Agro Biodiversity for Millet Crops Resource in Andhra Pradesh and Telangana

बारीक अनाज वाली फसलों की जैव विविधता के ससांधन का आन्ध्रप्रदेश एवं तेलगांना में अध्ययन

Naresh Kumar Jajoriya

Project Report

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SRI KARAN NARENDERA AGRICULTURE UNIVERSITY,
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in partial fulfillment of the requirement for
the degree of

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In the

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By

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2016

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Place: Jobner

Dated: …… ***(NARESH KUMAR JAJORIYA)***

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%	Percentage
GDP	Gross Domestic Product
QGIS	Quantum Geographic Information
OGC	Open Geospatial Consortium
CV	Coefficient of Variation
MGC	Millet Garden Cress Seed
RTE	Read to Eat
NARI	Nimbkar Agricultural Research Institute
ISEC	Institute for Social and Economic Change

CHAPTER-1
INTRODUCTION

A variety of animals, plants and microorganisms that are used directly or indirectly for food and agriculture purpose including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre and fuel uses. It also includes the diversity of non-harvested species that support production (soil microorganisms, predators and pollinators) and those in the wider environment that support agro-ecosystems (agricultural, forest and aquatic) as well as the diversity of the agro-ecosystem (Source: FAO, 1999a).

Agricultural biodiversity is a broad term that includes all components of biological diversity of relevance to food and agriculture and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystem. The variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes.

Biodiversity and Agriculture are strongly interdependent. Biodiversity is the basis of agriculture. It has enabled farming system to evolve ever since agriculture was first developed some 10,000 year ago. Biodiversity is the origin of all species of crops and domesticated livestock and the variety within them. It is also the foundation of ecosystem services essential to sustain agriculture and human well-begin.

Andhra Pradesh is virtual bio-reserve, which is unique both in terms of biodiversity and abundance. Andhra Pradesh is having huge agriculture crops biodiversity. The conservation and sustainable utilization is the need of the hour. In The state represents one of the richest repositories of biodiversity in the whole of south and south East Asia due

to varied topography from the hilly ranges of Eastern Ghats, the Nallamalais to the shore of Bay of Bengal. Andhra Pradesh is a home to at least eight species of millets, 12 species of pulse, 6 species of oil seeds and each one of them sporting dozens of varieties.

Agriculture plays a vital role in the Indian economy because about 70 percent of the rural households depend on agriculture as their principal means of livelihood. Agriculture along with fisheries and forestry accounts for one-third of the nation's Gross Domestic Product (GDP) and is a single largest contributor. Agricultural exports contribute about fifth part in the total export basket of the country.

Quantum geographical information system (QGIS) is a free computer program for mapping and geographic data analysis a geographic information system (GIS) with QGIS. You can make maps of the world, or of a very small area, using, for example, state boundaries, rivers, a satellite image, and the locations of sites where an animal species was observed. We also provide free spatial data for the whole world that you can use in QGIS or other programs. You can use the program to analyze data, for example by making grid (raster) maps of the distribution of biological diversity, to find areas that have high, low, or complementary levels of diversity based on this you can also map and query climate data.

Agricultural station involves use of more information on resources used in crop production. A large amount of information is needed and also produced on a day-to-day basis which needs to be stored, processed and analyzed for making decisions on farm resources allocation. Such huge information also needs to be linked to data of their corresponding location in the farm throughout the year. In most experimental farms, this information is maintained in registers or notebooks. The data is being stored in computers in the form of tables in a database for retrieval and

analysis as find when required. But the tabular data by itself is often Inadequate as its link with location on the farm cannot be visualized. Geographic Information Systems (GIS) allow attaching attribute information in tables to a geographic location and visualizing the distribution of the data spatially. Therefore there can be useful in effectively addressing the complex task of managing field operations across a wide range of field plots, crops and experiments, GIS is an extremely powerful tool for handling information about objects and events in the landscape (Worboys, 1995). The recent developments in adopting web services for various GIS applications, the issue of sharing spatial data in real time has additional dimension. The Open Geospatial Consortium (OGC) web services provide a vendor-neutral interoperable framework for web-based discovery, access, integration, analysis and visualization of multiple online geospatial data sources (Sreekanth et al, 2013). Currently use of GIS and Web GIS in Indian experimental farms is negligible.

In India, four millets species (Sorghum, Finger Millet, Pearl Millet, Small Millet,) are commonly cultivated under rainfed conditions. Pearl Millet and Sorghum are sown as major crop in the Telangana (AP), Maharashtra and some parts of Central India.

Finger Millet is a minor crop in Telangana. The sorghum predominates in areas receiving annual rainfall beyond 400 mm. Pearl Millet rivals it in areas with annual rainfall of 350 mm. Further the Small Millets like Finger Millet, Foxtail Millet, Barnyard Millet, Little Millet and Proso Millet are found in most of the Southern and Central States in India especially annual Rainfall is below 350 mm perhaps where no other cereal crop can grow under such moisture stress.

Andhra Pradesh lie between 12°41' and 19.07°N latitude and 77° and 84°40'E longitude and is bordered by Telangana in the north. The Bay of Bengal in the East area of 160, 25 km2 (61,855 sq mi) Telangana.

Millets are mainly grown in deltaic tracts of Godavari, Krishna and Cauvery Rivers and the non-deltaic rain fed area of Andhra Pradesh. Millets are grown under irrigated condition in deltaic tracts.

Millets are one of the oldest foods known to humans & possibly the first cereal grain to be used for domestic purposes. Millets are small-seeded grasses that are hardy and grow well in dry zones as rainfed crops, under marginal conditions of soil fertility and moisture. Millets are also unique due to their short growing season. They can be harvested in short duration in as little as 65 days. The storage of the millet is also easy can be stored for more than one year without much more problem.

The total of 23 million ha under millets, small millets alone account for about 3.5 million hectare and their cultivation is extending from sea level in Coastal Andhra Pradesh up to an altitude of 2438 meters above sea level in hills of Uttaranchal and North-eastern states. These are drought tolerant crops and are grown in diverse of soils, varying rainfall regimes and in areas widely differing in thermo and photoperiods. The resilience exhibited by these crops is helpful in their adjustment of different kinds of ecological niches and have made them quite indispensable to rainfed, tribal and hill agriculture where crop substitution is difficult. It is important to enhance production and productivity of these crops to ensure food and nutritional security.

These are grains eaten by breaking them it and cooking them it in the same way as rice or by grinding in into flour and preparing unleavened bread from it. It is furnished and important food for the poor people and labour class, and is particularly invaluable in cold weather because of its heating qualities. The flour made from the grain is very nutritious and is used for making bread. The stem and leaves are used as cattle fodder especially in north India. The crop has an enormous yield of forage. Its grains can be made into cakes, porridge and sweet meats. A beer is

brewed from the grains by the hill-tribes. The flour is used for puddings. Its straw is considered a valuable food for the milk animals. It is often a precious fodder for bovines.

The major growing states are Karnataka, Tamilnadu, Andhra Pradesh, Orissa, Jharkhand, Maharashtra and Uttaranchal. The grain is processed and consumed in traditional way and almost the entire produce is utilized at the farmers/ village level. In spite of superior nutritive value of grains, their use is confined more to rural areas and very little, finds its way to urban markets. Utilization of these grains is mainly as food for human consumption. The problem of pest and diseases in small millets is negligible. Being eco-friendly crops, they are suitable for fragile and vulnerable ecosystems and regarded as preferred crops for sustainable and green agriculture. The promotion of these crops can lead to efficient natural resource management and holistic approach in sustaining precious agro- biodiversity.

It is estimated that over 93% of Millet production is used as food, the reminder begin divided between animal and poultry feed (7%), other uses (seed, bakery products etc.) to very limited extent.

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crop or grains for fodder and human consumption purpose. Millets are important crops in the semiarid tropics of Asia and Africa with 97% of millet production share in developing countries. The crop is favoured due to its productivity and short growing season under dry, high-temperature conditions. The most widely grown millet is pearl millet, which is an important crop in India and parts of Africa. Finger millet, proso millet and foxtail millet are also important millet crop species.

Millets offer unique advantage for health being rich in micronutrients, particularly minerals and vitamin B as well as

nutraceuticals. Though millets are not the important part of daily diet of American and European people, now these countries have recognized the importance of millets as ingredient in multigrain and gluten-free cereal products. However, in many Asian and African countries millets are the staple food of the people in millet producing areas and are used to prepare various traditional foods and beverages like idli, dosa, papad, chakli, porridges, breads, infant and snack foods (Chandrasekara and Shahidi, 2011).

Many countries Including India, China, USA etc. have now started research projects to study and develop processing technology for nutritional Improvement and to harvest health benefits and promote their utilization as on large scale. 21st century challenges like climate change, water, scarcity, increasing world population, rising food prices, and other socio economic impacts are expected to generate a great threat to agriculture and food security worldwide, especially for the poorest people who live in arid and sub-arid regions (Saleh et al., 2013).Typical grain texture and hard seed coat of millets increases their keeping quality but makes them difficult to processing as well as cook in convenient form. Absence of appropriate primary processing technologies to prepare ready-to-use or ready-to-cook (RTC) products and also secondary as well as tertiary processing to prepare ready-to-eat value added products are the major limiting factors for their diversified food uses and better economic status (Malleshi, 2014).

Sorghum has been, for centuries, one of the most important staple foods for millions of poor rural people in the semiarid tropics of Asia and Africa. For some impoverished regions of the world, sorghum remains a principal source of energy, protein, vitamins and minerals. Sorghum grows in harsh environmental conditions where other crops do not grow well, just like other staple foods that are common in impoverished regions of the

world. It is usually grown without application of any fertilizers or other inputs by a multitude of small and marginal farmers in many countries.

Grain sorghum is the third most important cereal crop grown in the United States and the fifth most important cereal crop grown in the world in 2010. Nigeria was the world's largest producer of grain sorghum, followed by the United States and India. In developed countries, as well as in developing countries such as India, the predominant use of sorghum is as fodder for poultry and cattle.

Pearl millet (Bajra) is one of the major coarse grain cereal (millets) and is considered to be a poor man's food. It is widely grown in Africa and Asia sincepre-historic period. It is grown in Africa where it replaced sorghum as the principle crop on sandy soils and in the dry areas in India, Pakistan, China and south eastern Asia. In India, it is the most important millet crop which flourishes well even under poor soils and adverse weather conditions. It provides staple food for the poor in a short period dry tracts of the country. It is the most drought-tolerant crop amongst cereals and millets. The grain of Pearl millet is superior in nutritive value than sorghum grains but inferior in feeding value. Bajra grains contain about 11.6% protein, 5% fat, 67.5% carbohydrates and about 2.3% minerals. Pearl millet (Bajra) grains are eaten cooked like rice or 'chapatis' are prepared from bajra flour like flour of maize or sorghum. Pearl millet grain is also used as feed for poultry and green or dry fodder (karbi) for cattle.

In India, pearl millet is primary source of dietary energy (360 k cal/kg) for rural population in drier parts of the country and fourth most important cereal after rice, wheat and sorghum. It is a rich source of protein, calcium, phosphorous and iron. Pearl millet grain contains fairly high amount of thiamine, riboflavin and niacin. A significant portion of pearl

millet grain is also used for non-food purpose such as poultry feed, cattle feed and alcohol extraction (Basavaraj et al., 2010).

Pearl millet (*Pennisetum glaucum*) is one of the earliest foods known to human and has been a staple food for thousands of years in many parts of the world (Manning et al., 2010). The crop is highly tolerant to abiotic stress like drought, salinity and high temperature and therefore grown for grain and stover in the hottest and driest areas of Africa and South- Asia (hash 2002). It is estimated that over 95% of Pearl millet production is used as food, the remaining 5%) being divided between animal and poultry feed (ICRISAT 1997).

Food uses of millets have, however, been confined only to traditional consumers; limited especially to areas of their cultivation and still have remained underutilized. Processing them using traditional as well as contemporary methods for preparation of value added and convenience products would certainly diversify their food uses. Their exploitation for preparation of ready-to-use or ready-to-cook products would help in increasing the consumption of millets among non-millet consumers and thereby nutritional security. The present study is an attempt to describe some basic information about finger millet, the processing requirement and some avenue for its value addition and food uses.

Finger millet (ragi) is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The calcium content is higher than all the cereals and iodine content is said to be highest among all the food grains (Desai et al., 2010). Finger millet has best quality protein along with the presence of essential amino acids, vitamin A, vitamin B and phosphorus (Gopalan et al., 2004). Finger millet (ragi) provides highest level of calcium, antioxidants properties and photochemical which make it easily

and slowly digestible. Hence it helps to control blood glucose levels in diabetic patients very efficiently.

Small millets are the hardiest crops, belong to family *Poacea* and include an estimated 8000 species belonging to some 600 genera. Among them, eight small seeded species are used as food crops in different countries globally. These include finger millet (*Eleusine coracana*), foxtail millet (*Setaria italic*), proso millet (*Panicum miliaceum*), little millet (*Panicum sumatrense*), barnyard millet (*Echinochloa esculenta*), kodo millet (*Paspalum scrobiculatum*), ICRISAT has the global responsibility of germplasm assembly, characterization, conservation, documentation and distribution of the first six of these crops and hence this paper confines to these six small millets. The small millets are adapted to varied agro climatic regions, which can be grown in lands almost at sea level to about 3200 metres above sea level. Their use as food, feed and fodder make them important for food security. Their grains are rich sources of calcium, iron, zinc, beta-carotene, and high quality proteins, contributing significantly in reducing malnutrition that affects nearly half of the world's population, particularly in developing countries of Africa and Asia. The Stover serves as quality fodder for cattle. Small millets can be stored for long periods without insect damage and provide succour during famine. Considering their nutritive values it would be appropriate to call them nutritious millets. Small millets are early maturing, water-use efficient and input responsive crops. The six small millet crops are together cultivated on 18-20 m ha with a production of 15-18 m tons in the country for Africa and Asia (Prasada Rao and de Wet 1997). ICRISAT Genebank (Patancheru, India) conserves 10,193 accessions of six millets (finger millet 5949, kodo millet 658, foxtail millet1535, little millet 466, proso millet 842 and barnyard millet 743) from 50 countries.

Empirical micro studies on millet crops resource required proving that their status and Role were not only marginal and supplementary but central to the development of agriculture. Keeping these facts in view; the present study was undertaken with regard to the “Agro-biodiversity for Millet crops resource in Andhra Pradesh and Telangana” state of India.

The specific objectives of the study are:-

1. To collect the Secondary data for Millet crops resource of Andhra Pradesh and Telangana.
2. To study the crop diversity available in Andhra Pradesh and Telangana and locate the distribution map using GIS.

CHAPTER-2
REVIEW LITERATURE

Millet is a group of several species of small grained cereal crops and is a staple food in some parts of India, Africa and China. Millet has been cultivated since longs time in regions of North Africa and Central Asia, Most of the millets are produced in Asia and Africa. In Europe and the United States, millet is grown mainly as feed for poultry and as birds. Millet contains an average of 10 - 12% protein and it is superior to that of wheat or corn in terms of content of essential amino acids, it contain less than half the amount of the essential amino acid lysine that is found in high quality protein sources such as meat. Millet lacks gluten, the wheat protein that makes dough prepared from wheat flour elastic; hence millet flour is not suitable for leavened breads. Millet flour is used in making flat cakes and breads. The whole grain is used in soups, stews or as a cooked cereal. Millet is also popped; roasted or sprouted.

The millet is employed for several related genera, some used to produce grain, or forage or both. Millets are cereal species growing in an equally broad range of environments. The most widely cultivated millets are finger millet (*Eleusine coracona*), foxtail millet (*Setaria itallica*), pearl millet (*Pennisetum glaucum*), proso millet (*Panicum miliaceum*), barnyard millet (*Echinochooa esculenta*) etc. Millets are considered the least important cereals, with annual production less than 2% of the world's grain production. However they are of great local importance as staples and as reserve crops in marginal areas.

The chapter has been divided into two sections for presenting the available studies in a systematic manner.

i. To collect the Secondary data for Millet crops resource of Andhra Pradesh and Telangana.

ii. To study the crop diversity available in Andhra Pradesh and Telangana and locate the distribution map using GIS.

2.1. To collect the secondary data on Millets crop.

Kumar De (2000) pointed out agricultural diversification particularly the changing cropping pattern had been contributing significantly to the rural development in West Bengal, which was an important agricultural state of India over a long period. The paper examined the spatio-temporal nature of crop diversification in the state in terms of some crop diversification indices.

Alemu (2005) conducted a study to measure the causes of instability in cereal production in Ethiopia. In this study the extent of instability in cereal production was analyzed by computing the statistics, namely average production, coefficient of variation (CV), and F-statistics. The CVs were computed based on results on the fitted trend lines of polynomials of different order. He found that production instability was caused more by increased yield instability than instability in an area. The instability in yield could be the result of changes in technology, changes in policy and changes in weather conditions. It was concluded by this study that instability regarding yield was predominantly the result of weather variability.

Meenakshi and Gayathri (2006) measured instability in cereals production. They identified that change in the interaction between mean area and yield variance had been an important contributor to the cereals production instability in Tamil Nadu state. Therefore, efforts should be made to stabilize cereals production in the state.

Sharma *et al.* (2006) carried out a study on the extent and source of instability in food grains production in India. They found that an increase in average production of major food grain crops, namely, rice, maize, bajra and pulses and total food grains in the nineties over eighties. The

decomposition of change in average production further revealed that increase in mean yield was the most important source of increase in the average production of individual crops and total food grains. The notable exceptions were jowar, small millets and ragi where increase in area was an important source of increase in average production.

Swain and Bhakar (2006) analysed the trends in the area, production and yield of some common commercial crops, cereals and pulse crops grown in Rajasthan and they also focused on the degree of fluctuations in the growth of area, production and yield of commercial crops.

Marothia *et al.* (2007) analysed the crop diversification in Chhattisgarh state. This study clearly indicated that there was no evidence of crop diversification in the agro-climatic zones as well as in the state even after a massive emphasis placed on agriculture diversification, particularly after the formation of the state.

2.2. To study the crop diversity of millets and locate the distribution map using GIS tools.

Nagarajan and Smale (2005) studied that the local seed systems and village-level determinants of millet crop diversity in marginal environments of India. In the subsistence-oriented, semi-arid production systems of Andhra Pradesh and Karnataka, the environment is marginal for crop growth and often there is no substitute for millet crops. Across communities, farmers grow thirteen different combinations of pearl millet, sorghum, finger millet, little millet, and foxtail millet varieties, but individual farmers grow an average of only two to three millet varieties per season. The notion of the seed system includes all channels through which farmers acquire genetic materials, outside or in interaction with the commercial seed industry. The data were compiled through household surveys and interviews with traders and dealers in village and district

markets. Based on the concept of the seed lot, several characteristics of local seed markets are defined and measured by millet crop, including seed transfer rates for farmer-to-farmer transactions and seed replacement ratios. Most seed transactions appear to be based on money. Seed supply channels differ by improvement status of the genetic material. Econometric results indicate the significance of the seed replacement ratios and seed volumes traded in determining the levels of crop biodiversity managed by communities, in addition to the household, farm and other market-related factors identified by previous studies were who interpreted as indicators of market strength.

Nagarajan *et al*. (2006) studied the local seed availability for millet crops in marginal environment of India and reported that most advances have been made in the major millet crops, sorghum and pearl millet, as compared to finger millet and other minor millet crops, which in many ways dependent on local markets for seed purposes. In this study, he analysed the evolving interactions between formal systems related to the delivery of modern varieties and informal systems for maintaining traditional seeds in the semi-arid regions of India. It is evident that in these marginal environment, crop and variety use decisions and the crop biodiversity levels take place within the context of local seed markets and a national seed industry. The outcome of the study has helped to identify potential entry points for millet crop improvement and related seed system interventions for marginal environments of India.

Jackson *et al.* (2010) studied that the biodiversity and agricultural sustainability can be achieved by better utilization of local and often only locally known plant species in diversified cropping systems can be an important first step toward secure food provision in times of uncertainty. It is also likely to contribute to the resilience of rural communities and to

‘sustainability’—the capability for dynamic and intelligent responses to future unpredictable events.

Yenagi *et al.* (2010) studied that The local crops are directly consumed as staple foods, can provide valuable nutrients as part of a healthier diet are also used as fodder and thus can be converted into meat, milk or eggs, and can be processed into other products and sold to increase income thus providing greater flexibility to producers and consumers.

Ashok *et al.* (2011) analysed that sorghum is one of the most important cereal crop widely grown for food, feed, fodder/forage, and fuel in the semi-arid tropics of Asia, Africa, the America and Australia. The global sorghum area remained static as the increased area in Africa compensated the area loss in Asia. Inspite of rapid decline in sorghum area in Asia due to competition from other remunerative crops, sorghum grain production levels have not declined at the same rate owing to adoption of high yielding hybrids. Though impressive gains have been made in improving productivity levels, biotic and abiotic challenges such as shoot fly, stem borer, grain molds, and terminal drought stress continue to haunt the sorghum growers across the world. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the respective national programs are working on genetic enhancement of sorghum for high yield; shoot fly, and grain moldresis-tance, and sweet stalk traits. In addition, research focus at ICRISAT also includes adaptation to post rainy season, terminal drought tolerance, and increasing micronutrient contents (Fe and Zn) in grain. Genetic and cytoplasmic diversification of hybrid parents and varieties for key traits is critical for sustaining the productivity gains. The grain and Stover quality requirements of different market segments needs special attention in sorghum improvement research to enhance its market value.

Meles (2011) through assessed diversity and sustainability in agricultural landscape. Relationships between diversity of crops, trees and shrubs at the farmers' field level and physical environment, soil erosion, crop production characteristics, farmers' wealth parameters, and proximity to urban area and road in soil erosion were to be the main indicators of unsustainability. He found plant diversity increased significantly with altitude, soil class and number of crop selection criteria, while this diversity declined as farmers' access to credit and chemical fertiliser use increased. Plant and crop diversity were positively correlated with number of weed species and number of insect pests per farm but negatively with soil erosion class. Soil erosion was positively associated with fertilizer use and negatively with plant diversity and numbers of animals per household, as indigenous plants and landraces were purposefully maintained to feed the animals. Proximity of farms to urban area and roads negatively affected biodiversity (plant and crop diversity) in agricultural landscapes. He suggested that indigenous farming practices in mosaic agricultural landscape are associated with higher plant diversity and sustainability of agro-ecosystems.

Shantharaj *et al*. (2011) studied nutritional bio-fortification in pearl millet. They focused on nutritional enhancement and improvement in pearl millet a staple food crop of the semi-arid tropic largely grown for food and fodder in part of India. Two of the most comprehensive models of climate change suggest that pearl millet is among the winner crops which are likely to be most suited and widely cultivated in future. Apart from being used as food for human consumption & feed for livestock & poultry. Pearl millet grain is also gaining importance as a cheap source of starch for fine quality brewing & in other diversified food uses. Pearl millet being a crop grown & consumed by the poorest farmers needs nutritional bio-fortification by conventional and transgenic approaches to counteract the

present nutritional deficiency in sub-saharan Africa and part of India. The crop is highly tolerant to abiotic stressors like drought, salinity and high temperatures. Breeding crops for better nutritional qualities is the main aim of bio-fortification. Bio-fortification technology apart from improving nutrition uptake in plants also helps host plants in defending plant diseases. Pearl millet is projected as a climate change compliant crop. It is a rich source of energy, protein, vitamins and minerals for the poorest of the poor. The beneficial properties of pearl millet in terms of nutrition and health play a major role in securing nutrition to the undernourished people and food-based health management, however, some to the best endowed lines lack in terms of iron and zinc content. Therefore, bio-fortification on pearl millet is a promising technology.

Elangovan and KiranBabu (2013) in their study on crop diversity play important role on sustainable development: A study on crop diversity in Andhra Pradesh. The cultivated crop plant species resulted in augmentation of 140 species belonging to 132 genera and 46 families. The maximum species strength was observed in the Rayalaseema region (127 species belonging to 120 genera and 43 families), followed by Telangana region (125 species belonging to 114 genera and 43 families) and parts of Coastal Andhra region (118 species belonging to 103 genera and 46 families). Species richness was predominant in cultivated crops like vegetable crops (31 species belonging 25 genera and 12 families), Fruit crops (25 species belonging 18 genera and 14 families), commercial crops (23 species belonging 23 genera and 15 families) and Leafy vegetables (12 species belonging 12 genera and 8 families). The present and the past similar studies observed that many more native species remain in agriculture than previously thought, under the suitable environment. There is a need to establish mechanisms to control the introduction of exotic species in natural habitats. We also need to

strengthen the legislation on the use of biodiversity and create awareness on the economic potential of our local flora and fauna as an alternative to introduction of exotic species to safeguard our traditional crop diversity.

Kahane *et al.* (2013) found the agro-biodiversity for food security, health and income. To maintain that level of productivity indefinitely agriculture must do so using environmentally sustainable production systems. This task is being profoundly complicated by the effects of climate change, increasing competition for water resources and loss of productive lands. Agricultural production methods also need to recognize and accommodate ongoing rural to urban migration and address a host of economic, ecological and social concerns about the 'high inputs/high outputs' model of present-day industrial agriculture. At the same time, there is a need to confront the unacceptable levels of continuing food and nutrition insecurity, greatest in the emerging economy countries of Africa and Asia where poverty, rapid population growth and climate change present additional challenges and where agriculture is practiced primarily by small-scale farmers. It was reviewed that science-based evidence arguing that diversification with greater use of highly valuable but presently under valorised crops and species should be an essential element of any model for sustainable smallholder agriculture.

