study to find out the influence of different agroforestry land use system on runoff soil and nutrient losses in central dry zone – IV f Karnataka with following objectives:

- To study the systematic evaluation and quantification of soil, water and nutrient losses in different land use system
- To study the physical and chemical properties of soil in different land use system
- To study the production of different crop in different land use system
- To study the change in hydrology at different soil depths under different land use system