CHAPTER I
INTRODUCTION

Sustainable food and nutrition security involves meeting current need in agriculture production without sacrificing the prospects for meeting the need of future generation. We face many challenges in our quest to achieve sustainable food security. First land is a shrinking resource for agricultural and we have to produce more and more from less and less land. This would necessitate optimization of our efforts in land utilization, soil and moisture conservation with greater emphasis on residue management with adequate nutrition through different sources. Crop residue incorporation is an environmental friendly strategy which is becoming a common soil management practice for sustainability of soil.

In less affluent countries such as those in South and South East Asia, grain is directly used for human consumption and crop residues are the main source of cattle feed. In addition, crop residues have several other uses like thatching of dwelling huts and cattle shed. Crop residues are certainly an asset in these countries and seldom left in the field. In India, about 78 and 85 million tonnes dry rice and wheat straw were generated, out of that 17 and 19 million tonnes (Gupta, et. al. 2004) may end up in field burning, respectively. In Saurashtra region of Gujarat, maize (Zea mays L.) can be sown after harvesting of winter crops. Farmers in these areas, usually burning crop residue such as wheat residues for faster land preparation for the next crop. This burning may lead to release of soot particles and smoke causing human and animal health problems. It also leads to emission of greenhouse gases namely carbon dioxide, methane and nitrous oxide, causing global warming. It also causes considerable nutrient losses, about 25% N and P, 50% of S and 75% of K which is a valuable nutrient source. The burning of crop residues is wastage of valuable resources which could be a source of carbon, bio-active compounds, feed and energy for rural households and small industries. Heat generated from the burning of crop residues elevates soil temperature causing death of active beneficial microbial population. The burning of agricultural residues leads to significant emissions of chemically and radioactively important trace gases such as methane (CH$_4$), carbon monoxide (CO), nitrous oxide (N$_2$O), oxides of nitrogen (NO$_x$) and sulphur (SO$_x$) and other hydrocarbons to the atmosphere. One ton of rice straw on burning releases about 3 kg
particulate matter, 60 kg CO, 1460 kg CO$_2$, 199 kg ash and 2 kg SO$_2$ (Gadi et al. 2003). These gases are of major concern for their global impact and may lead to increase in the levels of aerosols, acid deposition, increase in tropospheric ozone and depletion of the stratospheric ozone layer. These may subsequently undergo trans-boundary migration depending upon the wind speed/direction, reactions with oxidants like OH, leading to physico-chemical transformation and eventually wash out by precipitation. Many pollutants found in large quantities in biomass smoke are known or suspected carcinogens and could be a major cause of concern leading to various air-borne/lung diseases.

In recent days, use of combine harvester, crop residues largely remain in the field and must be managed to provide the greatest advantage possible, especially for water conservation, erosion control and maintenance of soil organic matter. The residue of cultivated crop can be significantly improves the physical, chemical and biological properties along with overall quality of soil (Kumar and Goh, 2000) and consequently result in better establishment of crop. Wheat residue contain 6.2 kg N, 1.1 kg P, 18.9 kg K, 9-11 kg S, 100 g Zn, 777 g Fe and 745 g Mn per ton of straw (Van Duivenbooden, 1992) which is a valuable nutrient source for crop production. In recent past, microbial cultures are used for residue management, which helps in easy decomposition of residue through secretion of enzymes which facilitates bioconversion of organic waste into bio stabilized compost speedily and release nutrients with a minimum adverse effect on the environment. Also it has role in disease management and promoting plant growth.

Maize (Zea mays L.) is one of the most important fodder crop all over the world. It is also fondly called as a “king of fodder” due to its great importance in animal diet, as it can be grown throughout the year mainly due to its photo-thermo-insensitive character. Among the cultivated non-legume fodder as well as grain crops, maize is the most important cereal crop in India, which can be grown in all the three seasons- kharif, rabi and summer. About 85 per cent of maize is produced in the kharif season (Anon. 2011). Maize is cultivated in diverse production environments ranging from temperate hill zone to the semi-arid region (Singhal, 2003). In India, maize is grown on area of 8.71 million ha having production 22.23 million tonnes and productivity of 2552 kg ha$^{-1}$. Major maize growing states in India includes Andhra Pradesh, Karnataka and Bihar having production of 4.81, 3.43 and 2.33 million tonnes
and per cent share of total production is 21.64 %, 15.43 % and 10.48 % respectively. In Gujarat, maize is an important crop traditionally grown in tribal areas comprising of Panchmal, Dahod, Sabarkantha, Banaskantha and parts of Vadodara and Kheda districts, grown on area of 0.48 million ha having production of 0.84 million tonnes with productivity of 1750 kg ha\(^{-1}\) (Anon. 2013).