Kavita *et al.* (2013) studied that the nutrient enrichment of little millet (*Panicum miliare*) flakes with garden cress seeds. Little millet (*Panicum miliare*) is one of the nutritious minor millet. Garden cress seed was blended with little millet at 5 per cent ratio to prepare iron enriched little millet flakes. Addition of garden cress seeds significantly increased iron content in Millet Garden Cress seed (MGC) flakes by 7.18 per cent and recorded 65.83 mg iron per 100 g of flakes compared to control little millet flakes (61.42 mg/100g). Protein content of MGC flakes was 13.15 per cent and fat content was 114.28 per cent higher than control millet

flakes. However, MGC flakes recorded significantly lower total carbohydrates (64.53%) and total dietary fiber (22.70%) than control millet flakes (66.14 and 24.10%) respectively and both the flakes recorded zero *trans* fats. Iron enriched flakes exhibited a shelf life of five months whereas control flakes were acceptable for more than six months.

Nagaraj *et al.* (2013) studied that more than60% of the cultivated area in India is in arid and semi-arid regions, characterized by long dry seasons, inadequate and unpredictable rainfall, and infertile and fragile soils. These regions provide around 40% of the food produced. Farmers exposed to harsh agro-climatic conditions cultivate shallow and poor soils receiving low and erratic rainfall below 600 mm recurrent droughts, coupled with frequent dry spells. Pearl millet and sorghum are grown in arid and semi-arid regions of India under rainfed conditions and continue to play a prominent role in the dry land economy. These crops possess unique features such as high nutritive value and high fodder value, and are drought tolerant. The productivity of these crops increased significantly during the green revolution era due to public and private investments in research and development (R&D).Though there was enhanced productivity, lack of economic incentives and effective demand meant that farmers reduced the area under millets by shifting to other crops.

Shanmugam and Joseph (2013) reported that the millets are widely grown around the world for food and fodder. Millets have been important staples food in human history, particularly in the poor, semi-arid tropics of Asia and Africa. The impact of new methods of field demonstrations indicated vast potential for increase in yield due to new methods are used. The yield level and income of farmers could be substantially increased by the used of the new methods. Enhancement in yield was around 82 % in finger millet, 95% in little millet, 83% in kodo millet, 43% in foxtail millet, 76% in proso millet and 82 % in barnyard millet

etc. Small millets despite low genetic potential are grown because of socio-economic conditions of the farmers and assured income under low input conditions. Inclusion of legumes as component crops helped in additional legume yield leading to nutritional security of the family and improved soil productivity and health. Similarly the adoption of other key components like use of new high yielding variety, application of fertilizers etc. showed significant influence on the yield of the crop.

Srivastav *et al*. (2014) reported that millets are nutritionally rich and occupy an important place in the diet of people in many regions of the world. Although millets are nutritionally superior to cereals their utilization as a food is still mostly confined to the traditional consumers and population of lower economic. The climate change, water scarcity, population increase, declining yields of major cereals, adequate access to enough food, strengthening local agro food systems present challenge to scientists and nutritionists to investigate the possibilities of producing, processing, and utilizing other potential food sources to end hunger and poverty. However, the special features of the millets, their beneficial uses and health consciousness of the consumer have made food scientists and engineers to develop various food products and mechanize the processes. Various traditional and convenience foods including ready-to-eat (RTE) food products have developed from millets and product characteristics.

Bhag Mal *et al*. (2015) studied the role of Minor Millets as a central element for sustainably enhanced income, empowerment, and nutrition in rural India. Minor millets comprise a group of cereal species that are genetically diverse and adapted to a range of marginal growing conditions where major cereals such as wheat, rice, and maize are relatively unsuccessful. Millets require few inputs and with stand severe biotic and abiotic stresses and are more nutritious than major cereals. Despite these advantages, negelence of there in several arenas has resulted in a steady

decline in the cultivation of minor millets in India over the past few decades. As part of a United Nations global project on underutilized species, we undertook action research intended to study the decline in cultivation and enhance the conservation and use of minor millets in 753 households spread across 34 villages in four states of India with the aim was to improve incomes, nutritional status, and empowerment, especially for women. Overall, our holistic approach to mainstreaming species such as finger millet, little millet, foxtail millet, and barnyard millet indicates that these neglected and underutilized species can play a strategic role in improving many dimensions of livelihoods.

Raizada *et al*. (2015) in their study observed that the small millets are food sources traditionally grown and consumed by subsistence farmers in Asia. They include finger millet, foxtail millet, kodo millet, proso millet, barnyard millet, and little millet. Local farmers value the small millets for their nutritional and health benefits, tolerance to extreme stress including drought, and ability to grow under low nutrient input conditions, ideal in an era of climate change natural resources. Little scientific attention has been paid to these crops; hence they have been termed “orphan cereals.” Despite this challenge, an advantageous quality of the small millets is that they continue to be grown in remote regions of the world which has preserved their biodiversity, providing breeders with unique for crop improvement. The purpose of this review paper is highlighting the diverse traits of each small millet species that are valued by farmers and consumers which hold potential for selection, improvement. For each species, the germplasm, genetic and genomic resources available will then be described as potential tools to exploit this biodiversity. They concluded that the noting current trends and gaps in the literature and make recommendations on how to better preserve and

utilize diversity within these species to accelerate a new green revolution for subsistence farmers in Asia.

Mishra *et al.* (2015) reported that agro biodiversity is a confluence of the past, present and future and both a tangible and intangible resource critical for both rural and urban food and nutrition security. Agro biodiversity consists of a series of village level interventions like establishment of gene-seed-grain banks, participatory conservation systems, participatory varietal selection, seed purification, promotion of farmer to farmer seed exchange, promotion of good agronomic and planting practices, use of small machinery for processing millets at local level, product diversification and linking to markets for strengthening livelihoods as well as mainstreaming use of agro biodiversity among urban consumers.

Rajvanshi and Nimbkar (2015) conducted research work on sweet sorghum at the Nimbkar Agricultural Research Institute (NARI) during last twenty-five years and summarized: their finally as case study Phaltan, Maharashtra, India. American lines were crossed with a local Indian fodder/grain variety to produce varieties with a juicy stalk and good quality grain. Further breeding work was carried out to produce varieties and hybrids giving high yield of good quality grain while retaining the characteristic of juicy stalks high in sugar content. Also development complete of indigenous technology for fermentation of sweet sorghum juice, solar distillation of ethanol and finally its use as a cooking and lighting fuel in new and improved stoves and lanterns. The technology of producing jaggery (unrefined sugar) and syrup from sweet sorghum was also developed and consumer response to these products was assessed by marketing them in limited quantities. A completely automated multi fuel gasification system capable of producing thermal output between 120-500 Kilowatt was developed for direct heat applications such as those in

jaggery and syrup making units. Sweet sorghum bagasse was also tested in an existing paper mill to assess its suitability for paper manufacture. Areas of possible research for better exploitation of sweet sorghum have been suggested.

Verma *et al.* (2015) studied finger millet from processing, value addition and point of view to enhance nutritional security among tribals. Finger millet is in food use since time immemorial, and large number of traditional food preparations is in practice in the rural areas particularly in the production catchments. Processing the finger millet using traditional as well as modern techniques for the development of value added and convenient food products would be the possible solution for its promotion and enhancement of consumption, nutritional status and thereby increasing profitability and better livelihood to the tribal community. This also helped the country to diversify the food basket for nutritional sustainable food availability to the common mass with low purchasing capacity. The review describes the almost possible made by finger millet.

CHAPTER- 3

MATERIALS AND METHODS

In this chapter is the material and methods adopted for the present investigation including selection of the problems and objectives of the study together with source of data, sample selections, period of study, scope and significance of the study and statistical tools used for data analysis are described. The research (project) work is depended, mainly on the use of secondary data to a limited extent is made wherever necessary. The secondary data related to the research is collected from the various sources such as books, articles, periodicals, institutions and websites etc.

The Study Area

The study is conducted in the all districts of two states namely Telangana and Andhra Pradesh with respect to area, production and yield of millet crops. The brief study of geographical information is the both states were given below.

(a) Andhra Pradesh

S.No.	Name of Crops	Geographical Location		Area (mha)	Production (mt)	Productive (Kg/Ha)
		Latitude	Longitude			
1.	Sorghum	12°41' North and 19°07' North	77° East and 84°40'East	139	214	1539
2.	Pearl Millet	12°41' North and 19°07' North	77°East and 84°40'East	280	360	1286
3.	Finger Millet	12°41' North and 19°07' North	77°East and 84°40'East	340	360	1059
4.	Small Millet	12°41' North and 19°07' North	77°East and 84°40'East	190	140	737

(Source: - Directorate of Economics and Statistics 2014-15).

(b) Telangana

S.No.	Name of Crops	Geographical Location		Area (mha)	Production (mt)	Productive (Kg/Ha)
		Latitude	Longitude			
1.	Sorghum	16°30'North and 18.20°North	77°30'East and 79°30'East	73	74	1014
2.	Pearl Millet	16°30'North and 18.20°North	77°30'East and 79°30'East	8	7	875
3.	Finger Millet	16°30'North and 18.20°North	77°30'East and 79°30'East	1	1	1114
4.	Small Millet	16°30'North and 18.20°North	77°30'East and 79°30'East	0	140	737

(Source: - Directorate of Economics and Statistics 2014-15).

3.1 To analysis the secondary data for millet crops.

3.1.1 Data collection: Processing and Techniques of Analysis:

The research (project) is based on secondary data collected from various websites, books, journals, various govt. intuitions and ICAR-NAARM, Hyderabad. Millet crops data related to state and district-wise data are available on the Institutional websites namely Institute for Social and Economic Change (ISEC). The missing data were estimated by using linear regressions.

The data on area, production and yield of millet crops etc., were collected from various sources in different formats. By using MS Excel software, above data were brought on single platform and posted in to MS Access data base in the form of Tables. The table is a collection of data elements organised in terms of rows and columns.

3.1.2 Data spread sheet Analysis: The following features were applied in this study as given below.

(a) Sub Total: The MS Excel subtotal feature works by inserting the subtotal function into a database or a list of related data. The subtotal

feature has been developed to make it easy to extract specific information from rows of related data.

(b) Pivot Table: A pivot table is a program tool that allows reorganizing and summarizing selected columns and rows of data in a spread sheet or database table to obtain a desired report. A pivot table doesn't actually change the spread sheet or database itself. A pivot table is especially useful with large amounts of data and allow to quickly reorganize the data and create a summary.

3.2 To study the crop diversity and locate the distribution map.

3.2.1 The crop diversity for millet crops: Agro biodiversity for millet crops resource has been explored in Telangana and Andhra Pradesh states to collect the crop diversity. The data were plotted using QGIS software to study the distribution, diversity and richness of millet crops. Agro biodiversity for millet crops were collected by secondary data collection. The prime objective of the project of millet crops for the study of nutritional benefits and food security and sustainable crop production in drought and rain fed cultivated conditions.

Research for this project is accomplished through collection of data and analysis is done through open source software viz., QGIS and Microsoft Excel. Data base is Microsoft Access database in the form of table by using Database technique.

Table Preparation: Microsoft Access is used to store database of information system and then data base is linked with GIS maps. An open sources software Quantum GIS has been used for creating various thematic maps.

3.2.2 GIS Tools: A geographic information system (GIS) is a computer-based tool for mapping and analysing things that exist and events that happen on earth. GIS technology integrates common database operations

such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps.

3.3.3 External data linkage: External data linking in QGIS software were process is given below;

i. Loading of Millets data in shape file and opening in the QGIS software, adding vector layer.
ii. Selecting and layering of attribute data table.
iii. Examining the attribute of tracts shape file.
iv. To join a table with this shape file we need a unique and common attribute for each feature. In this the district id field is unique identifier for each tracts and it can be used to link this shape file with any other table containing the same id.

3.3.4 Thematic map: Thematic map linking in QGIS software were process is given below;

i. Load a shape file by clicking the 'Add Vector Layer' icon.
ii. To add data about the geography you've loaded and join it to the shape file click 'Add Delimited Text Layer.
iii. Once the data is loaded, it's time to 'join' it to the shape file or other layer we loaded earlier. Right-click on the layer and press 'Properties'.
iv. Select Joins, then the green plus.
v. Select your csv file ('Join layer'), the unique code you're using to join, which is probably a similar Id ('Join field') and the target field in your vector layer.
vi. Once the join is completed you can create a thematic map by modifying the 'Style' tab of the layer properties.
vii. I typically change 'Single Symbol' to 'Graduated' and selecting an appropriate colour gradient:

viii. The finished result should look something like this. If you want to reproduce this map you can obtain the districts send scores and shape file map layer.

CHAPTER-4
RESULT AND DISCUSSION

Geographical Information System (GIS) has been successfully used to study the location distribution of cultivated crop species as well as diversity assessment of millet crops. QGIS is GIS software designed to assist the crop diversity and agro biodiversity communities to map the range of distribution of crop species.

GIS is successfully used by policy makers and scientists identifying areas of high diversity sorghum, pearl millet, finger millet and small millet. Hence the present study was undertaken to investigate crops diversity of the area, production and productive, diversity and distribution maps of sorghum, pearl millet, finger millet and small millet with the help of QGIS.

The classify of the secondary data of three years 2004, 2009 and 2014 were used to prepare map and describe the location of distribution of crop diversity area, production and productive in Telangana and Andhra Pradesh state.

This study will provide baseline data for further data analysis on exploration, collection, conservation and use of crops diversity area, production and productive. Crop relatives as well as for studies on the factors that explain the location distribution of four millet crops.

Crops diversity originating in Telangana and Andhra Pradesh state were assembled by introducing already collected data from various organizations located in different district and by launching systematic collection missions in Telangana and Andhra Pradesh state in partnership with the Institute for Social and Economic Change (ISEC).

Table 4.1: Classification area, production and productivity of sorghum in Telangana state during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Adilabad	2801	93162	69279	0.74	58316	70743	1.21	3251	28886	8.89
Karimnagar	2803	2556	2470	0.97	956	806	0.84	167	0	0
Khammam	2810	6758	4949	0.87	8336	6584	0.79	1775	1553	0.87
Mahabubnagar	2807	95781	46892	0.49	63874	39234	0.61	13539	17158	1.27
Medak	2804	59292	52875	0.89	36761	32741	0.89	17274	26104	1.51
Nalgonda	2808	21079	7733	0.37	12628	8333	0.66	979	2080	2.12
Nizamabad	2802	25425	22094	0.87	10147	9868	0.97	5395	3900	0.72
Rangareddy	2806	44812	56504	1.26	21900	20202	0.92	2883	8282	2.87
Warangal	2809	11342	6486	0.57	11389	8204	0.72	2120	3086	1.46

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

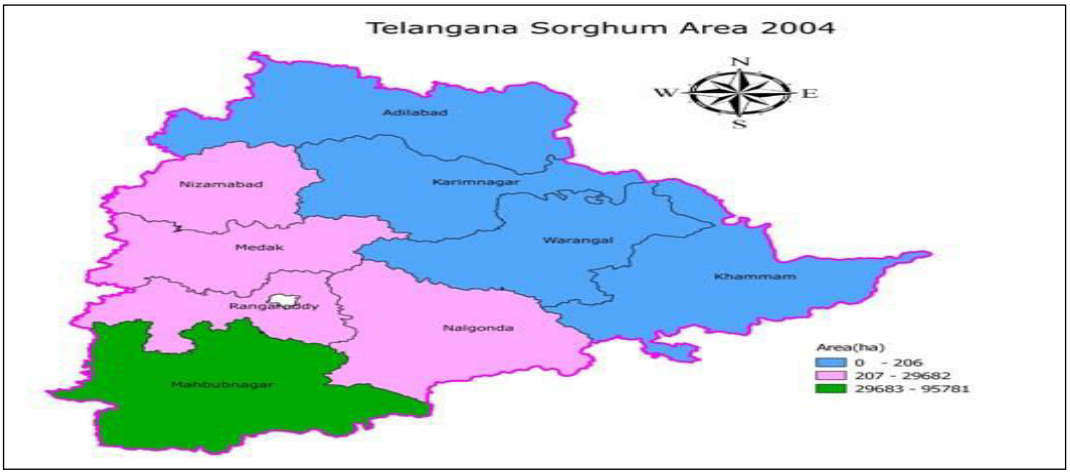

Fig.4.1. Area under cultivation of sorghum in Telangana (2004)

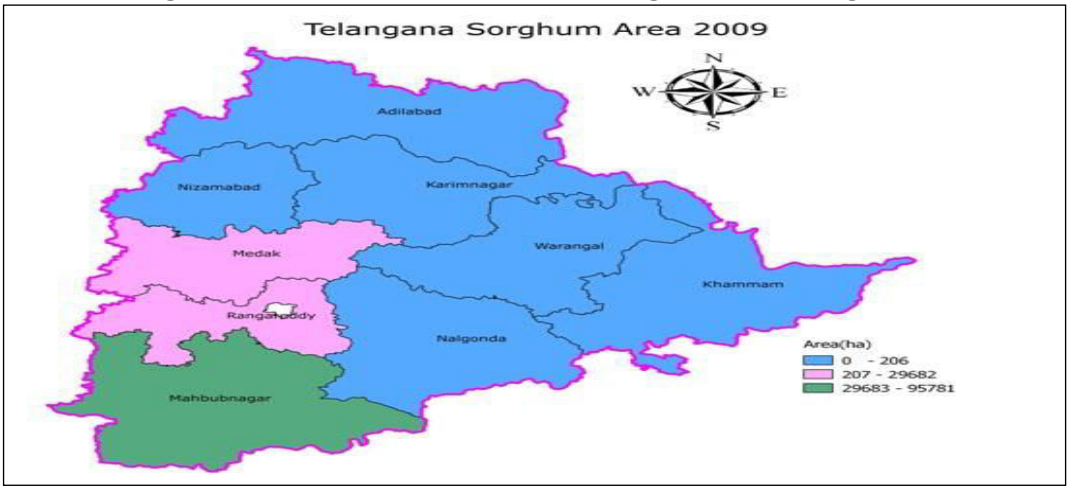

Fig.4.2. Area under cultivation of sorghum in Telangana (2009)

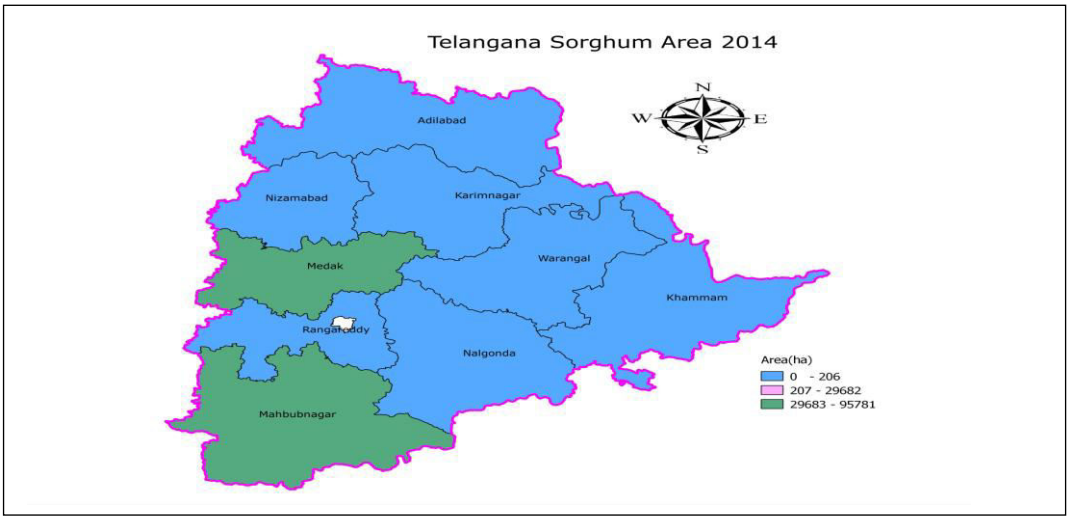

Fig. 4.3. Area under cultivation of sorghum in Telangana (2014)

Table 4.2: Classification of the range of low, medium and high of total sorghum cultivated area in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area of sorghum (ha)		
		Low (0-206)	Medium (207-29682)	High (29683-95781)
1	2004	4	4	1
2	2009	6	2	1
3	2014	7	-	2
Total		17	6	4

Sorghum cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.1 and Fig. 4.1, 4.2 and 4.3.

The sorghum cultivated area crop diversity map is shown in (Fig. 4.1 and Table 4.2) and found three ranges of area in 2004. One is consisting of the four districts Adilabad, Karimnagar, Warangal and Khamman having (0-206) low crop diversity and second range consisting of the four districts Nizamabad, Medak, Rangareddy and Nalgonda showed (207-29682) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (29683-95781) high crop diversity.

The sorghum cultivated area crop diversity map is shown in (Fig. 4.2 and Table 4.2) and found three ranges of area in 2009.One is consisting of the six districts Adilabad, Nizamabad, Karimnagar, Nalgonda, Warangal and Khamman having (0-206) low crop diversity and second range consisting of the two districts Medak and Rangareddy showed (207-29682) medium crop diversity, whereas the third range

consisting of the one district Mahbubnagar having (29683-95781) high crop diversity.

The sorghum cultivated area crop diversity map is shown in (Fig. 4.3 and Table 4.2) and found three ranges area in 2014. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Nalgonda, Warangal, Rangareddy and Khamman having (0-206) low crop diversity and second range consisting of the zero district showed (207-29682) medium crop diversity, whereas the third range consisting of the two districts Mahbubnagar and Medak having (29683-95781) high crop diversity.

The classification of the Telangana state for total districts crop diversity in sorghum cultivated area reflected that seventeen districts having (0-207) low crop diversity, six districts having (207-29782) medium crop diversity and four districts showed (29683-95781) high crop diversity that is also shown in Fig. 4.1, 4.2 and 4.3 and Table 4.2 during 2004, 2009 and 2014.

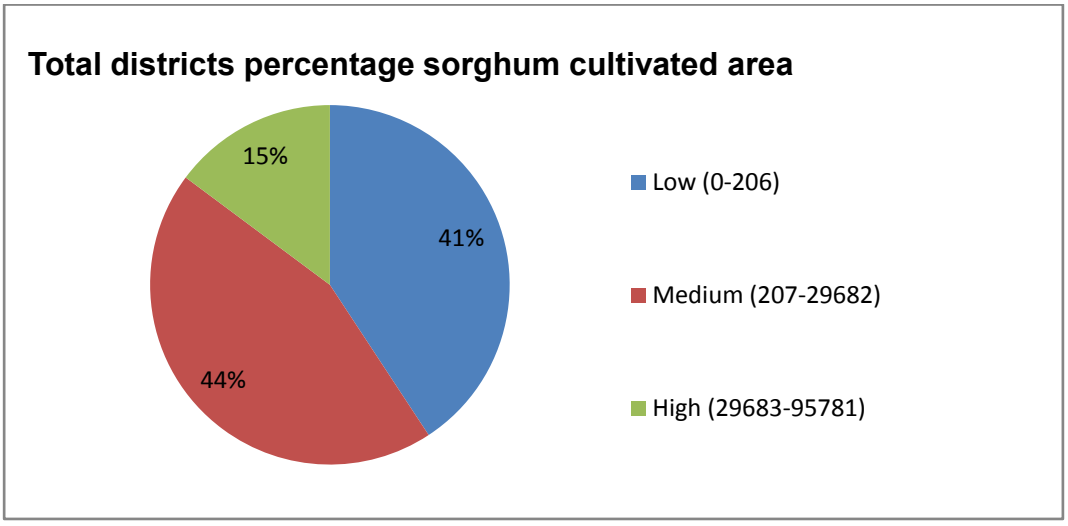

Fig. 4.4. Total districts sorghum cultivated area of Telangana state in three years (percentage).

The total districts crop diversity in sorghum cultivated area is found 63% low, 22% medium and 15% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.4

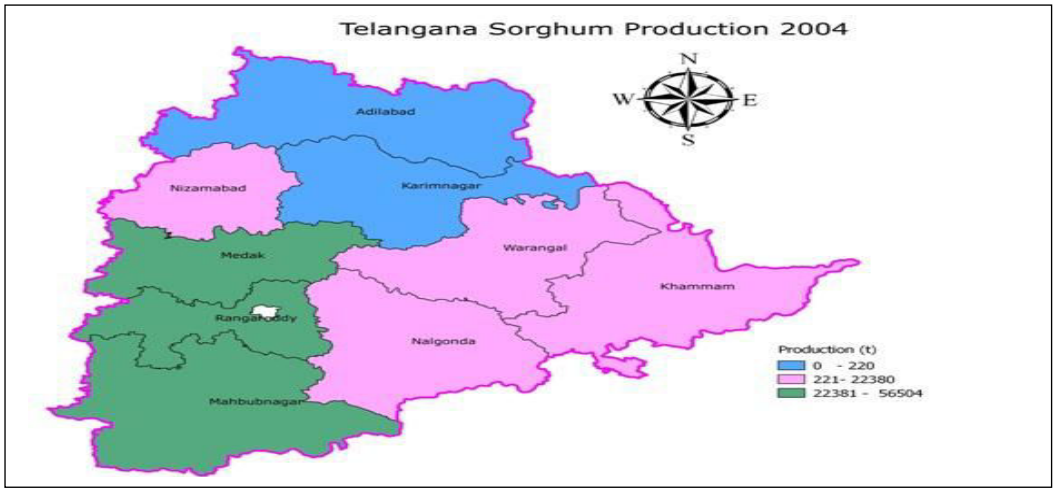

Fig. 4.5. Production under of sorghum in Telangana (2004)

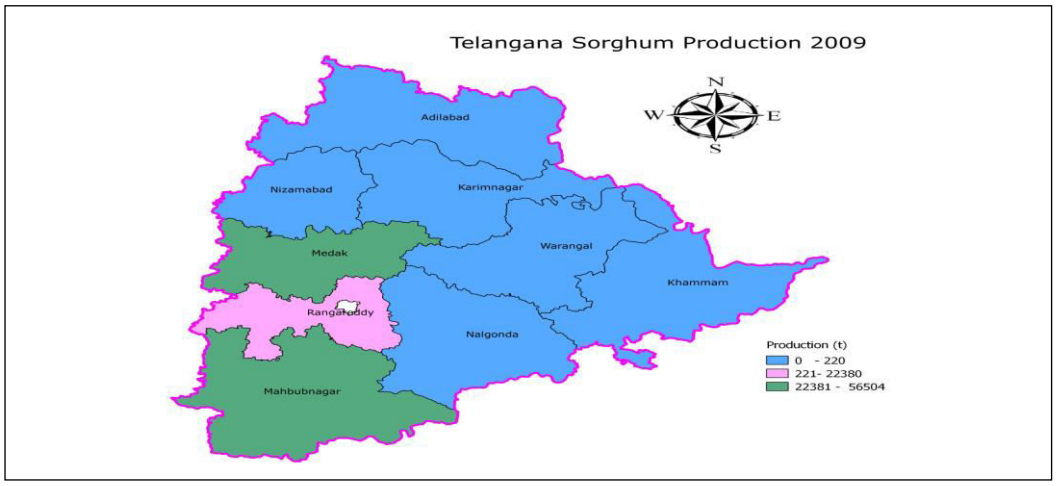

Fig. 4.6. Production under of sorghum in Telangana (2009)

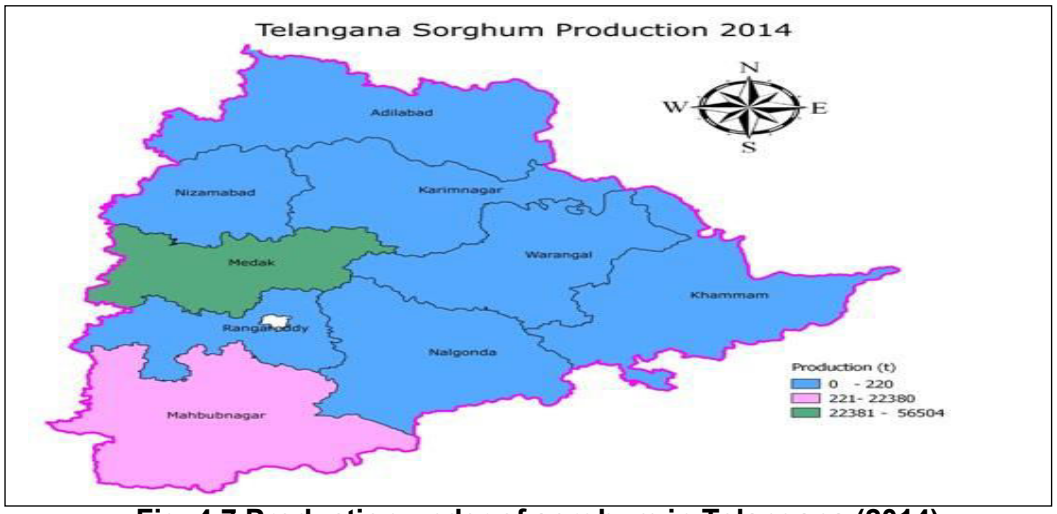

Fig. 4.7 Production under of sorghum in Telangana (2014).

Table 4.3: Classification of the range of low, medium and high of total sorghum production in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of sorghum (t)		
		Low (0-220)	Medium (221-22380)	High (22381-56504)
1	2004	2	4	3
2	2009	6	1	2
3	2014	7	1	1
Total		15	6	6

Sorghum production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients is shown in Table 4.1 and Fig. 4.5, 4.6 and 4.7.

The sorghum production crop diversity map is shown in (Fig. 4.5 and Table 4.3) and found that three ranges of production in 2004. One is consisting of the two districts Adilabad and Karimnagar having (0-220) low crop diversity and second range consisting of the four districts Nizamabad, Nalgonda, Warangal and Khammam showed (221-22380) medium crop diversity, whereas the third range consisting of the three districts Medak, Rangareddy and Mahbubnagar having (22381-56504) high crop diversity.

The sorghum production crop diversity map is shown in (Fig. 4.6 and Table 4.3) found three ranges of production in 2009.One is consisting of the six districts Adilabad, Nizamabad, Karimnagar, Nalgonda, Warangal and Khamman having (0-220) low crop diversity and second range consisting of the one district Rangareddy showed (221-22380) medium crop diversity, whereas the third range consisting of the two districts Medak and Mahbubnagar having (22381-56504) high crop diversity.

The sorghum production crop diversity map is shown in (Fig. 4.7 and Table 4.3) and found that three ranges of production in 2014.One is

consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Nalgonda, Warangal, Rangareddy and Khamman having (0-220) low crop diversity and second range consisting of the one district Mahbubnagar showed (221-22380) medium crop diversity, whereas the third range consisting of the one district Medak having (22381-56504) high crop diversity.

The classification of the Telangana state for total districts crop diversity in sorghum production reflected that fifteen districts having (0-220) tonne low crop diversity, six districts having (221-22380) medium crop diversity and six districts showed (22381-56504) high crop diversity that is also shown in Fig. 4.5, 4.6 and 4.7 and Table 4.3 during 2004, 2009 and 2014.

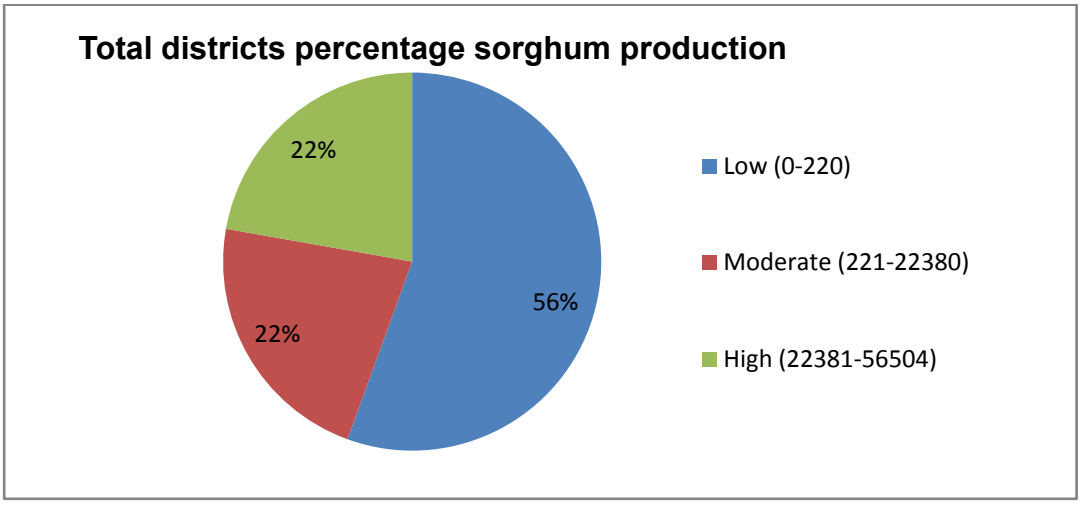

Fig. 4.8. Total districts sorghum production of Telangana state in three years (percentage).

The total districts crop diversity in sorghum production is found 56% low, 22% medium and 22% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.8.

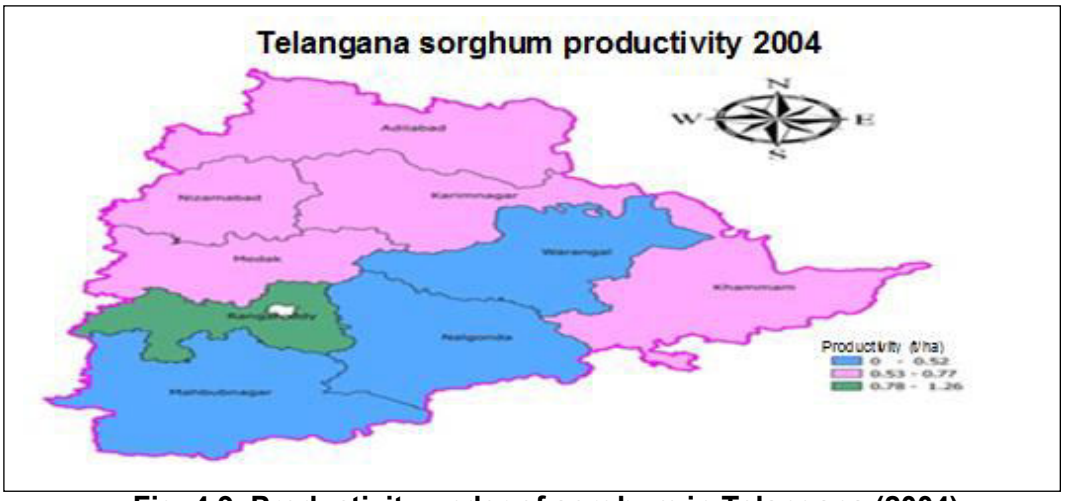

Fig. 4.9. Productivity under of sorghum in Telangana (2004)

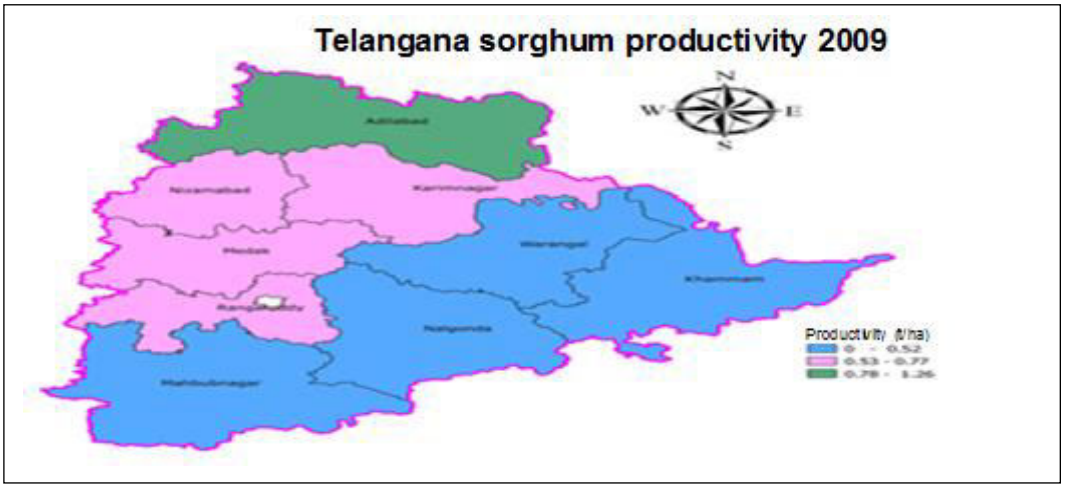

Fig. 4.10. Productivity under of sorghum in Telangana (2009)

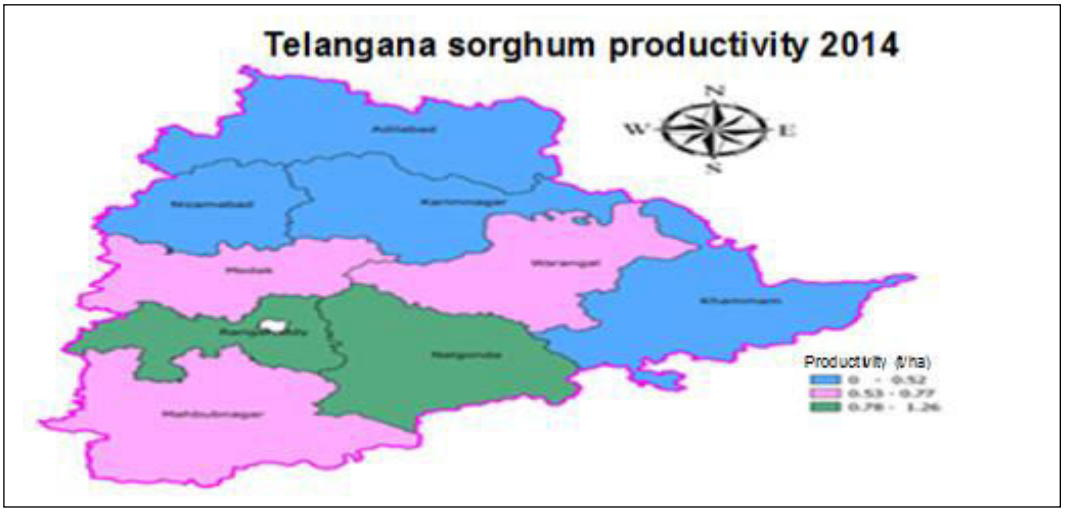

Fig. 4.11. Productivity under of sorghum in Telangana (2014)

Table 4.4: Classification of the range of low, medium and high of total sorghum productivity in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of sorghum (t/ha)		
		Low (0.0-0.52)	Medium (0.53-0.77)	High (0.78-1.26)
1	2004	3	5	1
2	2009	4	4	1
3	2014	4	3	2
Total		11	12	4

Sorghum productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.1 and Fig. 4.9, 4.10 and 4.11.

The sorghum productivity crop diversity map is shown in (Fig. 4.9 and Table 4.4) and found three ranges productivity in 2004. One is consisting of the three districts Mahbubnagar, Nalgonda and Warangal having (0-0.52) low crop diversity and second range consisting of the five districts Adilabad, Nizamabad, Medak, Karimnagar and Khammam showed (0.53-0.77) medium crop diversity, whereas the third range consisting of the one district Rangareddy having (0.78-1.26) high crop diversity.

The sorghum productivity crop diversity map is shown in (Fig. 4.10 and Table 4.4). It was found that three ranges productivity in 2009. One is consisting of the four districts Mahbubnagar, Nalgonda, Warangal and Khamman having (0-0.52) low crop diversity and second range consisting of the four districts Nizamabad, Karimnagar, Medak and Rangareddy showed (0.53-0.77) medium crop diversity, whereas the third range consisting of the one district Adilabad having (0.78-1.26) high crop diversity.

The sorghum productivity crop diversity map is shown in (Fig. 4.11 and Table 4.4) and found three ranges productivity in 2014. One is consisting of the four districts Adilabad, Nizamabad, Karimnagar, Nalgonda and Khamman having (0-0.52) low crop diversity and second range consisting of the three districts Medak, Warangal and Mahbubnagar showed (0.53-0.77) medium crop diversity, whereas the third range consisting of the two districts Rangareddy and Nalgonda having (0.78-1.26) high crop diversity.

The classification of the Telangana state for total districts crop diversity in sorghum productivity reflected that eleven districts having (0-0.52) low crop diversity, twelve districts having (0.53-0.77) medium crop diversity and four districts showed (0.78-1.26) high crop diversity that is also shown in Fig. 4.9, 4.10 and 4.11 and Table 4.4 during 2004, 2009 and 2014.

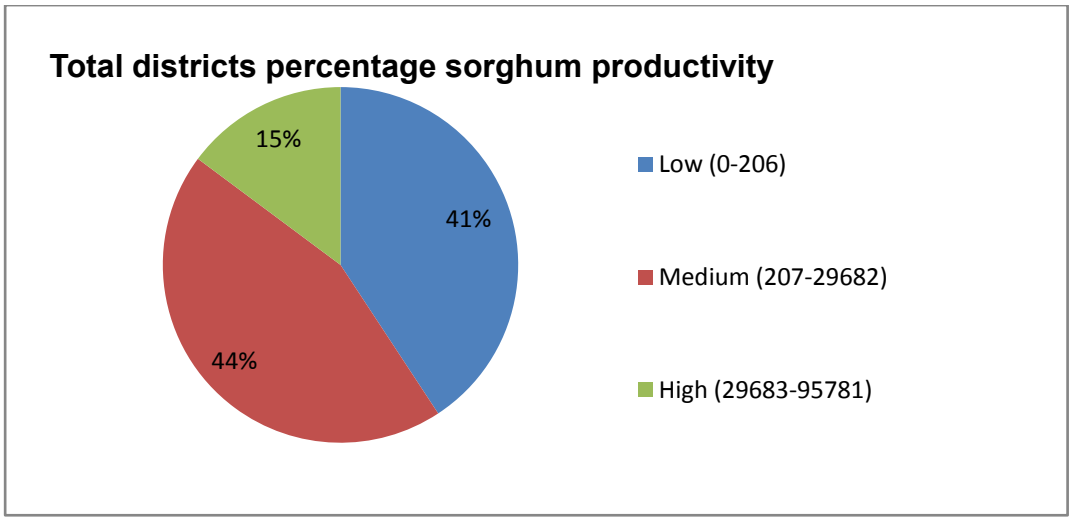

Fig. 4.12. Total districts sorghum productivity of Telangana state in three years (percentage).

The total districts crop diversity in sorghum productivity is found 41% low, 44% medium and 15% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.12.

Table 4.5: Classification area, production and productivity of pearl millet in Telangana state during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Adilabad	2801	93162	1230	389	0.32	831	402	0.48	733	701
Karimnagar	2803	2556	543	172	0.32	710	344	0.48	1806	1307
Khammam	2810	6758	202	64	0.32	32	16	0.5	0	0
Mahabubnagar	2807	95781	8405	3925	0.47	4979	2206	0.44	1415	1109
Medak	2804	59292	338	107	0.32	266	129	0.48	359	308
Nalgonda	2808	21079	11087	2217	0.2	1809	1080	0.6	3554	3265
Nizamabad	2802	25425	4783	1511	0.32	7950	3848	0.48	8426	6141
Rangareddy	2806	44812	969	307	0.32	168	81	0.48	7	15
Warangal	2809	11342	25	8	0.32	2586	1294	0.5	1399	701

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

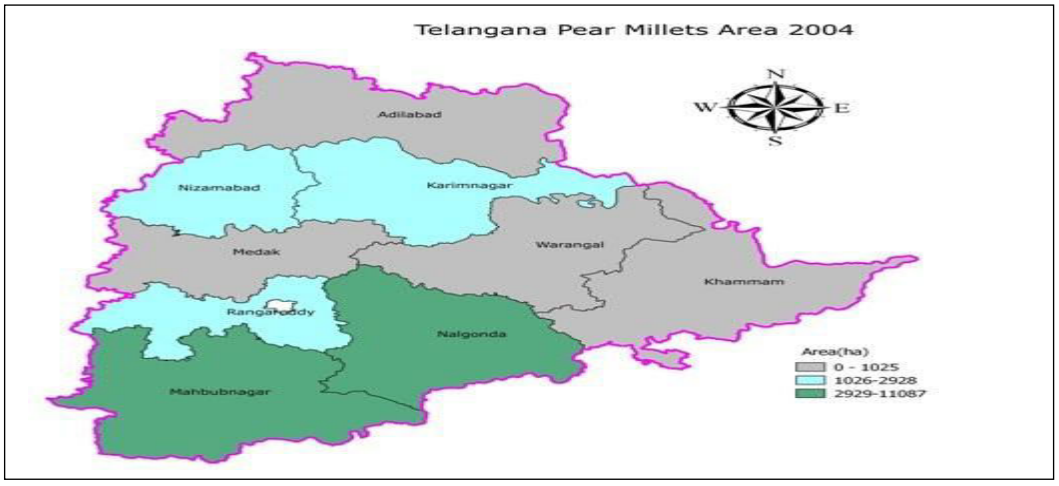

Fig. 4.13. Area under cultivation of pearl millet in Telangana (2004)

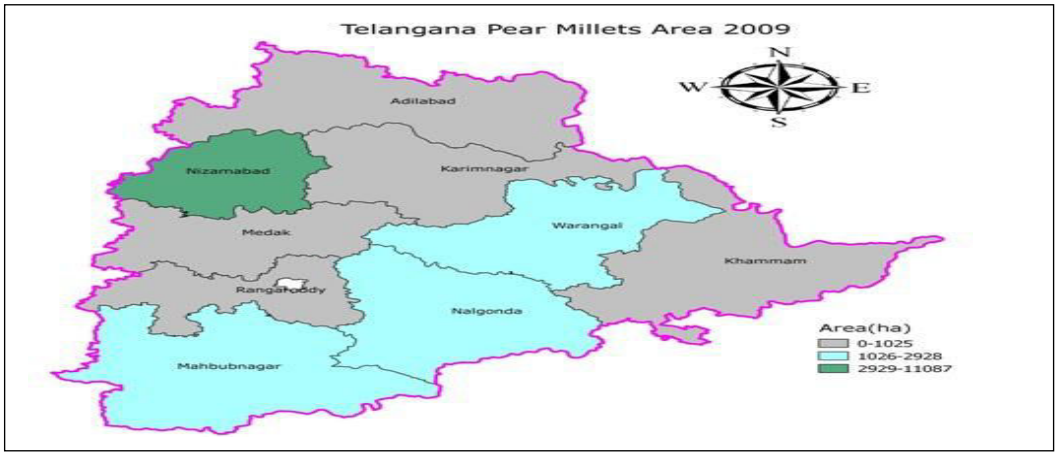

Fig. 4.14. Area under cultivation of pearl millet in Telangana (2009)

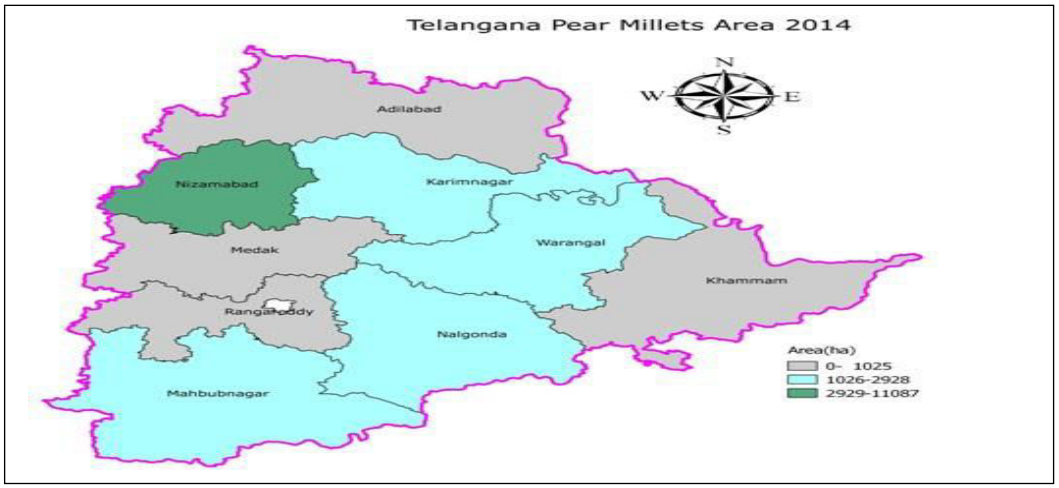

Fig. 4.15. Area under cultivation of pearl millet in Telangana (2014)

Table 4.6: Classification of the range low, medium and high of total pearl millet cultivated area in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area of pearl millet (ha)		
		Low (0-1025)	Medium (1026-2928)	High(2929-11087)
1	2004	4	3	2
2	2009	5	3	1
3	2014	4	4	1
Total		13	10	4

Pearl millet cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.5 and Fig. 4.13, 4.14 and 4.15.

The pearl millet cultivated area crop diversity map is shown in (Fig. 4.13 and Table 4.6) and found three ranges area in 2004. One is consisting of the four districts Adilabad, Medak, Khammam and Warangal having (0-1025) low crop diversity and second range consisting of the three districts Nizamabad, Karimnagar and Rangareddy showed (1026-2928) medium crop diversity, whereas the third range consisting of the two districts Nalgonda and Mahbubnagar having (2929-11087) high crop diversity.

The pearl millet cultivated area crop diversity map is shown in (Fig. 4.14 and Table 4.6) and found three ranges area in 2009. One is consisting of the five districts Adilabad, Karimnagar, Medak, Rangareddy and Khamman having (0-1025) low crop diversity and second range consisting of the three districts Warangal, Nalgonda and Mahbubnagar showed (1026-2928) medium crop diversity, whereas the third range

consisting of the one district Nizamabad having (2929-11087) high crop diversity.

The pearl millet cultivated area crop diversity map is shown in (Fig. 4.15 and Table 4.6) and found three ranges area in 2014. One is consisting of the four districts Adilabad, Medak, Rangareddy and Khamman having (0-1025) low crop diversity and second range consisting of the four districts Karimnagar, Nalgonda, Warangal and Mahbubnagar showed (1026-2928) medium crop diversity, whereas the third range consisting of the one district Nizamabad having (0.78-1.26) high crop diversity.

The classification of the Telangana state for total districts crop diversity in pearl millet cultivated area reflected that thirteen districts having (0-1025) low crop diversity, ten districts having (1026-2928) medium crop diversity and four districts showed (2929-11087) high crop diversity that is also shown in Fig. 4.13, 4.14 and 4.15 and Table 4.6 during 2004, 2009 and 2014.