Livestock is backbone of Indian economy and its importance in India cannot be over emphasized. India has the largest livestock population of 529.7 million in the world (Anon. 2007). It is about 15 per cent of world’s livestock population resides in only two per cent of worlds geographical area. The availability of nutritious feed and fodder are the major limiting factors for increasing livestock products like milk, meat, egg and wool. The supply of feed and fodder is essential for the vast livestock population.

It may not be possible to increase the area under fodder crop because ever increasing pressure on arable land for grain and commercial crops. So, only alternative option to meet the fodder requirement through increased production of fodder per unit area by adopting high yielding varieties and residue management.

Forage crop has served as an important source of feed for domestic animals for a long period. The benefits of forage crop is not only limited to livestock production. They also contribute to food crop production and many other aspects like soil conservation and amelioration, improvement and protection of environment from pollution, reclamation, revegetation and ecological repair of degraded land, potential conversion of biomass to energy and fiber for manufacturing of papers and sources of extract high quality proteins, medicinal and pharmaceutical products.

Maize is a succulent forage crop and it is almost free from anti nutritional factor and it is utilized in many ways, like other grain crops. Green cobs with grains at milk stage are roasted and eaten by the people with great interest. Several food dishes including chapattis are prepared from maize flour. It also supplies raw material for various industries manufacturing starch, alcohol, acetic acid, glucose, synthetic rubber, dyes, resin etc. About 59 % of total maize grain produced in the country is utilized in manufacture of concentrate feed for livestock. On an average, it contain 9-10 % crude protein, 60-64 % neutral detergent fiber, 38-41 % acid detergent fiber, 23-25 % hemicelluloses and 28-30 % cellulose on dry matter basis when harvested at milk to
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early-dough stage. Maize is also important not only because of its great adaptability to widely divergent conditions but also because of its high responsiveness to better management practices like irrigation and fertilizers.

At present, increasing intensive cultivation leads to moisture and nutrient stresses. For that there is an urgent need to overcome these problems by supplying adequate nutrients particularly nitrogen, phosphorus and potassium through fertilizers. Among these nutrients nitrogen is the most commonly deficient nutrient in the soil and gives considerable response in forage maize crop. It has quickest and most pronounced effect on plant growth and development and ultimately on forage yields. The adequate supply of this element is associated with vigorous vegetative growth and deep green color of the foliage. It is an integral part of chlorophyll, which is essential for photosynthesis. Nitrogen is an essential constituents of protein and is present in many other compounds of physiological importance in plant metabolites such as nucleotides, phosphatides, alkaloids, enzymes, hormones, vitamins etc. plant normally contain 1-5% by weight of this nutrient. Phosphorus nutrition plays a key role in energy storage, transfer and plant metabolism. It is most essential for all living creature for their growth and development. Being involved in various biochemical processes, it ensures transfer and storage of energy as ADP and ATP, permits conversion ant transmission of genetic characters, as it is a constituent of RNA and DNA. It stimulates early root development, rapid and vigorous start to plant, strengthen the straw and brings early maturity of crop. Potassium has role in energy relation; plant requires potassium for the production of high energy phosphate molecules (ATP). It imparts winter hardiness to crops, also helps in formation of proteins and chlorophyll. Potassium produces strong stiff straw in cereals and reduces lodging in cereals, imparts increased vigor and disease resistance to the plants.

Among the inorganic nutrients, nitrogen, phosphorus and potassium play important role in the growth and development of crop plants. Maize is an exhaustive crop and requires high quantities of nutrients during the period of efficient utilization for higher productivity. A maize crop with biomass yield of 4.5 tonnes ha\(^{-1}\) removes 115 kg N, 20 kg P\(_2\)O\(_5\) and 75 kg K\(_2\)O ha\(^{-1}\) (Dierolf \textit{et al.} 2001).

Practically no systematic research work has been done so far on residue management and different fertilizer levels on fodder maize particularly in the
Saurashtra region of Gujarat. Taking note on the points highlighted above, the present investigation was carried out to study the “Effect of wheat residue management and fertilizer levels on fodder maize (Zea mays L.) in medium black soils of Saurashtra” at Farming System Research Centre, AICRP-IFS, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh, during summer seasons of 2015 and 2016 with following objectives:

1. To study the effect of wheat residue management and fertilizer levels on growth, yield and quality of fodder maize.
2. To study the effect of wheat residue management and fertilizer levels on N, P, K content and uptake by plant and soil fertility.
3. To study the interaction effect of wheat residue management and fertilizer levels on fodder maize.
4. To study the effect of wheat residue management and fertilizer levels on soil microbes.
5. To study the effect of wheat residue management and fertilizer levels on soil moisture content.
6. To arrive at an economically viable conclusion for fodder maize.