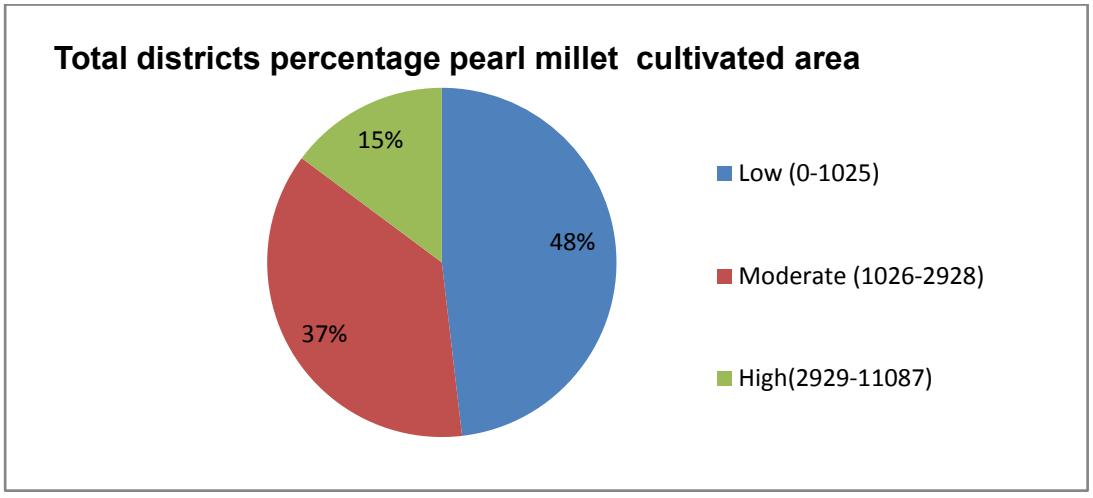

Fig. 4.16. Total districts pearl millet cultivated area of Telangana state in three years (percentage).

The total districts crop diversity in pearl millet cultivated area is found 48% low, 37% medium and 15% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.16.

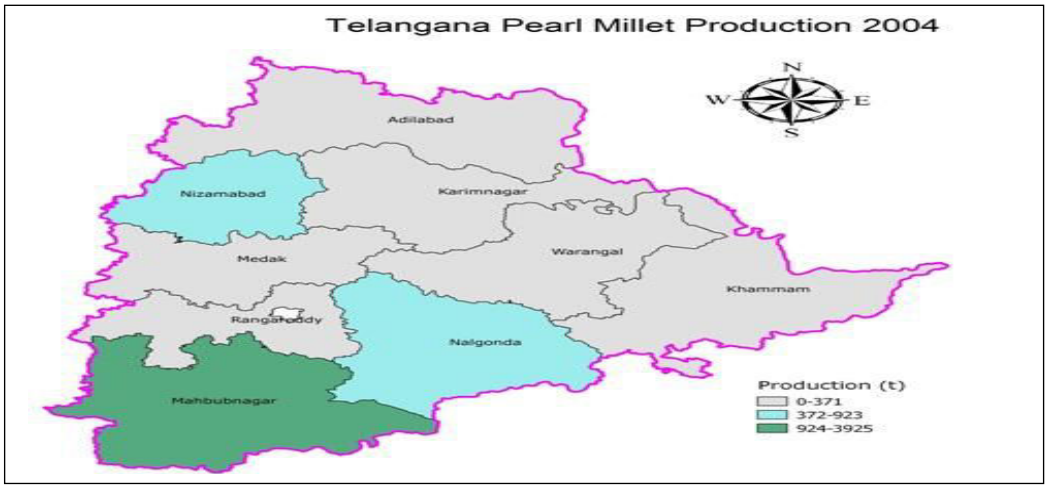

Fig. 4.17. Production under of pearl millet in Telangana (2004)

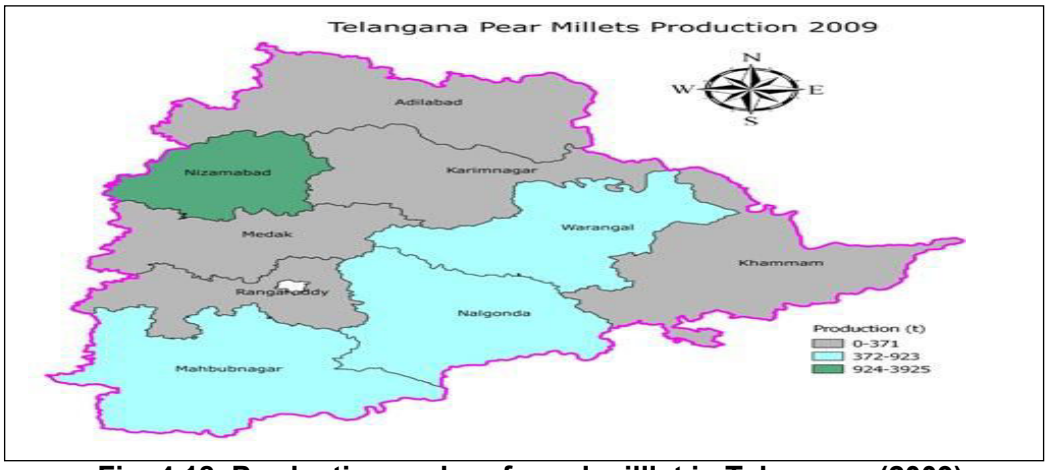

Fig. 4.18. Production under of pearl milllet in Telangana (2009)

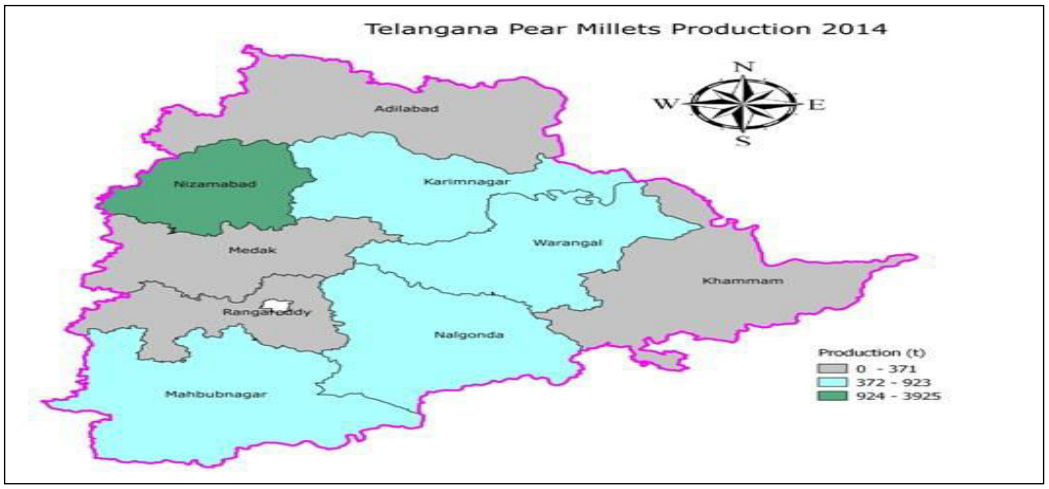

Fig. 4.19. Production under of pearl millet in Telangana (2014)

Table 4.7: Classification of the range low, medium and high of total pearl millet production in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of pearl millet (t)		
		Low (0-371)	Medium (372-923)	High(924-3925)
1	2004	6	2	1
2	2009	5	3	1
3	2014	4	4	1
Total		15	9	3

Pearl millet production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.5 and Fig. 4.17, 4.18 and 4.19.

The pearl millet production crop diversity map is shown in (Fig. 4.17 and Table 4.7) and found three ranges production in 2004. One is consisting of the six districts Adilabad, Karimnagar, Medak, Khammam, Rangareddy and Warangal having (0-371) low crop diversity and second range consisting of the two districts Nizamabad and Nalgonda showed (372-923) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (924-3925) high crop diversity.

The pearl millet production crop diversity map is shown in (Fig. 4.18 and Table 4.7) and found three ranges production in 2009. One is consisting of the five districts Adilabad, Karimnagar, Medak, Rangareddy and Khamman having (0-371) low crop diversity and second range consisting of the three districts Warangal, Nalgonda and Mahbubnagar showed (372-923) medium crop diversity, whereas the third range

consisting of the one district Nizamabad having (924-3925) high crop diversity.

The pearl millet production crop diversity map is shown in (Fig. 4.19 and Table 4.7) and found three ranges production in 2014. One is consisting of the four districts Adilabad, Medak, Rangareddy and Khamman having (0-371) low crop diversity and second range consisting of the four districts Karimnagar, Nalgonda, Warangal and Mahbubnagar showed (372-923) medium crop diversity, whereas the third range consisting of the one district Nizamabad having (924-3925) high crop diversity.

The classification of the Telangana state for total districts crop diversity in pearl millet production reflected that fifteen districts having (0-371) low crop diversity, nine districts having (372-923) medium crop diversity and three districts showed (924-3925) high crop diversity that is also shown in Fig. 4.17, 4.18 and 4.19 and Table 4.7 during 2004, 2009 and 2014.

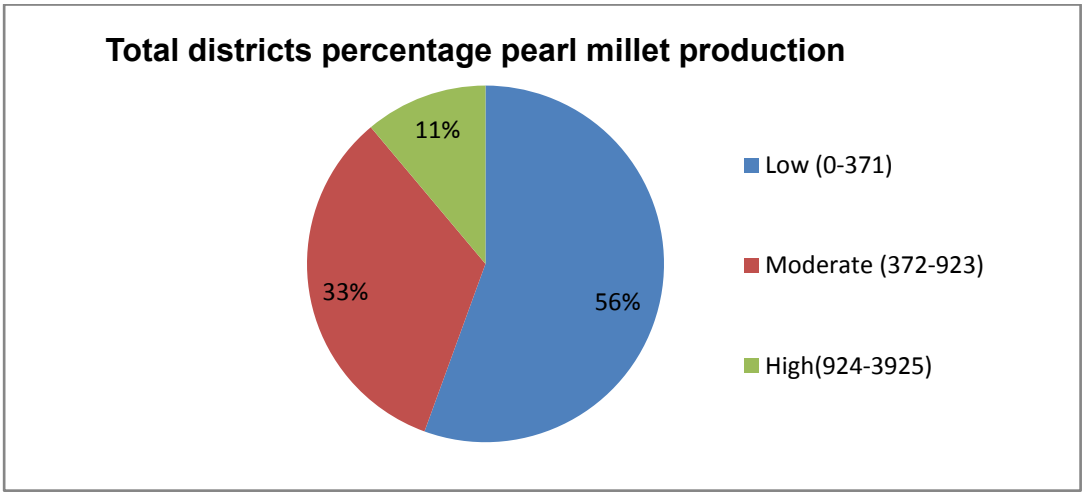

Fig. 4.20. Total districts pearl millet production of Telangana state in three years (percentage).

The total districts crop diversity in pearl millet production is found 56% low, 33% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.20.

Fig. 4.21. Productivity under of pearl millet in Telangana (2004)

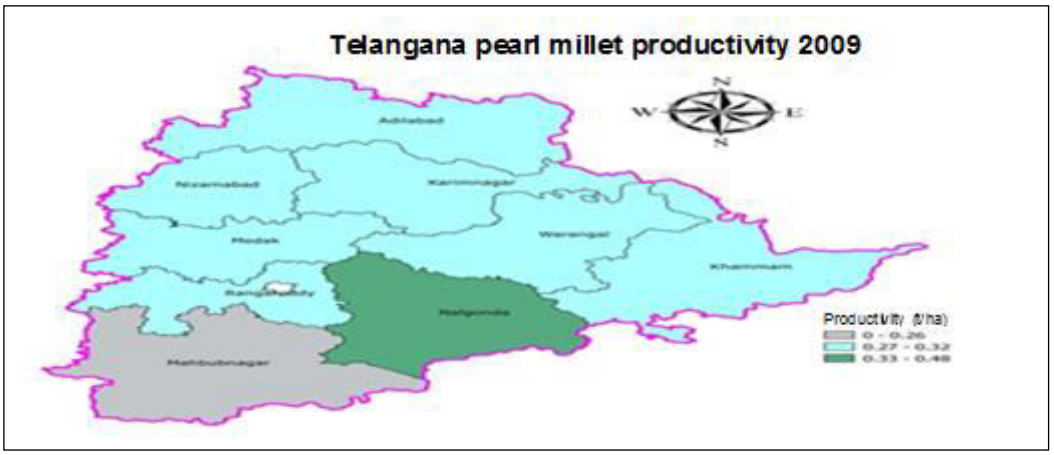

Fig. 4. 22. Productivity under of pearl millet in Telangana (2009)

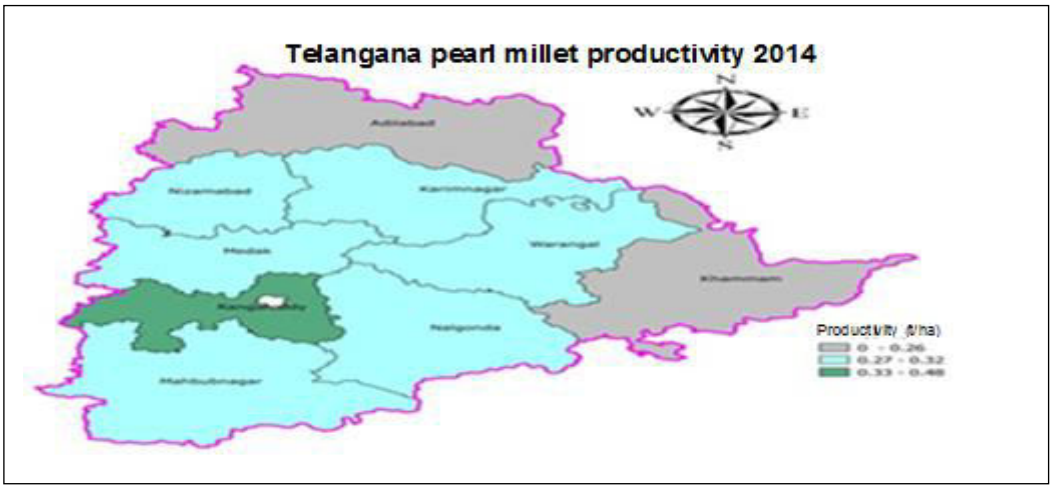

Fig. 4.23. Productivity under of pearl millet in Telangana (2014)

Table 4.8: Classification of the range of low, medium and high of total pearl millet productivity in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of pearl millet (t/ha)		
		Low (0-0.26)	Medium (0.27-0.32)	High(0.33-0.48)
1	2004	1	7	1
2	2009	1	7	1
3	2014	2	6	1
Total		4	20	3

Pearl Millet productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.5 and Fig. 4.21, 4.22 and 4.23.

The pearl millet productivity crop diversity map is shown in (Fig. 4.21 and Table 4.8) and found three ranges productivity in 2004. One is consisting of the one district Nalgonda having (0-0.26) low crop diversity and second range consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Khammam and Rangareddy showed (0.27-0.32) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (0.33-0.48) high crop diversity.

The pearl millet productivity crop diversity map is shown in (Fig. 4.22 and Table 4.8) and found three ranges productivity in 2009. One is consisting of the one district Mahbubnagar having (0-0.26) low crop diversity and second range consisting of the sevsen districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Khammam and Rangareddy showed (0.27-0.32) medium crop diversity, whereas the third range consisting of the one district Nalgonda having (0.33-0.48) high crop diversity.

The pearl millet productivity crop diversity map is showed (Fig. 4.23) and (Table 4.8) and found three ranges productivity in 2014. One is consisting of the two districts Adilabad and Khamman having (0-0.26) low crop diversity and second range consisting of the six districts Karimnagar, Nizamabad, Medak, Nalgonda, Warangal and Mahbubnagar showed (0.27-0.32) medium crop diversity, whereas the third range consisting of the one district Rangareddy having (0.33-0.48) high crop diversity.

The classification of the Telangana state for total districts crop diversity in pearl millet productivity reflected that four districts having (0-0.26) low crop diversity, twenty districts having (0.27-0.32) medium crop diversity and three districts showed (0.33-0.48) high crop diversity that is also shown in Fig. 4.21, 4.22 and 4.23 and Table 4.8 during 2004, 2009 and 2014.

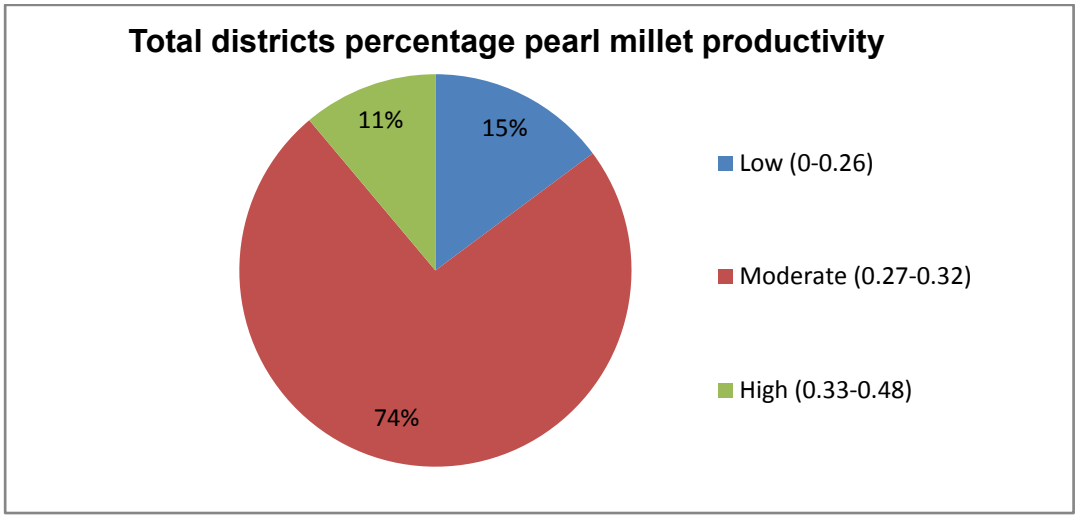

Fig. 4.24. Total districts pearl millet productivity of Telangana state in three years (percentage).

The total districts crop diversity in pearl millet productivity is found 15% low, 74% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.24.

Table 4.9: Classification area, production and productivity of finger millet in Telangana state during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Adilabad	2801	0	0	0	0	0	0	0	0	0
Karimnagar	2803	0	0	0	0	0	0	0	0	0
Khammam	2810	11	18	1.64	15	12	0.8	20	15	1.46
Mahabubnagar	2807	6224	9554	1.54	1714	1766	1.03	1088	1588	1.78
Medak	2804	10	15	1.5	3	1	0.33	9	16	0.86
Nalgonda	2808	0	0	0	0	0	0	0	0	0
Nizamabad	2802	5	10	2	0	0	0	0	0	0
Rangareddy	2806	2842	6796	2.39	392	353	0.9	405	676	2.14
Warangal	2809	0	0	0	0	0	0	0	0	0

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

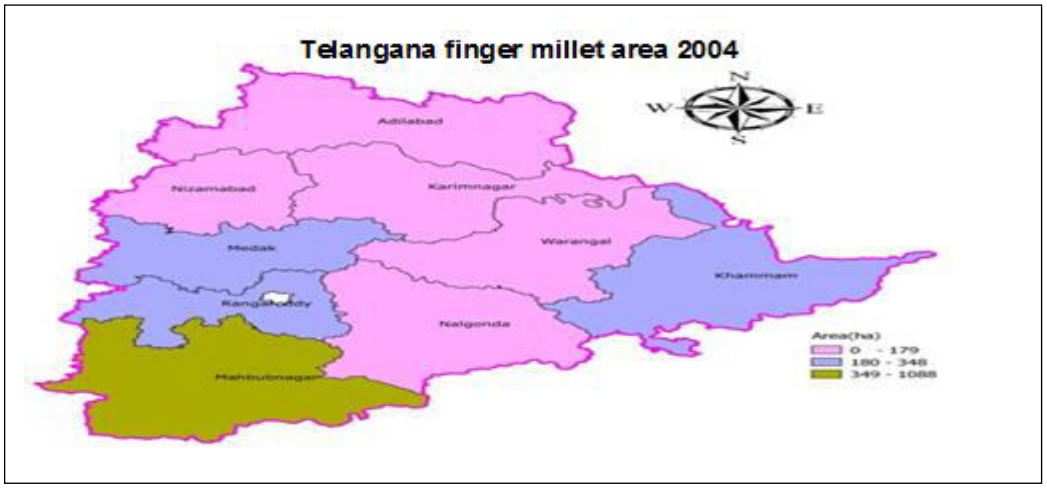

Fig. 4.25. Area under cultivation of finger millet in Telangana (2004)

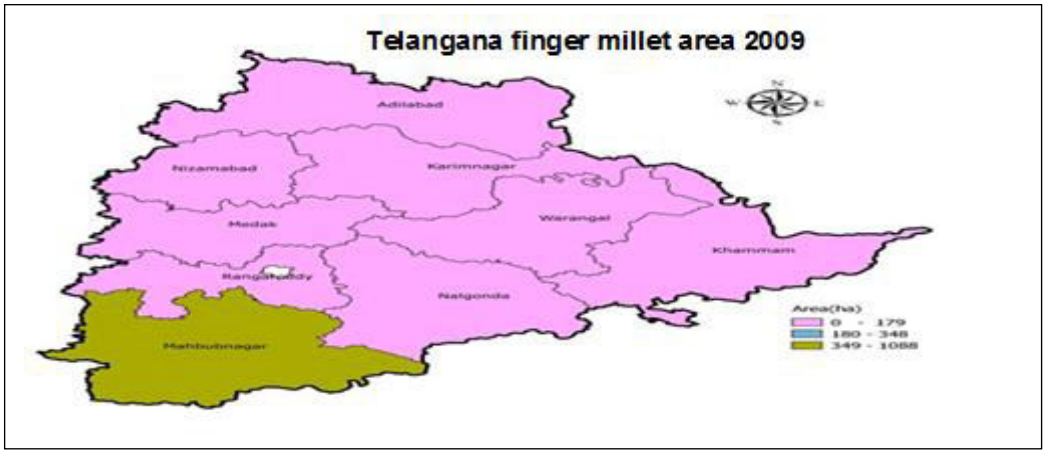

Fig. 4.26. Area under cultivation of finger millet in Telangana (2009)

Fig. 4.27. Area under cultivation of finger millet in Telangana (2014)

Table 4.10: Classification of the range of low, medium and high of total finger millet cultivated area in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of district		
		The range of cultivated area of finger millet (ha)		
		Low (0-179)	Medium (180-349)	High (350-1088)
1	2004	5	3	1
2	2009	8	-	1
3	2014	5	3	1
Total		18	6	3

Finger Millet cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.9 and Fig. 4.25, 4.26 and 4.27.

The finger millet cultivated area crop diversity map is shown in (Fig. 4.25 and Table 4.10) and found three ranges area in 2004. One is consisting of the five districts Adilabad, Karimnagar, Nizamabad, Warangal and Nalgonda having (0-179) low crop diversity and second range consisting of the three districts Medak, Khammam and Rangareddy showed (180-349) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (350-1088) high crop diversity.

The finger millet cultivated area crop diversity map is shown in (Fig. 4.26 and Table 4.10) and found three ranges area in 2009. One is consisting of the eight districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Rangareddy, Nalgonda and Khammam having (0-179) low crop diversity and second is not consisting range, whereas the third range

consisting of the one district Mahbubnagar having (350-1088) high crop diversity.

The finger millet cultivated area crop diversity map is shown in (Fig. 4.27 and Table 4.10) and found three ranges area in 2014. One is consisting of the five districts Adilabad, Nizamabad, Karimnagar, Warangaland Nalgonda having (0-179) low crop diversity and second range consisting of the three districts Medak, Rangareddy and Khammam showed (180-349) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (350-1088) high crop diversity.

The classification of the Telangana state for total districts crop diversity in finger millet cultivated area reflected that eighteen districts having (0-179) low crop diversity, six districts having (180-349) medium crop diversity and three districts showed (350-1088) high crop diversity that is also shown in Fig. 4.25, 4.26 and 4.27 and Table 4.10 during 2004, 2009 and 2014.

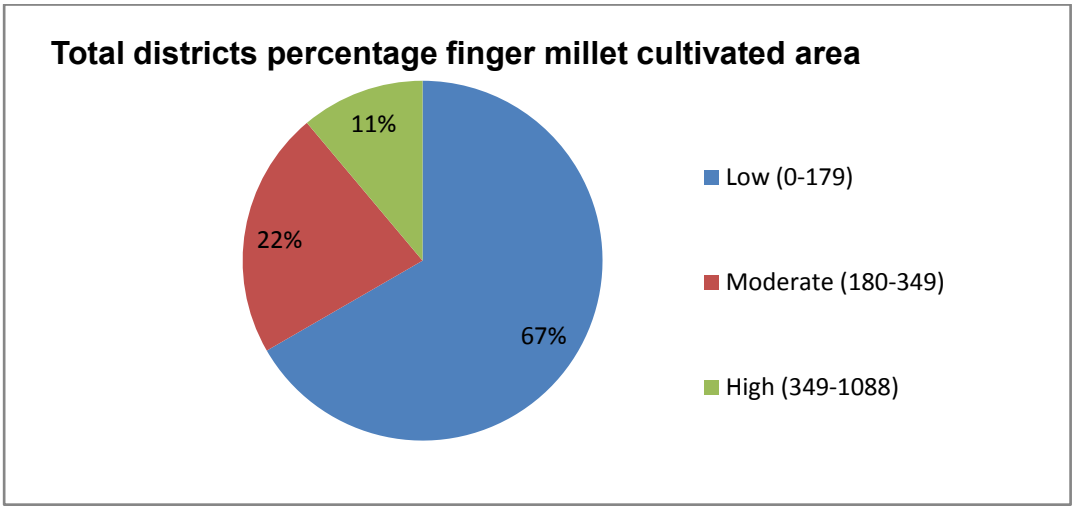

Fig. 4.28. Total districts finger millet cultivated area of Telangana state in three years (percentage).

The total districts crop diversity in finger millet cultivated area is found 67% low, 22% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.28.

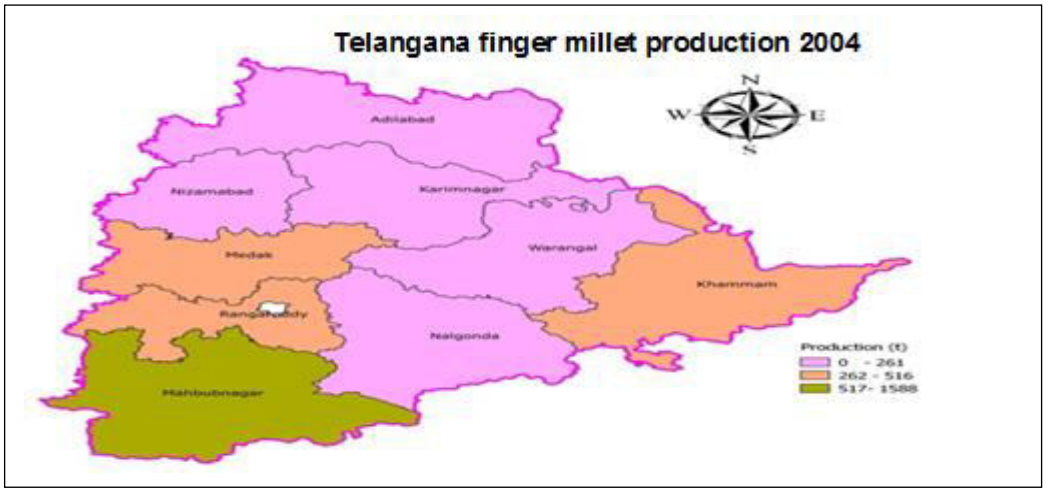

Fig. 4.29. Production under of finger millet in Telangana (2004)

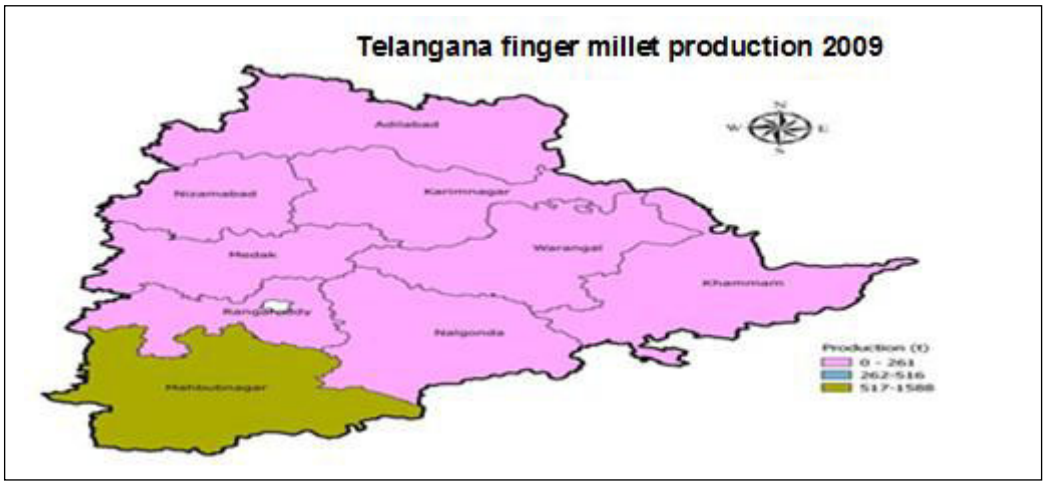

Fig. 4.30. Production under of finger millet in Telangana (2009)

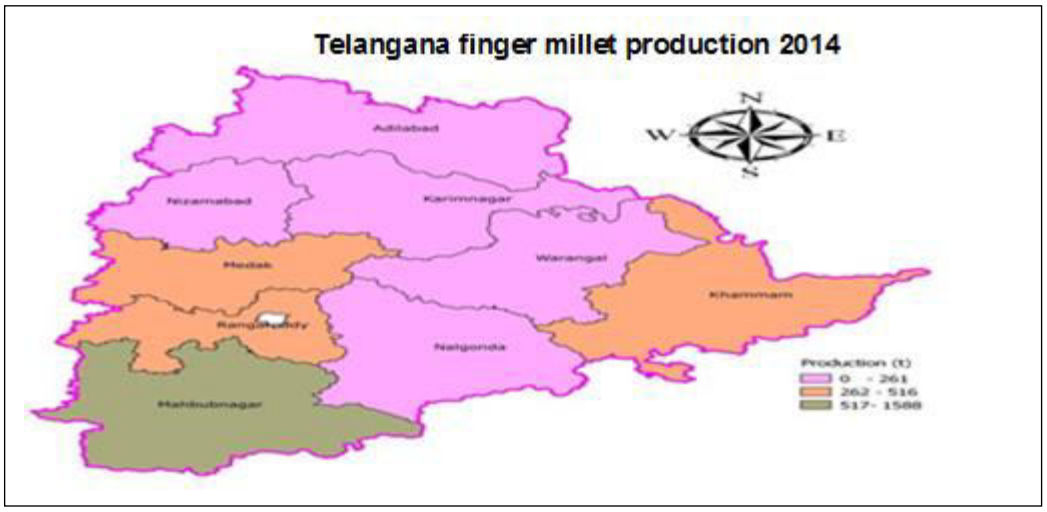

Fig. 4.31. Production under of finger millet in Telangana (2014)

Table 4.11: Classification of the range of low, medium and high of total finger millet production in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of finger millet (t)		
		Low (0-261)	Medium (262-516)	High (517-1588)
1	2004	5	3	1
2	2009	8	-	1
3	2014	5	3	1
Total		18	6	3

Finger Millet production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.9 and Fig. 4.29, Fig. 4.30 and Fig. 4.31.

The finger millet production crop diversity map is shown in (Fig. 4.29 and Table 4.11) and found three ranges production in 2004. One is consisting of the five districts Adilabad, Karimnagar, Nizamabad, Warangal and Nalgonda having (0-261) low crop diversity and second range consisting of the three districts Medak, Khammam and Rangareddy showed (262-516) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (517-1588) high crop diversity.

The finger millet production crop diversity map is shown in (Fig. 4.30 and Table 4.11) and found three ranges production in 2009. One is consisting of the eight districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Rangareddy, Nalgonda and Khammam having (0-261) low crop diversity and second is not consisting range, whereas the third range consisting of the one district Mahbubnagar having (517-1588) high crop diversity.

The finger millet production crop diversity map is shown in (Fig. 4.31 and Table 4.11) and found three ranges production in 2014. One is consisting of the five districts Adilabad, Nizamabad, Karimnagar, Warangal and Nalgonda having (0-261) low crop diversity and second range consisting of the three districts Medak, Rangareddy and Khammam showed (262-516) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (517-1588) high crop diversity.

The classification of the Telangana state for total districts crop diversity in finger millet production reflected that eighteen districts having (0-261) low crop diversity, six districts having (262-516) medium crop diversity and three districts showed (517-1588) high crop diversity that is also shown in Fig. 4.29, 4.30 and 4.31 and Table 4.11 during 2004, 2009 and 2014.

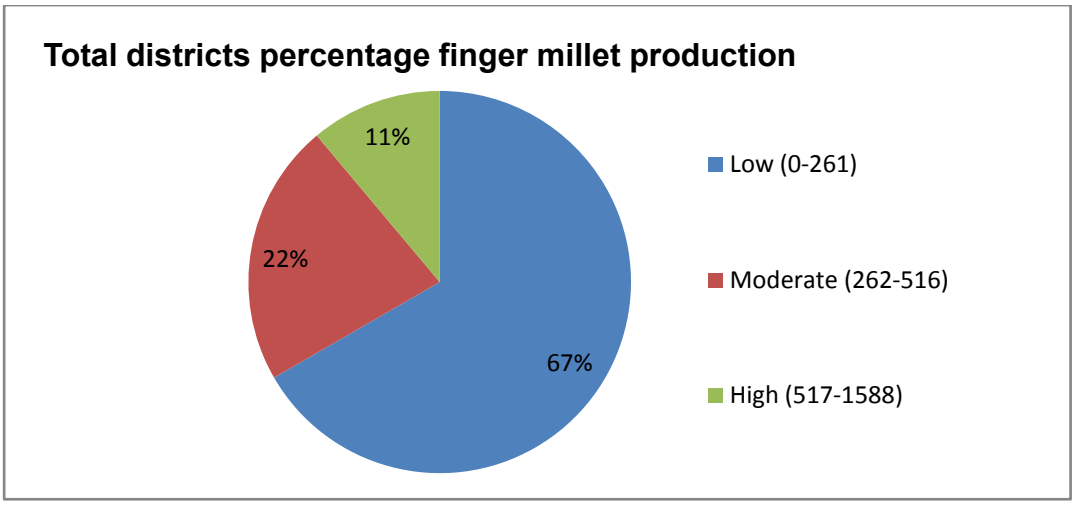

Fig. 4.32. Total districts finger millet production of Telangana state in three years (percentage).

The total districts crop diversity in finger millet production is found 67% low, 22% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.32.

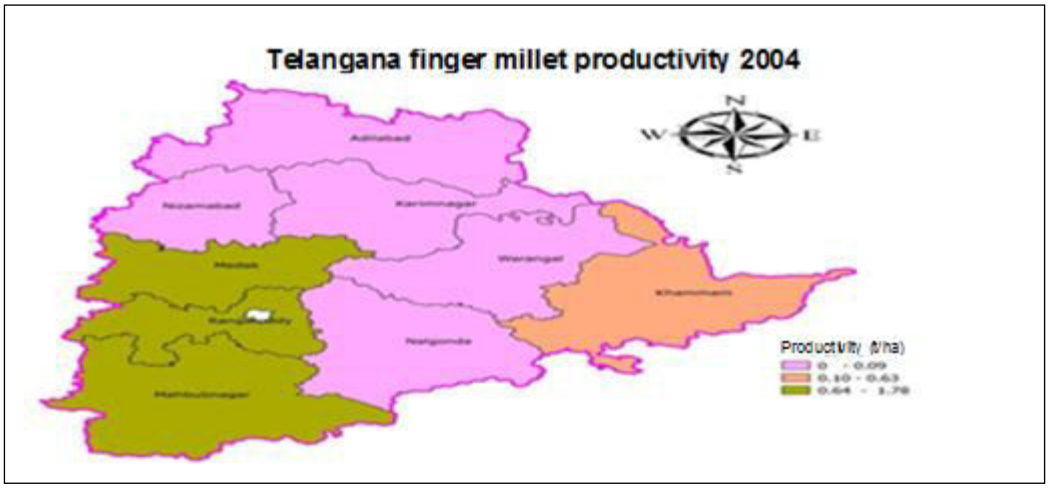

Fig.4.33. Productivity under of finger millet in Telangana (2004)

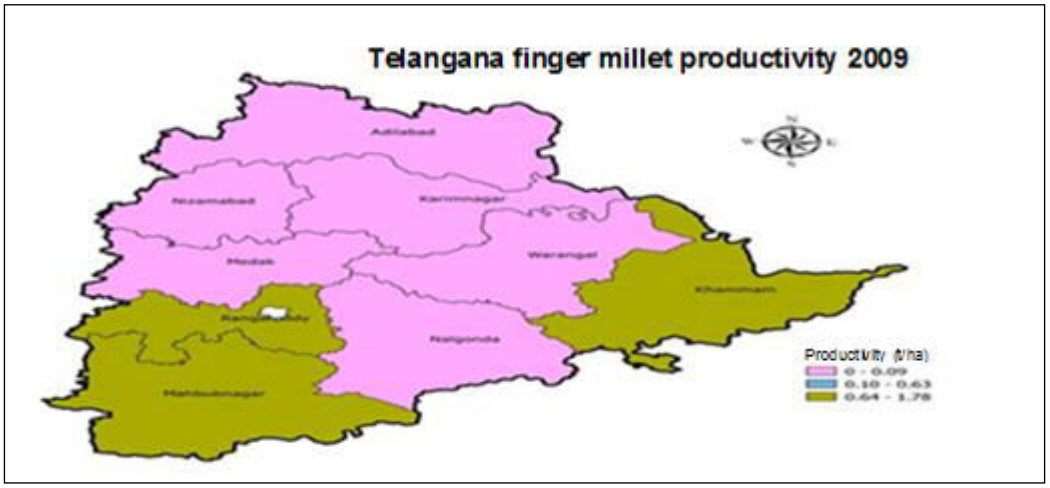

Fig. 4.34. Productivity under of finger millet in Telangana (2009)

Fig. 4.35. Productivity under of finger millet in Telangana (2014)

Table 4.12: Classification of the range of low, medium and high of total finger millet productivity in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productive of finger millet (t/ha)		
		Low (0-0.09)	Medium (0.10-0.63)	High (0.64-1.78)
1	2004	5	1	3
2	2009	6	-	3
3	2014	5	1	3
Total		16	2	9

Finger Millet productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.8 and Fig. 4.33, 4.34 and 4.35.

The finger millet productivity crop diversity map is shown in (Fig. 4.33 and Table 4.12) and found three ranges productivity in 2004. One is consisting of the five districts Adilabad, Karimnagar, Nizamabad, Warangal and Nalgonda having (0-0.09) low crop diversity and second range consisting of the one district Karimnagar showed (0.10-0.63) medium crop diversity, whereas the third range consisting of the three districts Rangareddy, Mahbubnagar and Khammam having (0.64-1.78) high crop diversity.

The finger millet productivity crop diversity map is shown in (Fig. 4.34 and Table 4.12) and found three ranges productivity in 2009. One is consisting of the six districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal and Nalgonda having (0-0.09) low crop diversity and second is not consisting range, whereas the third range consisting of the three

districts Rangareddy, Mahbubnagar and Khammam having (0.64-1.78) high crop diversity.

The finger millet productivity crop diversity map is shown in (Fig. 4.35 and Table 4.12) and found three ranges productiveityin 2014. One is consisting of the five districts Adilabad, Nizamabad, Karimnagar, Warangal and Nalgonda having (0-0.09) low crop diversity and second range consisting of the one district Khammam showed (0.10-0.63) medium crop diversity, whereas the third range consisting of the three districts Medak, Rangareddy and Mahbubnagar having (0.64-1.78) high crop diversity.

The classification of the Telangana state for total districts crop diversity in finger millet productivity reflected that sixteen districts having (0-0.09) low crop diversity, two districts having (0.10-0.63) medium crop diversity and nine districts showed (0.64-1.78) high crop diversity that is also shown in Fig. 4.33, 4.34 and 4.35 and Table 4.12 during 2004, 2009 and 2014.

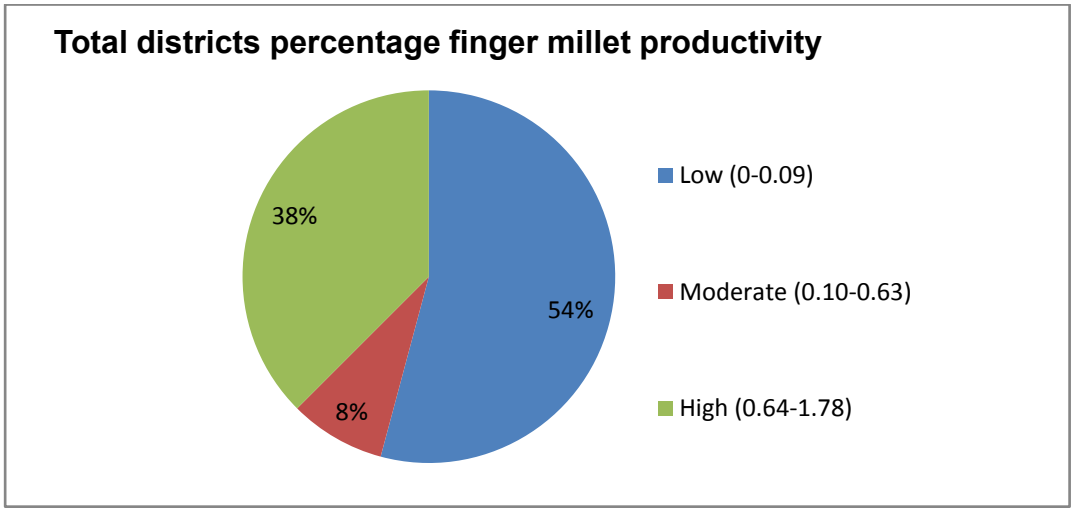

Fig. 4.36. Total districts finger millet productivity of Telangana state in three years (percentage).

The total districts crop diversity in finger millet productivity is found 54% low, 8% medium and 38% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.36.

Table 4.13: Classification Area, Production and productivity of Small millet in Telangana State during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Adilabad	2801	0	0	0	0	0	0	0	0	0
Karimnagar	2803	0	0	0	0	0	0	0	0	0
Khammam	2810	10	3	0.3	0	0	0	0	0	0
Mahabubnagar	2807	1149	892	0.78	303	201	0.66	124	3	0.02
Medak	2804	0	0	1.5	0	0	0	0	0	0
Nalgonda	2808	0	0	0	0	0	0	0	0	0
Nizamabad	2802	0	0	0	0	0	0	0	0	0
Rangareddy	2806	35	13	0.37	8	4	0.5	8	9	1.5
Warangal	2809	0	0	0	0	0	0	0	0	0

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

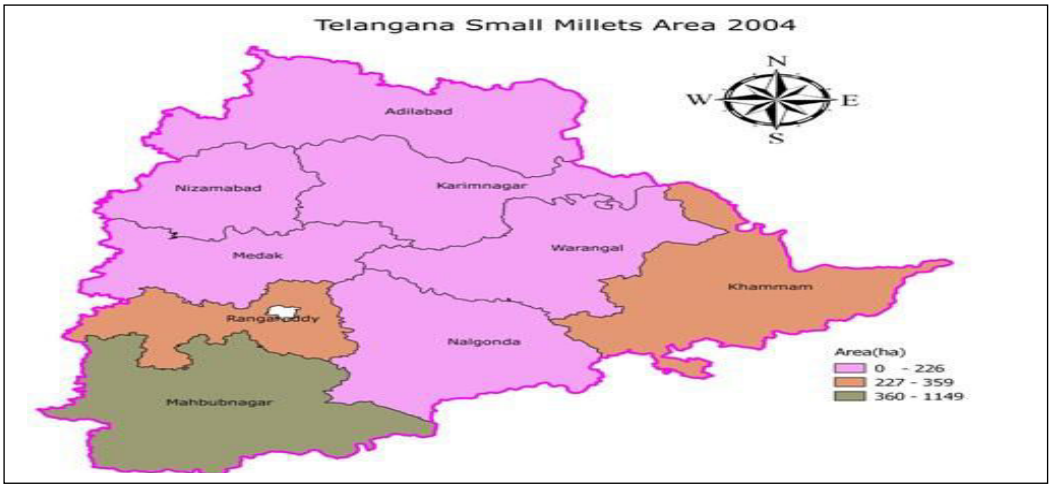

Fig. 4.37. Area under cultivation of small millet in Telangana (2004)

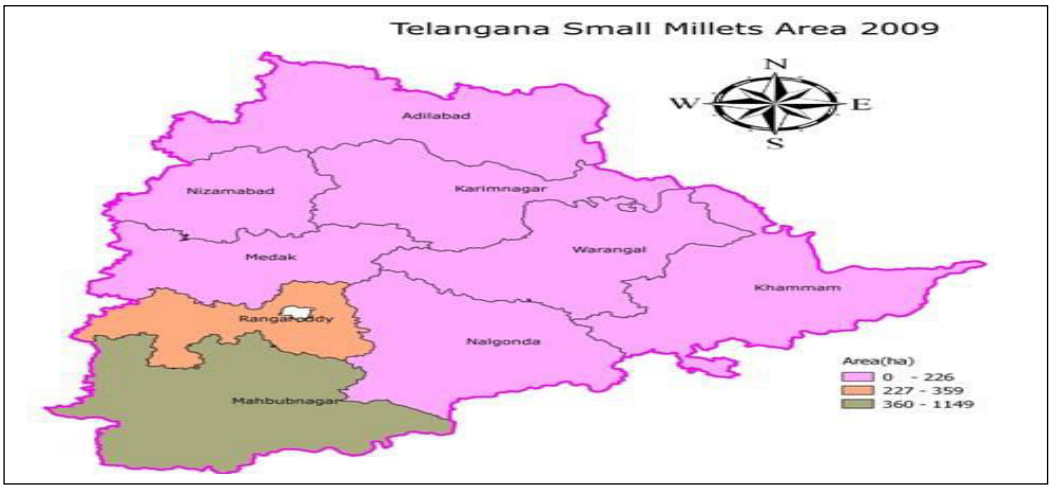

Fig. 4.38. Area under cultivation of small millet in Telangana (2009)

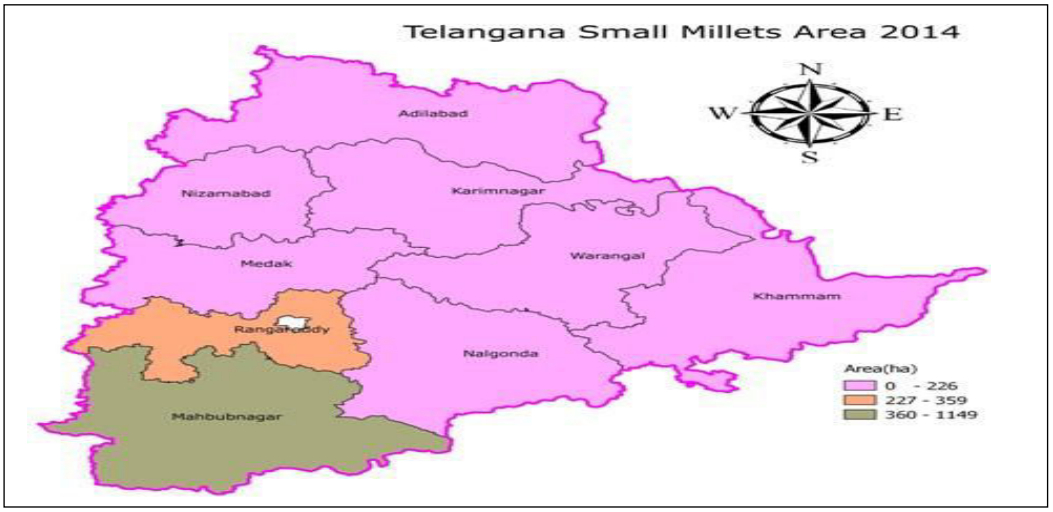

Fig. 4.39. Area under cultivation of small millet in Telangana (2014)

Table 4.14: Classification of the range low, medium and high of total small millet cultivated area in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area of small millet (ha)		
		Low (0-226)	Medium (227-359)	High (360-1149)
1	2004	6	2	1
2	2009	7	1	1
3	2014	7	1	1
Total		20	4	3

Small Millet cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.13 and Fig. 4.37, 4.38 and 4.39.

The small milllet cultivated area crop diversity map is shown in (Fig. 4.37 and Table 4.14) and found three ranges area in 2004. One is consisting of the six districts Adilabad, Karimnagar, Nizamabad, Warangal, Medak and Nalgonda having (0-226) low crop diversity and second range consisting of the two districts Khammam and Rangareddy showed (227-359) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (360-1149) high crop diversity.

The small millet cultivated area crop diversity map is shown in (Fig. 4.38 and Table 4.14) and found three ranges area in 2009. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Nalgonda and Khammam having (0-226) low crop diversity and second consisting of the one district Rangareddy (227-359)

medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (360-1149) high crop diversity.

The small millet cultivated area crop diversity map is shown in (Fig. 4.39 and Table 4.14) and found three ranges area in 2014. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Khammam, Warangal and Nalgonda having (0-226) low crop diversity and second range consisting of the one district Mahbubnagar showed (227-359) medium crop diversity, whereas the third range consisting of the one district Rangareddy having (360-1149) high crop diversity.

The classification of the Telangana state for total districts crop diversity in small millet cultivated area reflected that twenty districts having (0-226) low crop diversity, four districts having (227-359) medium crop diversity and three districts showed (360-1149) high crop diversity that is also shown in Fig. 4.37, 4.38 and 4.39 and Table 4.14 during 2004, 2009 and 2014.

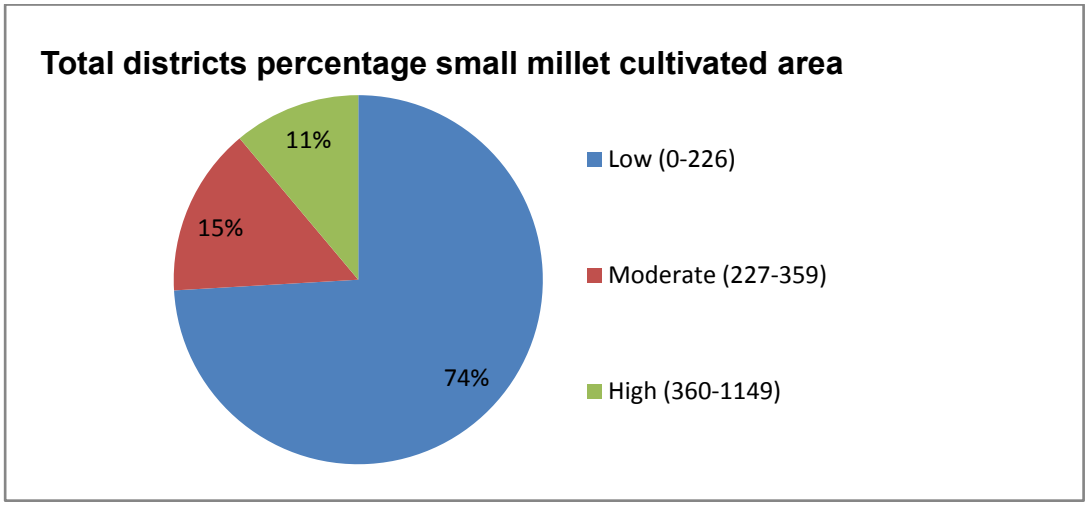

Fig. 4.40. Total districts small millet cultivated area of Telangana state in three years (percentage).

The total districts crop diversity in small millet cultivated area is found 74% low, 15% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.40.

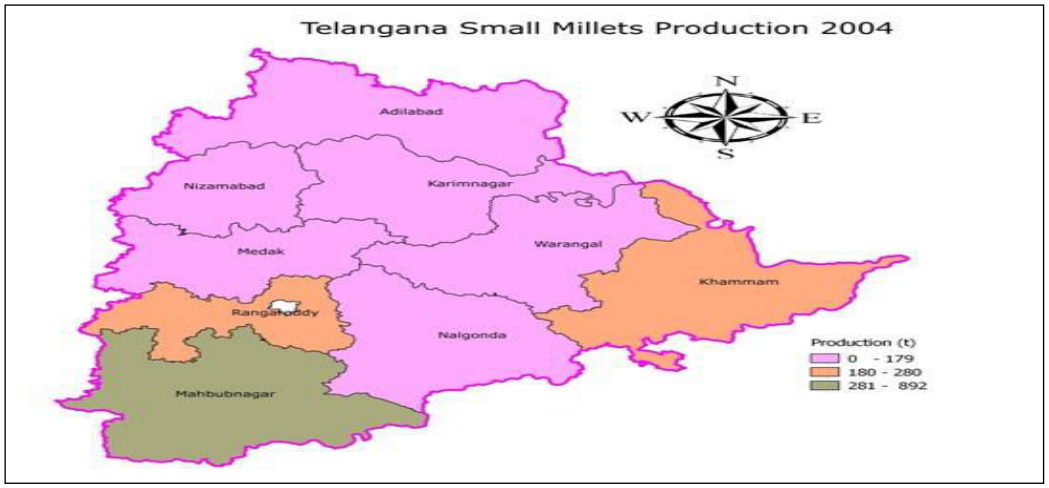

Fig. 4.41. Production under of small millet in Telangana (2004)

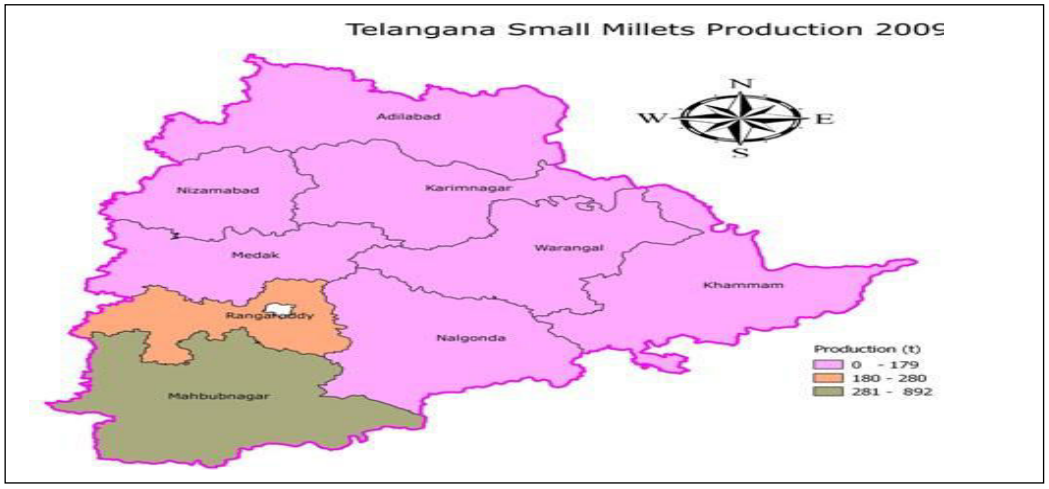

Fig. 4.42. Production under of small millet in Telangana (2009)

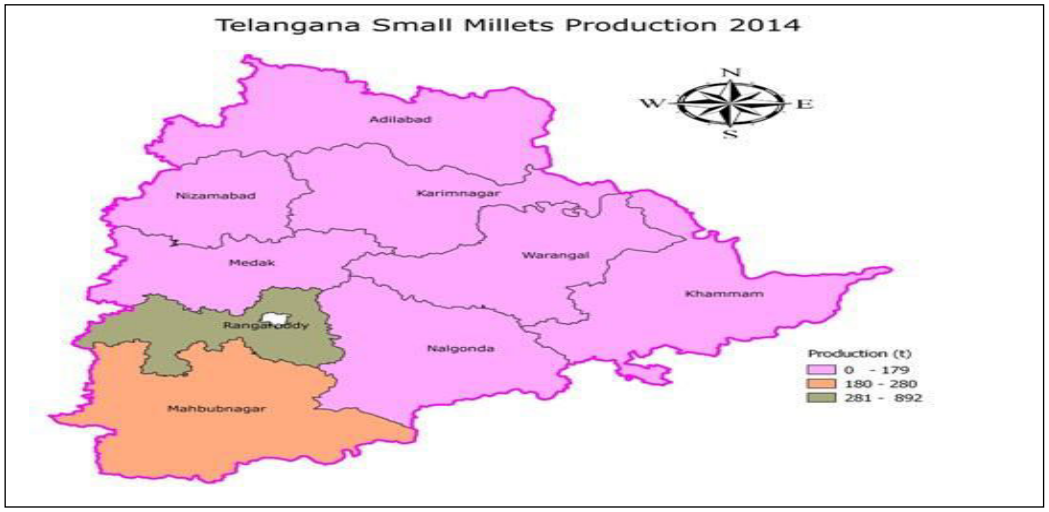

Fig. 4.43. Production under of small millet in Telangana (2014)

Table 4.15: Classification of the range of low, medium and high of total small millet production in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of small millet (t)		
		Low (0-179)	Medium (180-280)	High (281-892)
1	2004	6	2	1
2	2009	7	1	1
3	2014	7	1	1
Total		20	4	3

Small Millet production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.12 and Fig. 4.41, 4.42 and 4.43.

The small milllet production crop diversity map is shown in (Fig. 4.41 and Table 4.15) and found three ranges production in 2004. One is consisting of the six districts Adilabad, Karimnagar, Nizamabad, Warangal, Medak and Nalgonda having (0-179) low crop diversity and second range consisting of the two districts Khammam and Rangareddy showed (180-280) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (281-892) high crop diversity.

The small millet production crop diversity map is shown in (Fig. 4.42 and Table 4.15 and found three ranges production in 2009. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Nalgonda and Khammam having (0-179) low crop diversity and second consisting of the one district Rangareddy (180-280) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (281-892) high crop diversity.

The small millet production crop diversity map is shown in (Fig. 4.43 and Table 4.15) and found three ranges production in 2014. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Khammam, Warangal and Nalgonda having (0-179) low crop diversity and second range consisting of the one district Mahbubnagar showed (180-280) medium crop diversity, whereas the third range consisting of the one district Rangareddy having (281-892) high crop diversity.

The classification of the Telangana state for total districts crop diversity in small millet production reflected that twenty districts having (0-179) low crop diversity, four districts having (180-280) medium crop diversity and three districts showed (281-890) high crop diversity that is also shown in Fig. 4.41, 4.42 and 4.43 and Table 4.15 during 2004, 2009 and 2014.

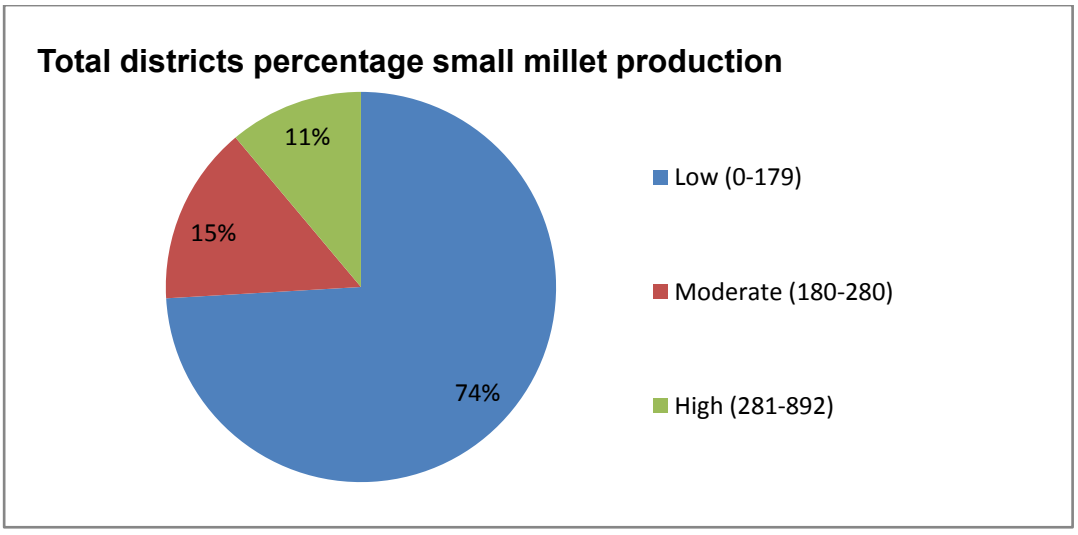

Fig. 4.44. Total districts small millet production of Telangana state in three years (percentage).

The total districts crop diversity in small millet production is found 74% low, 15% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.44.

Fig. 4.45. Productivity under of small millet in Telangana (2004)

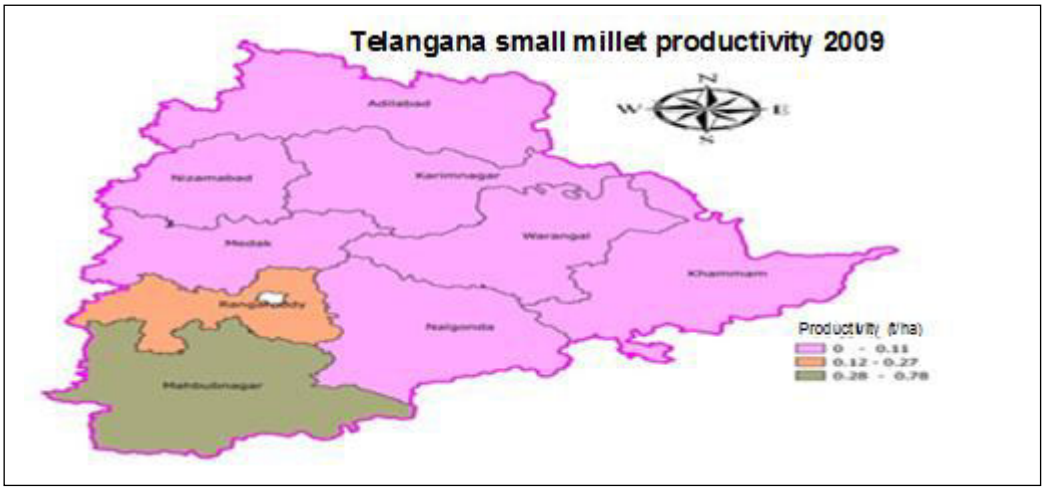

Fig. 4.46. Productivity under of small millet in Telangana (2009)

Fig. 4.47. Productivity under of small millet in Telangana (2014)

Table 4.16: Classification of the range of low, moderate and high of total small millet productivity in Telangana state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of small millet (t/ha)		
		Low (0-0.11)	Medium (0.11-0.27)	High (0.28-0.78)
1	2004	6	2	1
2	2009	7	1	1
3	2014	7	1	1
Total		20	4	3

Small Millet productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.12 and Fig. 4.45, 4.46 and 4.47.

The small milllet productivity crop diversity map is shown in (Fig. 4.45 and Table 4.16) and found three ranges productivity in 2004. One is consisting of the six districts Adilabad, Karimnagar, Nizamabad, Warangal, Medak and Nalgonda having (0-0.11) low crop diversity and second range consisting of the two districts Khammam and Rangareddy showed (0.11-0.27) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (0.28-0.78) high crop diversity.

The small millet productivity crop diversity map is shown in (Fig. 4.46 and Table 4.16) and found three ranges productivity in 2009. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Nalgonda and Khammam having (0-0.11) low crop diversity and second consisting of the one district Rangareddy (0.11-0.27) medium crop diversity, whereas the third range consisting of the one district Mahbubnagar having (0.28-0.78) high crop diversity.

The small millet productivity crop diversity map is shown in (Fig. 4.47 and Table 4.16) and found three ranges productivity in 2014. One is consisting of the seven districts Adilabad, Nizamabad, Karimnagar, Medak, Khammam, Warangal and Nalgonda having (0-0.11) low crop diversity and second range consisting of the one district Mahbubnagar showed (0.11-0.27) medium crop diversity, whereas the third range consisting of the one district Rangareddy having (0.28-0.78) high crop diversity.

The classification of the Telangana state for total districts crop diversity in small millet productivity reflected that twenty districts having (0-0.11) low crop diversity, four districts having (0.12-0.27) medium crop diversity and three districts showed (0.28-0.78) high crop diversity that is also shown in Fig. 4.45, 4.46 and 4.47 and Table 4.16 during 2004, 2009 and 2014.

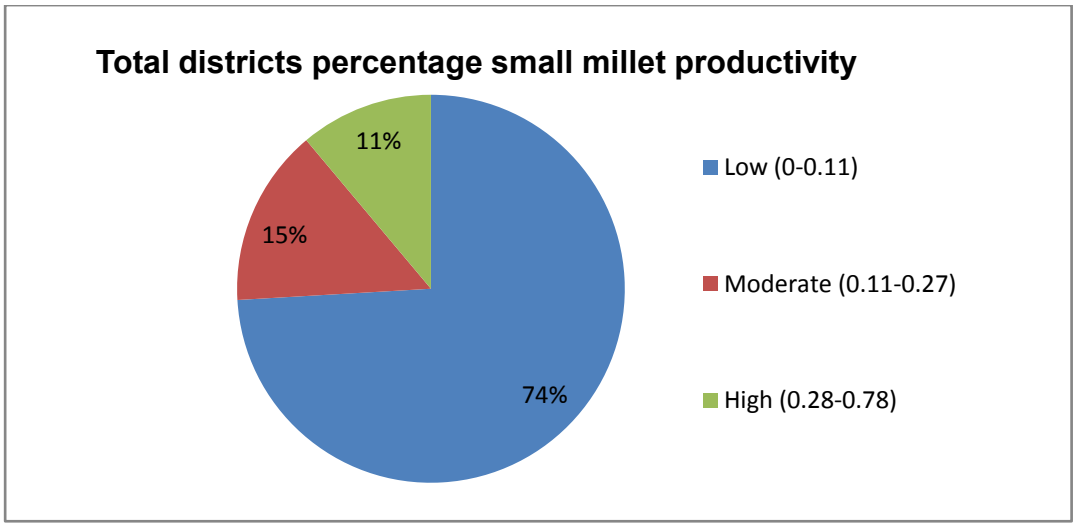

Fig. 4.48. Total districts small millet productivity of Telangana state in three years (percentage).

The total districts crop diversity in small millet productivity is found 74% low, 15% medium and 11% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.48.

Table 4.17: Classification Area, Production and Productivity of Sorghum in Andhra Pradesh State during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Anantpur	2822	16171	19962	1.23	59130	40164	0.68	18452	5602	0.3
Chittor	2823	2684	2483	0.93	1302	1413	1.09	23	16	0.7
Cuddapha	2820	3860	1554	0.4	11390	17830	1.57	15268	22455	1.47
East Godavari	2814	539	290	0.54	544	720	1.32	2086	1621	0.78
Guntur	2817	3312	9004	2.72	3629	20634	5.69	21939	151031	6.88
Krishna	2816	961	1193	1.24	3169	9721	3.07	524	2370	4.52
Kurnool	2821	103085	204616	1.98	71706	129015	1.8	67167	135952	2.02
Nellore	2819	178	310	1.74	27	94	3.48	2352	4260	1.81
Prakasam	2818	7710	5384	0.76	7512	16941	2.26	12899	19645	1.52
Srikakulam	2811	328	195	0.59	185	218	1.18	44	65	1.48
Visakhaptnam	2813	1163	715	0.61	916	1272	1.39	398	610	1.53
Vizianagarm	2812	349	242	0.69	445	536	1.2	130	209	1.61
Wast Godavari	2815	446	327	0.73	572	1926	3.37	179	639	3.57

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

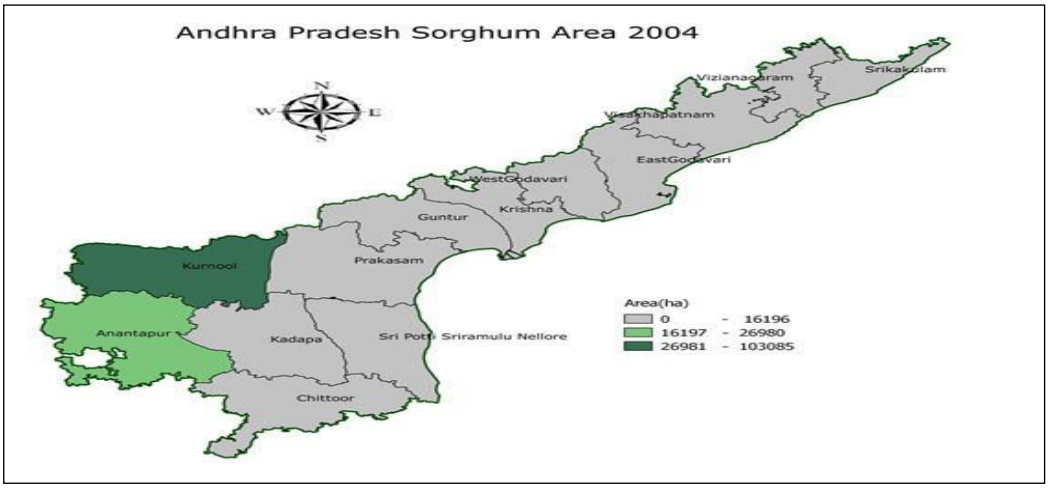

Fig. 4.49. Area under cultivation of sorghum in Andhra Pradesh (2004)

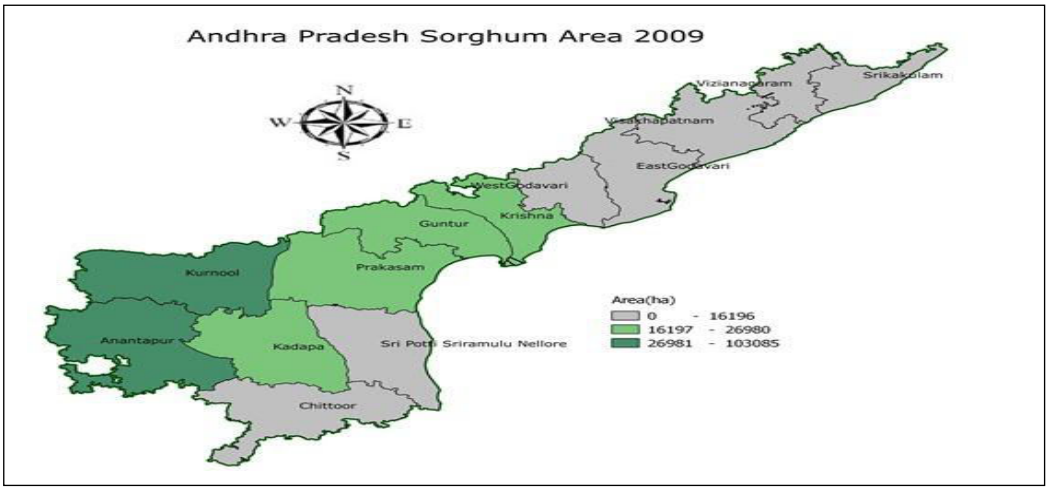

Fig. 4.50. Area under cultivation of sorghum in Andhra Pradesh (2009)

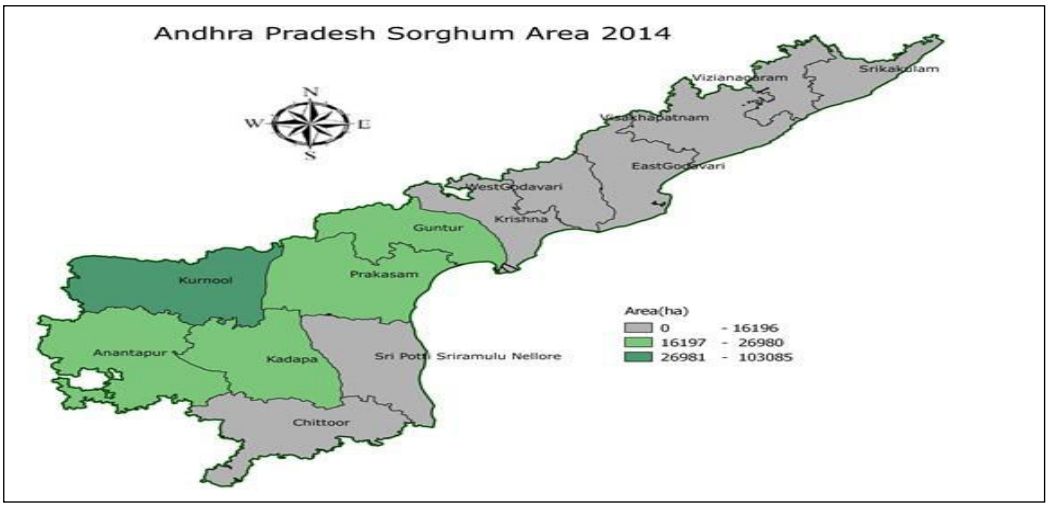

Fig. 4.51. Area under cultivation of sorghum in Andhra Pradesh (2014)

Table 4.18: Classification of the range of low, medium and high of total sorghum cultivated area in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area sorghum (ha)		
		Low (0-16196)	Medium (16197-26980)	High (26981-103085)
1	2004	11	1	1
2	2009	7	4	2
3	2014	8	4	1
Total		26	9	4

Sorghum cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.17 and Fig. 4.49, 4.50 and 4.51.

The sorghum cultivated area crop diversity map is shown in (Fig. 4.49 and Table 4.18) and found three ranges area in 2004. One is consisting of the eleven districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Cuddapah, Nellore and chittor having (0-16196) low crop diversity and second range consisting of the one district Anantapur showed (16197-26980) medium crop diversity, whereas the third range consisting of the one district Kurnool having (26981-103085) high crop diversity.

The sorghum cultivated area crop diversity map is shown in (Fig. 4.50 and Table 4.18) and found three ranges area in 2009. One is consisting of the seven districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Nellore and Chittor having (0-16196) low

crop diversity and second range consisting of the four districts Krishna, Guntor, Prakasam and Cuddapah showed (161197-26980) medium crop diversity, whereas the third range consisting of the two districts Kurnool and Anantapur having (26981-103085) high crop diversity.

The sorghum cultivated area crop diversity map is shown in (Fig. 4.51 and Table 4.18) and found three ranges area in 2014. One is consisting of the eight districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Nellore, Chittor and Krishna having (0-16196) low crop diversity and second range consisting of the four districts Guntur, Prakasam, Cuddapah and Anantapur showed (16197-26980) medium crop diversity, whereas the third range consisting of the one district Kurnool having (26981-103085) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in sorghum cultivated area reflected that twenty six districts having (0-16196) low crop diversity, nine districts having (16197-26980) medium crop diversity and four districts showed (26981-103085) high crop diversity that is also shown in Fig. 4.49, 4.50 and 4.51 and Table 4.18 during 2004, 2009 and 2014.

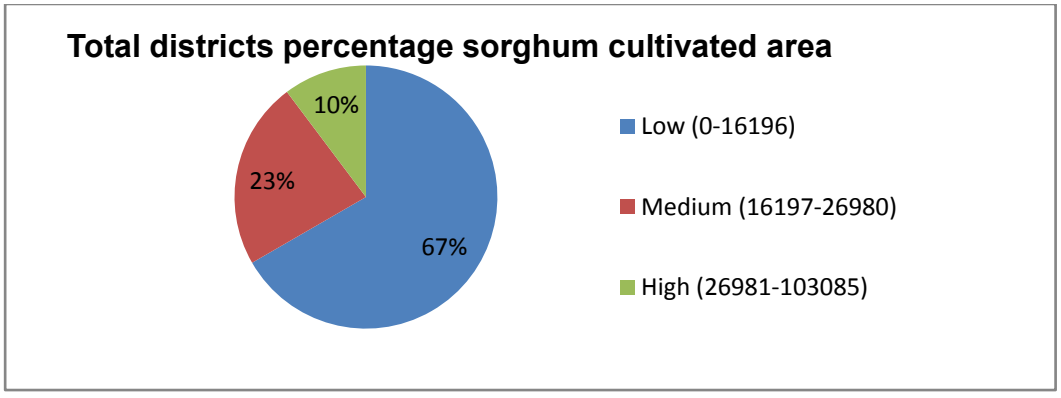

Fig. 4.52. Total districts sorghum cultivated area of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in sorghum cultivated area is found 67% low, 23% medium and 10% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.52.

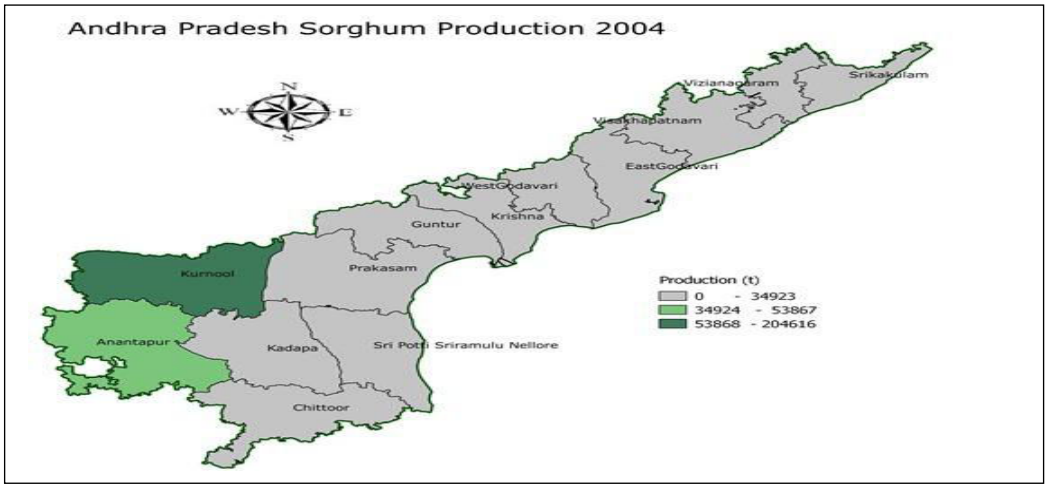

Fig. 4.53. Production under of sorghum in Andhra Pradesh (2004)

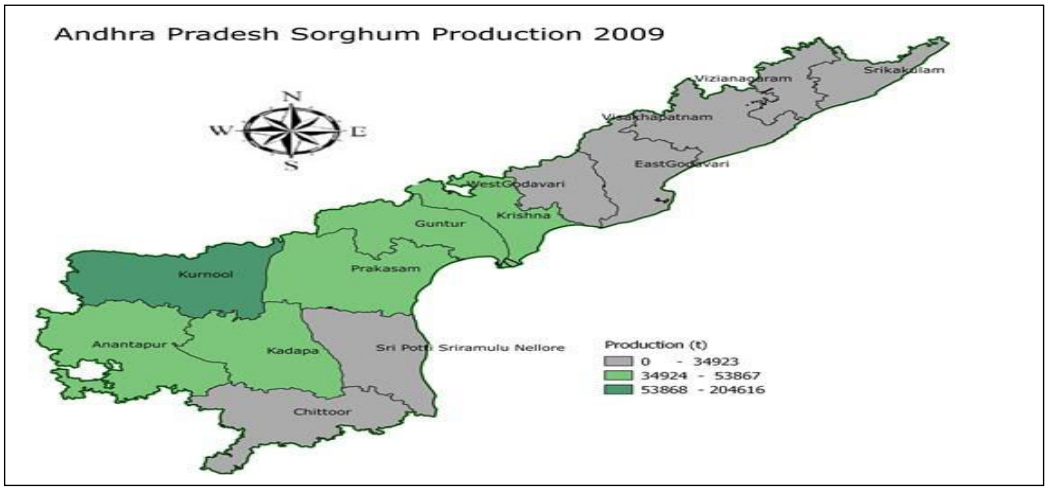

Fig. 4.54. Production under of sorghum in Andhra Pradesh (2009)

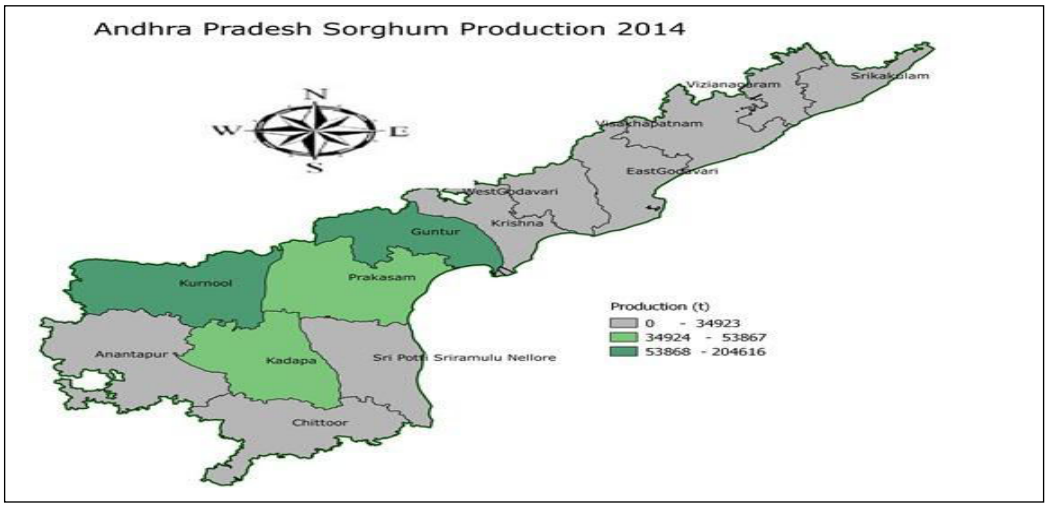

Fig. 4.55. Production under of sorghum in Andhra Pradesh (2014)

Table 4.19: Classification of the range of low, medium and high of total sorghum production in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of sorghum (t)		
		Low (0-34923)	Medium (34924-53867)	High (53868-204616)
1	2004	11	1	1
2	2009	7	5	1
3	2014	9	2	2
Total		27	8	4

Sorghum production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.17 and Fig. 4.53, 4.54 and 4.55.

The sorghum production crop diversity map is shown in (Fig. 4.53 and Table 4.19) and found three ranges production in 2004. One is consisting of the eleven districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Cuddapah, Nellore and Chittor having (0-34923) low crop diversity and second range consisting of the one district Anantapur showed (34924-53867) medium crop diversity, whereas the third range consisting of the one district Kurnool having (53868-204616) high crop diversity.

The sorghum production crop diversity map is shown in (Fig. 4.54 and Table 4.19) and found three ranges production in 2009. One is consisting of the seven districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Nellore and Chittor having (0-34923) low crop diversity and second range consisting of the five districts Krishna,

Guntor, Prakasam, Anantapur and Cuddapah showed (34924-53867) medium crop diversity, whereas the third range consisting of the one district Kurnool having (53868-204616) high crop diversity.

The sorghum production crop diversity map is shown in (Fig. 4.55) and (Table 4.19) and found three ranges production in 2014. One is consisting of the nine districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Nellore, Anantapur, Chittor and Krishna having (0-34923) low crop diversity and second range consisting of the two districts Prakasam and Cuddapah showed (34924-53867) medium crop diversity, whereas the third range consisting of the two districts Kurnool and Guntur having (53868-2046616) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in sorghum production reflected that twenty seven districts having (0-34923) low crop diversity, eight districts having (34924-53867) medium crop diversity and four districts showed (53868-204616) high crop diversity that is also shown in Fig. 4.53, 4.54 and 4.55 and Table 4.19 during 2004, 2009 and 2014.

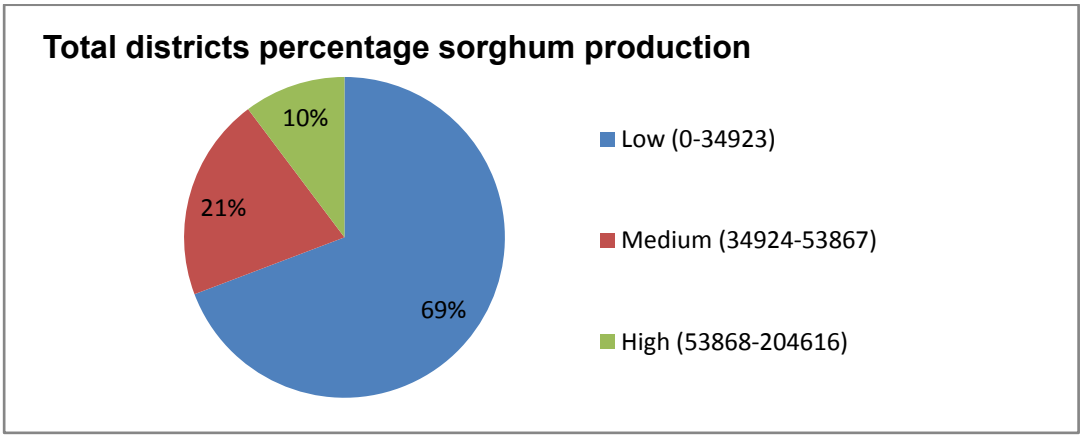

Fig. 4.56. Total districts sorghum production of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in sorghum production is found 69% low, 21% medium and 10% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.56.

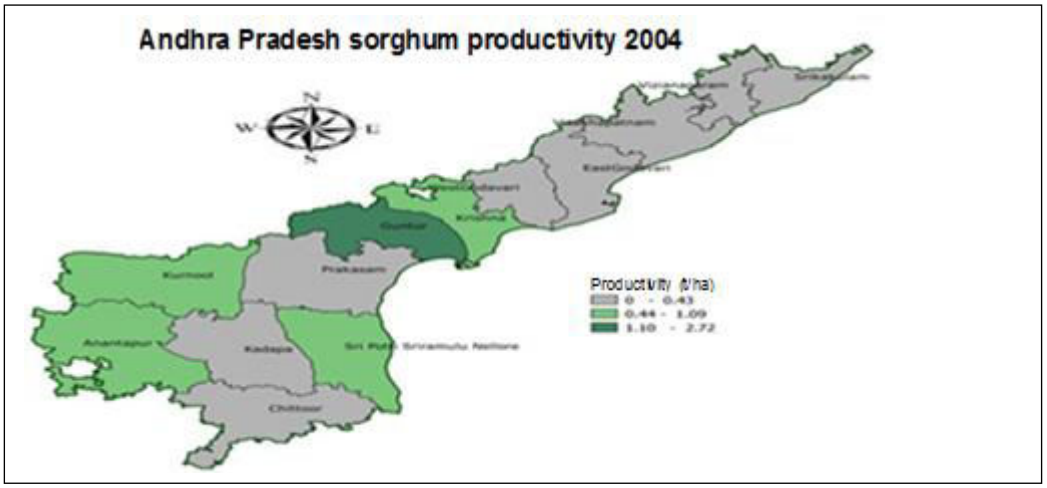

Fig. 4.57. Productivity under of sorghum in Andhra Pradesh (2004)

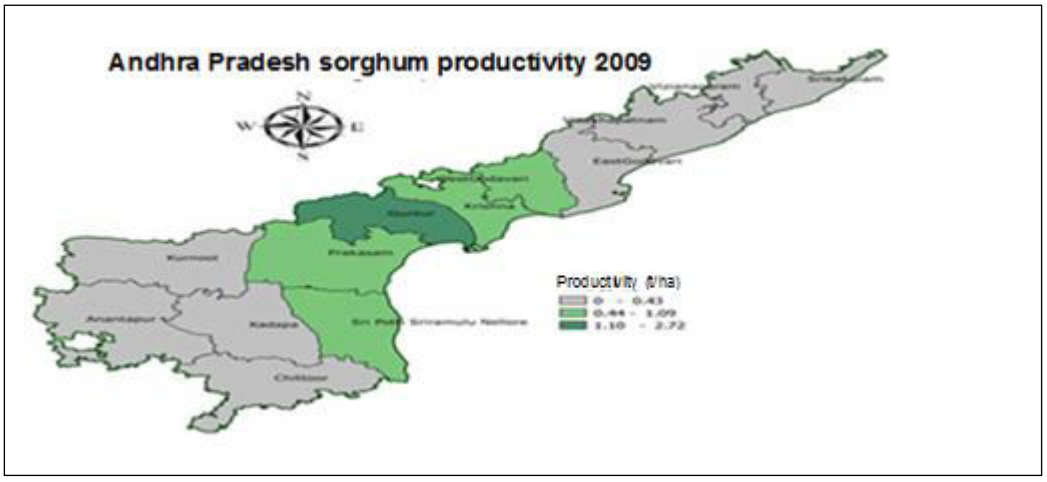

Fig. 4.58. Productivity under of sorghum in Andhra Pradesh (2009)

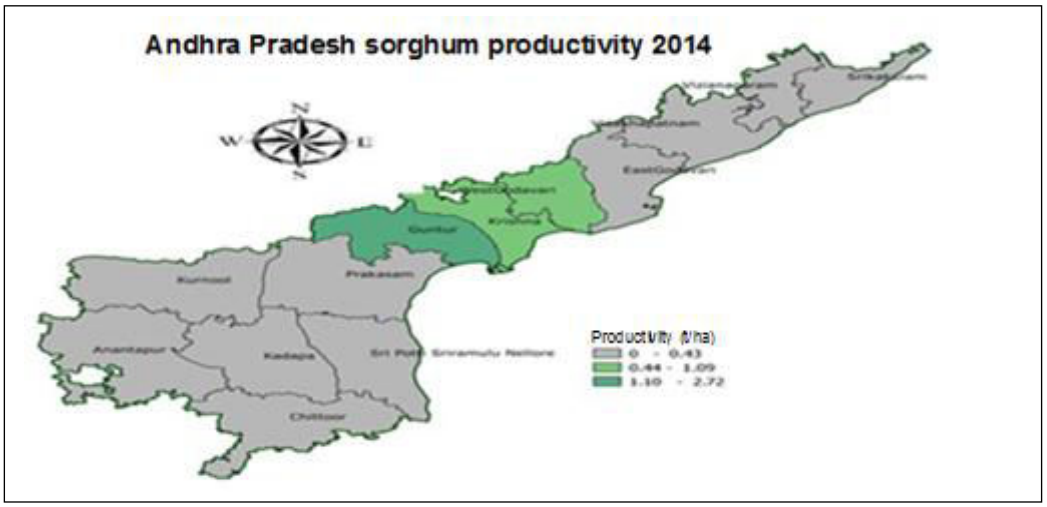

Fig. 4.59. Productivity under of sorghum in Andhra Pradesh (2014)

Table 4.20: Classification of the range of low, medium and high of total sorghum productivity in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of sorghum (t/ha)		
		Low (0-0.43)	Medium (0.44-1.09)	High (1.10-2.72)
1	2004	8	4	1
2	2009	8	4	1
3	2014	10	2	1
Total		26	10	3

Sorghum productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.17 and Fig. 4.57, 4.58 and 4.59.

The sorghum productivity crop diversity map is shown in (Fig. 4.57 and Table 4.20) and found three ranges productivity in 2004. One is consisting of the eight districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Prakasam, Cuddapah and Chittor having (0-0.43) low crop diversity and second range consisting of the four districts Krishna, Kurnool, Nellore and Anantapur showed (0.44-1.09) medium crop diversity, whereas the third range consisting of the one district Guntur having (1.10-2.72) high crop diversity.

The sorghum productivity crop diversity map is shown in (Fig. 4.58 and Table 4.20) and found three ranges productivity in 2009. One is consisting of the eight districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, Kurnool, Anantapur, Cuddapah and Chittor having (0-0.43) low crop diversity and second range consisting of the four districts Krishna, Prakasam, West Godavari and Nellore showed (0.44-1.09)

medium crop diversity, whereas the third range consisting of the one district Guntur having (1.10-2.72) high crop diversity.

The sorghum productivity crop diversity map is shown in (Fig. 4.59 and Table 4.20) and found three ranges productivity in 2014. One is consisting of the ten districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, Prakasam, Kurnool, Anantapur, Cuddapah, Nellore and Chittor having (0-0.43) low crop diversity and second range consisting of the two districts West Godavari and Krishna showed (0.44-1.09) medium crop diversity, whereas the third range consisting of the one district Guntur having (1.10-2.72) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in sorghum productivity reflected that twenty six districts having (0-0.43) low crop diversity, ten districts having (0.44-1.09) medium crop diversity and three districts showed (1.10-2.72) high crop diversity that is also shown in Fig. 4.57, 4.58 and 4.59 and Table 4.20 during 2004, 2009 and 2014.

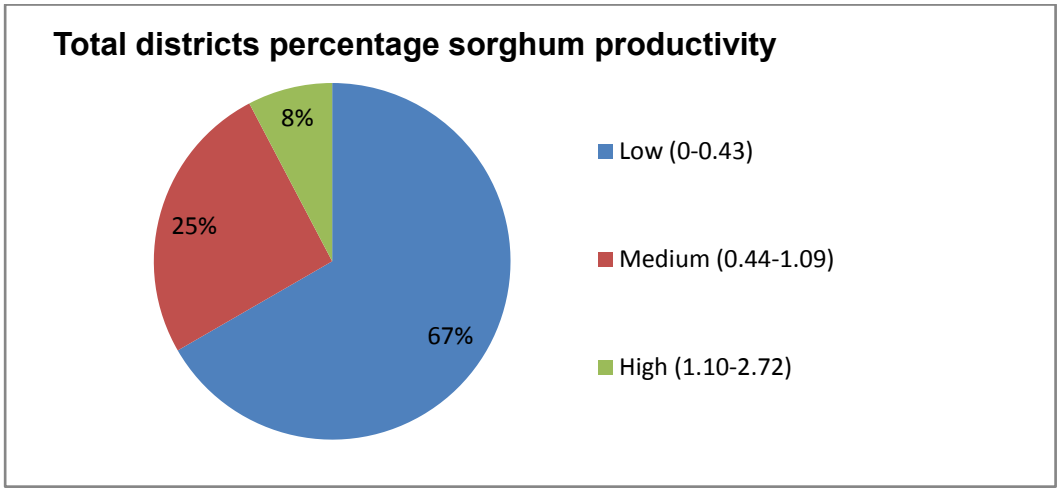

Fig. 4.60. Total districts sorghum productivity of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in sorghum productive is found 67% low, 25% medium and 8% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.60.

Table 4.21: Classification Area, Production and Productivity of Pearl Millet in Andhra Pradesh State during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Anantpur	2822	1083	427	0.39	1767	3250	1.84	1799	1056	0.59
Chittor	2823	2741	3596	1.31	2876	3356	1.17	2072	4624	2.23
Cuddapha	2820	6160	9154	1.49	3591	9344	2.6	3118	8001	2.57
East Godavari	2814	1840	1404	0.76	375	287	0.77	58	75	1.29
Guntur	2817	1552	890	0.57	315	557	1.71	751	826	1.1
Krishna	2816	4	4	1	1	2	2	6	12	2
Kurnool	2821	10835	11232	1.04	6747	4871	0.72	5240	7341	1.4
Nellore	2819	764	1036	1.36	864	2107	2.44	637	1703	2.67
Prakasam	2818	17789	21134	1.19	5341	13529	2.53	11789	12086	1.03
Srikakulam	2811	3711	6954	1.87	1047	1671	1.6	196	522	2.66
Visakhaptnam	2813	12458	13093	1.85	4829	5380	1.11	2395	2170	0.91
Vizianagarm	2812	1693	1297	0.77	851	895	1.05	132	95	0.72
West Godavari	2815	70	70	1	0	0	0	0	0	0

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

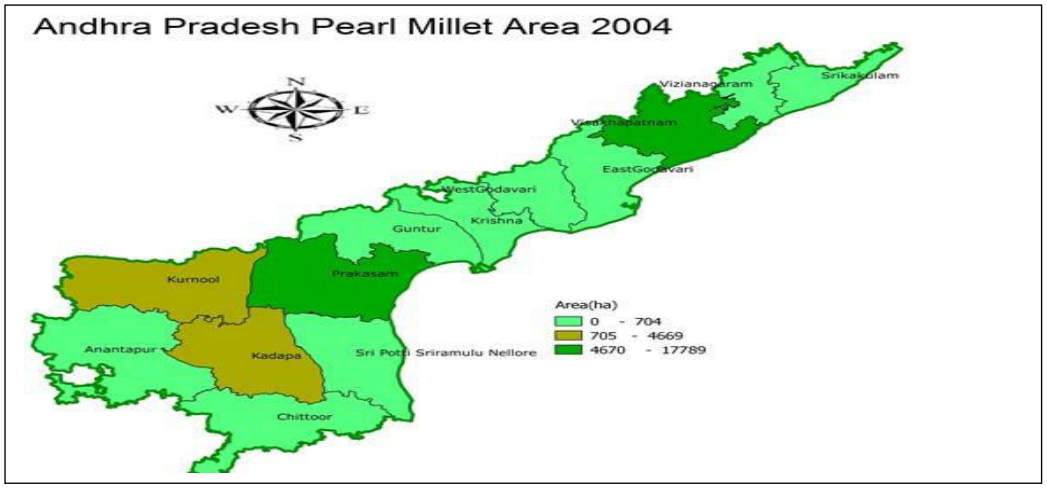

Fig. 4.61. Area under cultivation of pearl millet in Andhra Pradesh (2004)

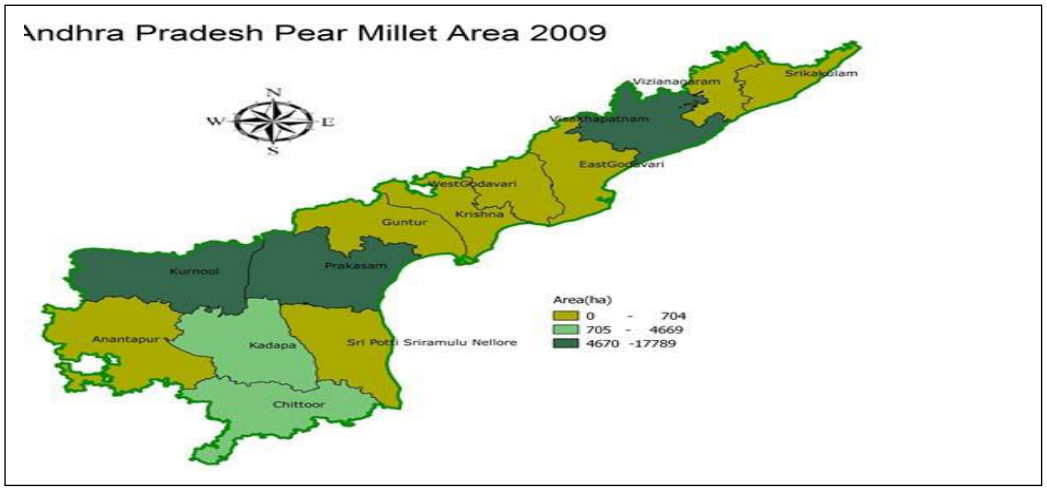

Fig. 4.62. Area under cultivation of pearl millet in Andhra Pradesh (2009)

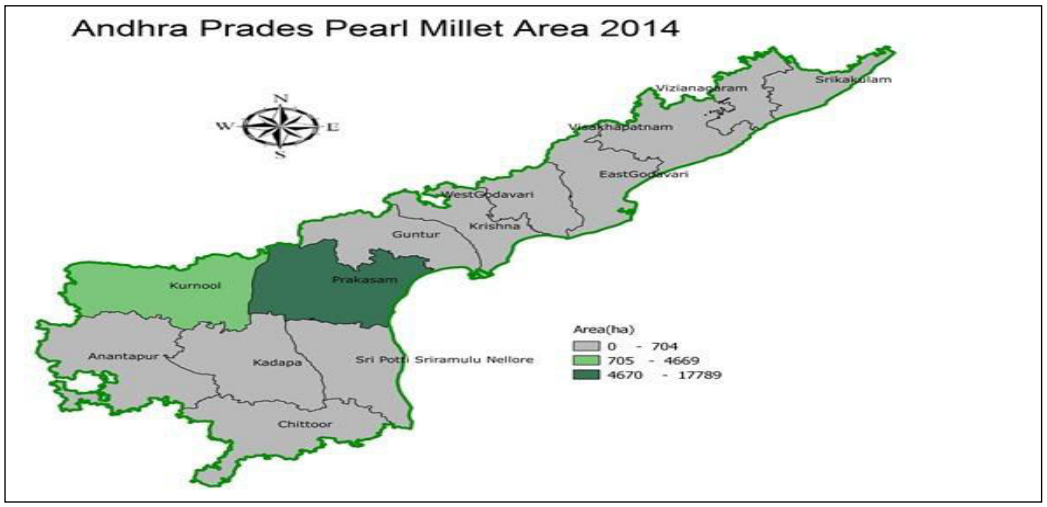

Fig. 4.63. Area under cultivation of pearl millet in Andhra Pradesh (2014)

Table 4.22: Classification of the range of low, medium and high of total pearl millet cultivated area in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area of pearl millet (ha)		
		Low (0-704)	Medium (705-4669)	High (4670-17789)
1	2004	9	2	2
2	2009	8	2	3
3	2014	11	1	1
Total		28	5	6

Pearl Millet cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.21 and Fig. 4.61, 4.62 and 4.63.

The pearl millet cultivated area crop diversity map is shown in (Fig. 4.61 and Table 4.22) and found three ranges area in 2004. One is consisting of the nine districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Nellore, Anantapur and Chittor having (0-704) low crop diversity and second range consisting of the two districts Cuddapah and Kurnool showed (705-4669) medium crop diversity, whereas the third range consisting of the two districts Vishakapatnam and Prakasam having (4670-17789) high crop diversity.

The pearl millet cultivated area crop diversity map is shown in (Fig. 4.62 and Table 4.22) and found three ranges area in 2009. One is consisting of the eight districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna Guntur, Nellore and Anantapur having (0-704) low crop diversity and second range consisting of the two districts Cuddapah and Chittor showed (705-4669) medium crop diversity, whereas the third

range consisting of the three districts Kurnool, Prakasam and Vishakapatnam having (4670-17789) high crop diversity.

The pearl millet cultivated area crop diversity map is shown in (Fig. 4.63 and Table 4.22) and found three ranges area in 2014. One is consisting of the eleven districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Krishna, Guntur, Anantapur, Cuddapah, Nellore and Chittor having (0-704) low crop diversity and second range consisting of the one district Kurnool showed (705-4669) medium crop diversity, whereas the third range consisting of the one district Prakasam having (4670-17789) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in pearl millet cultivated area reflected that twenty eight districts having (0-704) low crop diversity, five districts having (705-4669) medium crop diversity and six districts showed (4670-17789) high crop diversity that is also shown in Fig. 4.61, 4.62 and 4.63 and Table 4.22 during 2004, 2009 and 2014.

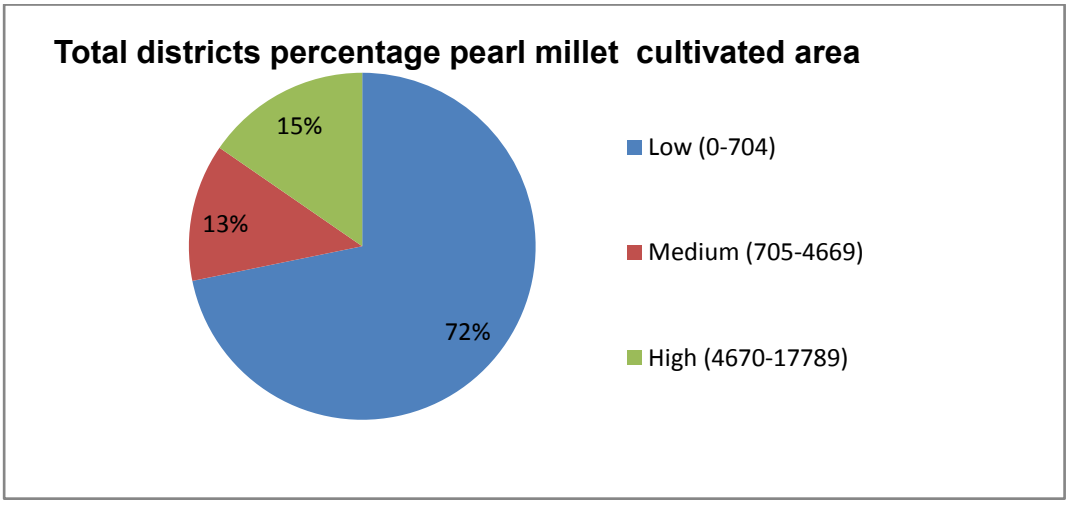

Fig. 4.64. Total districts pearl millet cultivated area of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in pearl millet cultivated area is found 72% low, 13% medium and 15% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.64.

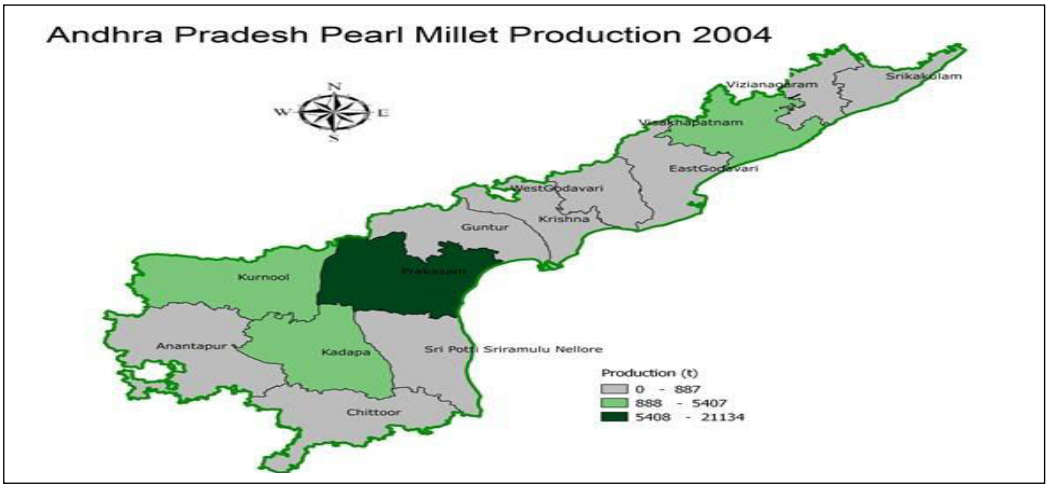

Fig. 4.65. Production under of pearl millet in Andhra Pradesh (2004)

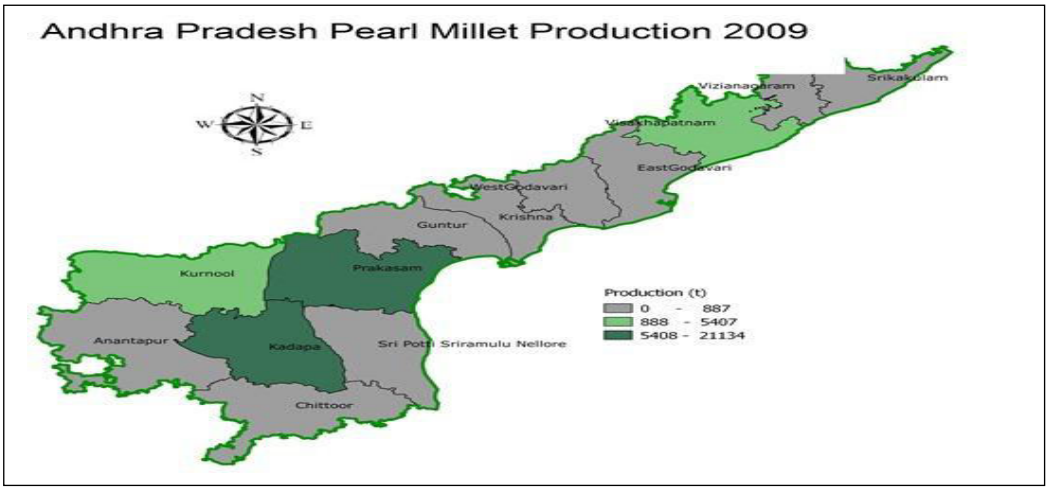

Fig. 4.66. Production under of pearl millet in Andhra Pradesh (2009)

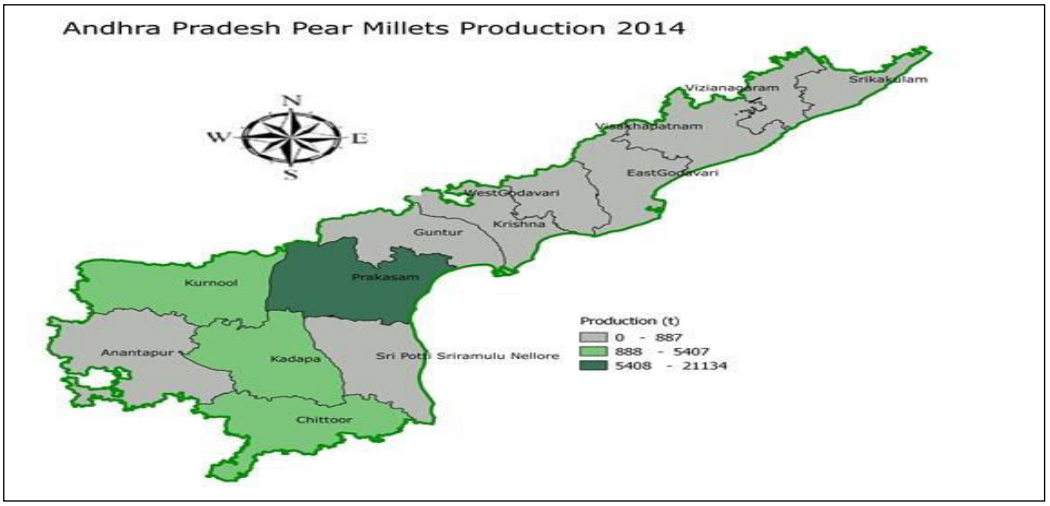

Fig. 4.67. Production under of pearl millet in Andhra Pradesh (2014)

Table 4.23: Classification of the range of low, medium and high of total pearl millet production in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of pearl millet (t)		
		Low (0-887)	Medium (888-5407)	High (5408-21134)
1	2004	9	3	1
2	2009	9	2	2
3	2014	9	3	1
Total		27	8	4

Pearl Millet production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.21 and Fig. 4.65, 4.66 and 4.67.

The pearl millet production crop diversity map is shown in (Fig. 4.65 and Table 4.23) and found three ranges production in 2004. One is consisting of the nine districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Nellore, Anantapur and Chittor having (0-887) low crop diversity and second range consisting of the three districts Vishakapatnam, Krishna and Kurnool showed (888-5407) medium crop diversity, whereas the third range consisting of the one district Cuddapah having (5408-21134) high crop diversity.

The pearl millet production crop diversity map is shown in (Fig. 4.66 and Table 4.23) and found three ranges production in 2009. One is consisting of the nine districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Nellore, Chittor and Anantapur having (0-887) low crop diversity and second range consisting of the two districts Vishakapatnam and Kurnool showed (888-5407) medium crop diversity,

whereas the third range consisting of the two districts Cuddapah and Prakasam having (5408-21134) high crop diversity.

The pearl millet production crop diversity map is shown in (Fig. 4.67 and Table 4.23) and found three ranges production in 2014. One is consisting of the nine districts Srikakulam, Vizianagram, Vishakapatnam, East Godavari, West Godavari, Krishna, Guntur, Anantapur and Nellore having (0-887) low crop diversity and second range consisting of the three districts Kurnool, Cuddapah and Chittor showed (888-5407) medium crop diversity, whereas the third range consisting of the one district Prakasam having (5408-21134) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in pearl millet production reflected that twenty seven districts having (0-887) low crop diversity, eight districts having (888-5407) medium crop diversity and four districts showed (5408-21134) high crop diversity that is also shown in Fig. 4.65, 4.66 and 4.67 and Table 4.23 during 2004, 2009 and 2014.

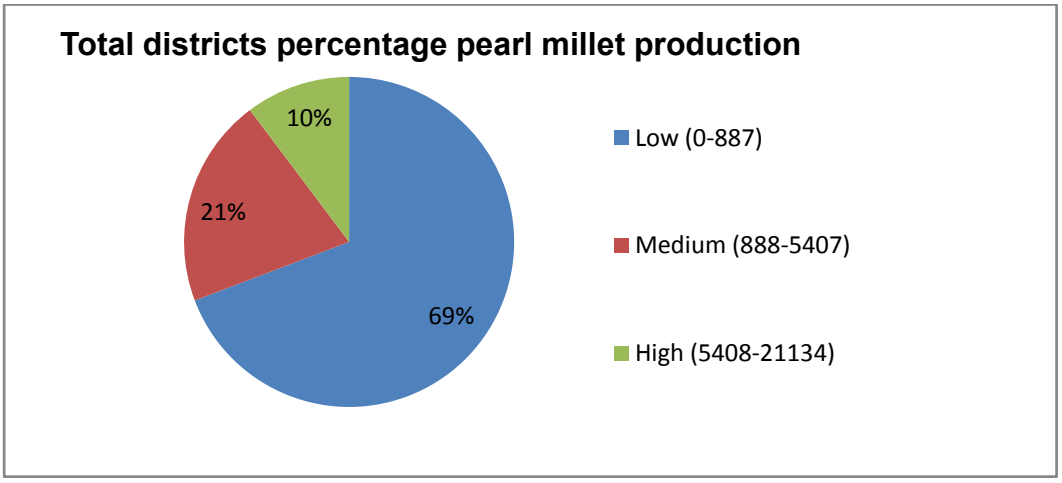

Fig. 4.68. Total districts pearl millet production of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in pearl millet production is found 69% low, 21% medium and 10% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.68.

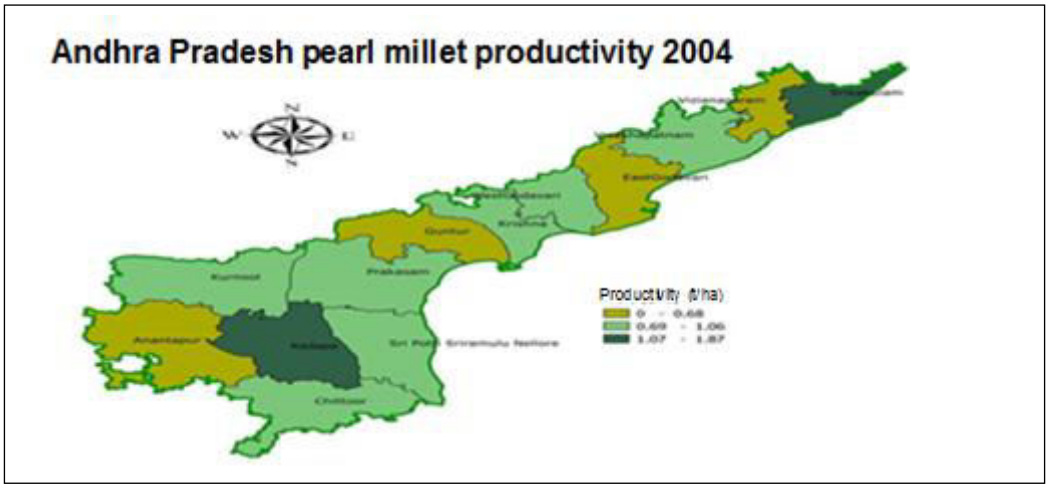

Fig. 4.69. Productivity under of pearl millet in Andhra Pradesh (2004)

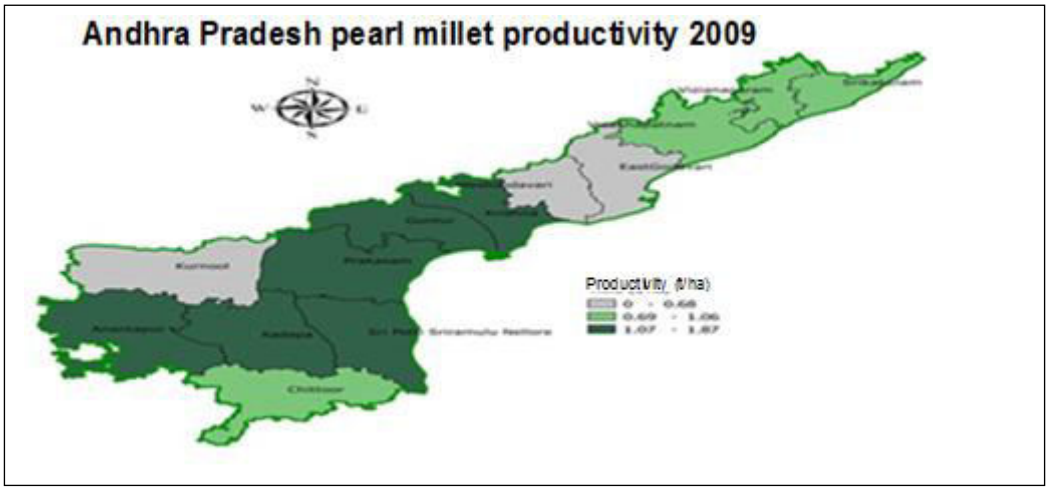

Fig. 4.70. Productivity under of pearl millet in Andhra Pradesh (2009)

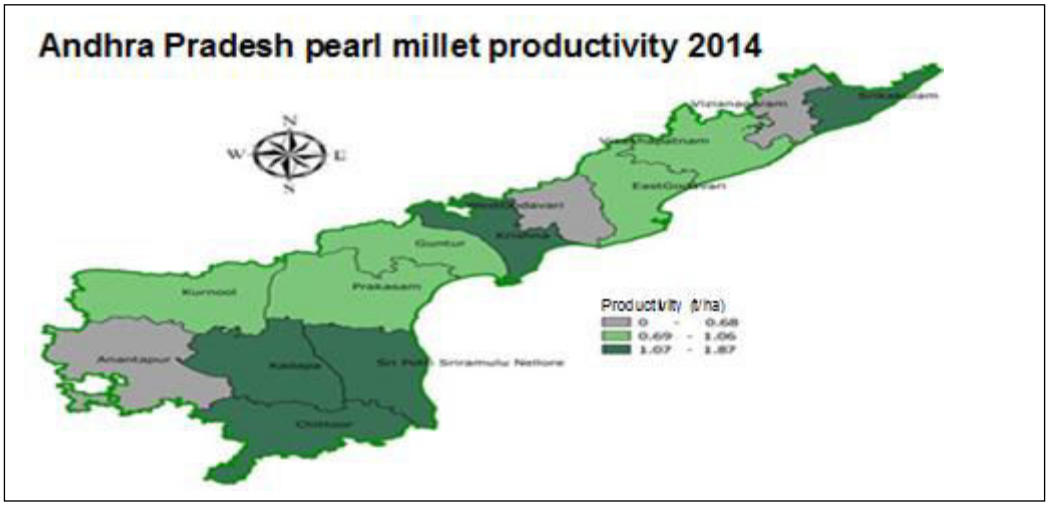

Fig. 4.71. Productivity under of pearl millet in Andhra Pradesh (2014)

Table 4.24: Classification of the range of low, medium and high of total pearl millet productivity in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of pearl millet (t/ha)		
		Low (0-0.68)	Medium (0.69-1.06)	High (1.07-1.87)
1	2004	4	7	2
2	2009	3	4	6
3	2014	3	5	5
Total		10	16	13

Pearl Millet productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.21 and Fig. 4.69, 4.70 and 4.71.

The pearl millet productivity crop diversity map is shown in (Fig. 4.69 and Table 4.24) and found that three ranges productivity in 2004. One is consisting of the four districts Vizianagram, East Godavari, Guntur and Anantapur having (0-0.68) low crop diversity and second range consisting of the seven districts Vishakapatnam, West Godavari, Krishna, Nellore, Chittor and Kurnool showed (0.69-1.06) medium crop diversity, whereas the third range consisting of the two districts Srikakulam and Cuddapah having (1.07-1.87) high crop diversity.

The pearl millet productivity crop diversity map is shown in (Fig. 4.70 and Table 4.24) and found three ranges productivity in 2009. One is consisting of the three districts East Godavari, West Godavari and Kurnool having (0-0.68) low crop diversity and second range consisting of the four districts Srikakulam, Vishakapatnam, Vizianagaram and Chittor showed (0.69-1.06) medium crop diversity, whereas the third range consisting of

the six districts Krishna, Guntur, Nellore, Anantapur, Cuddapah and Prakasam having (1.07-1.87) high crop diversity.

The pearl millet productivity crop diversity map is shown in (Fig. 4.71 and Table 4.24) and found three ranges productivity in 2014. One is consisting of the three districts Vizianagram, West Godavari and Anantapur having (0-0.68) low crop diversity and second range consisting of the five districts Vishakapatnam, East Godavari, Guntur, Kurnool and Prakasam showed (0.69-1.06) medium crop diversity, whereas the third range consisting of the five districts Srikakulam, Krishna, Cuddapah, Nellore and Chittor having (1.07-1.87) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in pearl millet productivity reflected that ten districts having (0-0.68) low crop diversity, sixteen districts having (0.69-1.06) medium crop diversity and thirteen districts showed (1.07-1.87) high crop diversity that is also shown in Fig. 4.69, 4.70 and 4.71 and Table 4.24 during 2004, 2009 and 2014.

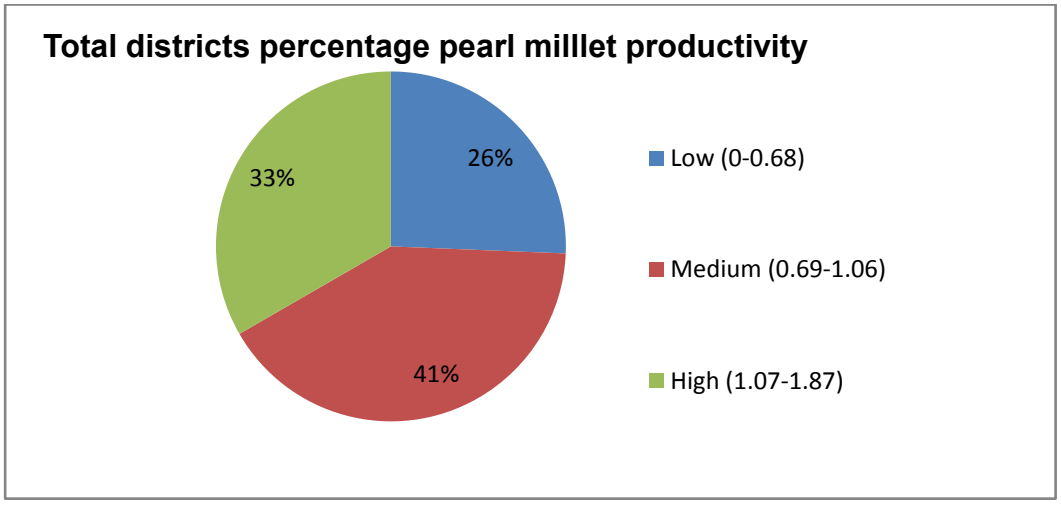

Fig. 4.72. Total districts pearl millet productivity of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in pearl millet productivity is found 26% low, 41% medium and 33% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.72.

Table 4.25: Classification Area, Production and Productivity of finger millet in Andhra Pradesh state during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Anantpur	2822	3567	6757	1.9	3542	6238	1.76	1870	2835	1.52
Chittor	2823	12117	16337	1.35	9243	12350	1.34	5108	4530	0.89
Cuddapha	2820	457	1011	2.21	211	438	2.08	89	129	1.45
East Godavari	2814	417	436	1.05	712	714	1	412	396	0.96
Guntur	2817	11	18	1.64	740	1480	2	400	595	1.49
Krishna	2816	0	0	0	0	0	0	0	0	0
Kurnool	2821	16	22	1.38	260	510	1.96	151	296	1.96
Nellore	2819	483	722	1.49	200	284	1.42	90	115	1.28
Prakasam	2818	2610	4268	1.64	1611	3206	1.99	960	1451	1.51
Srikakulam	2811	2625	3909	1.49	1815	2185	1.2	1176	1446	1.23
Visakhaptnam	2813	31552	30017	0.95	22304	21017	0.94	21121	20341	0.96
Vizianagarm	2812	7166	8813	1.23	3469	5139	1.48	2214	2562	1.16
West Godavari	2815	0	0	0	0	0	0	0	0	0

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

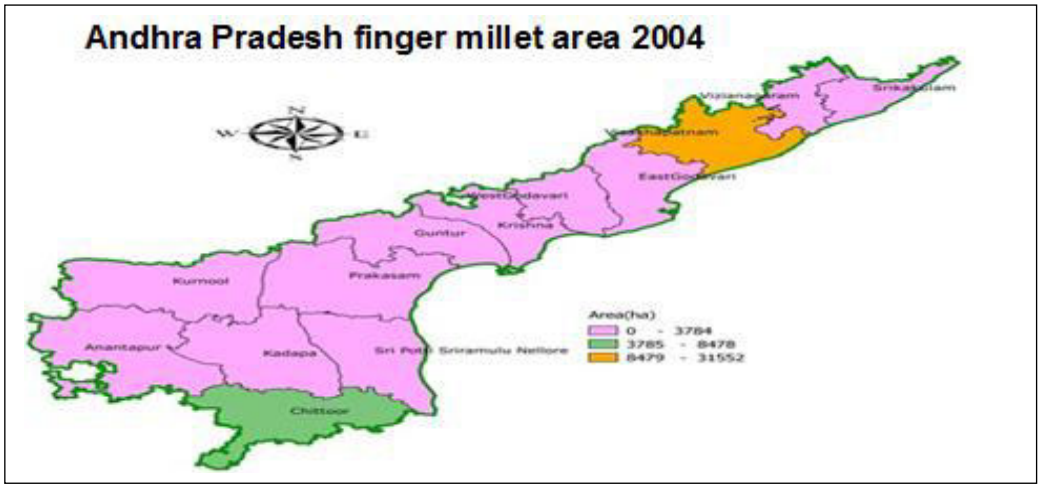

Fig. 4.73. Area under cultivation of finger millet in Andhra Pradesh (2004)

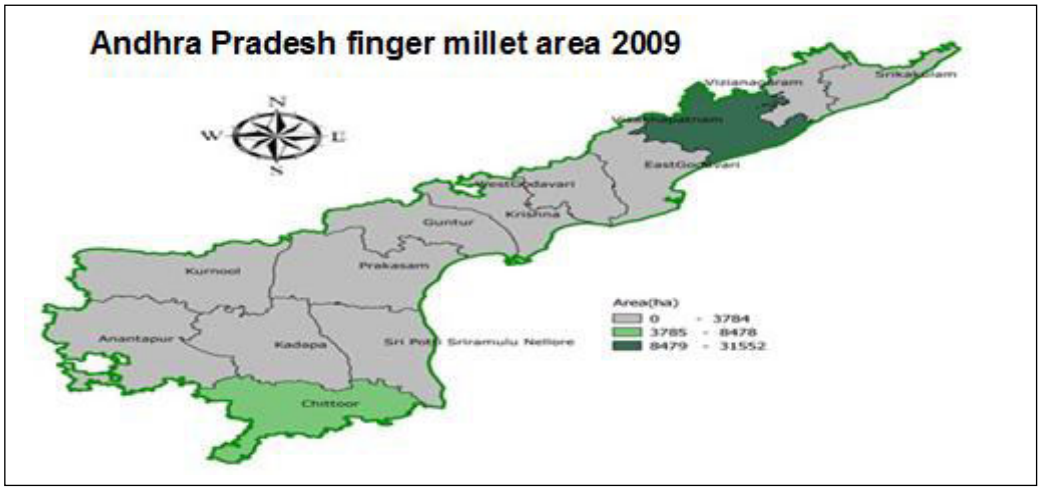

Fig. 4.74. Area under cultivation of finger millet in Andhra Pradesh (2009)

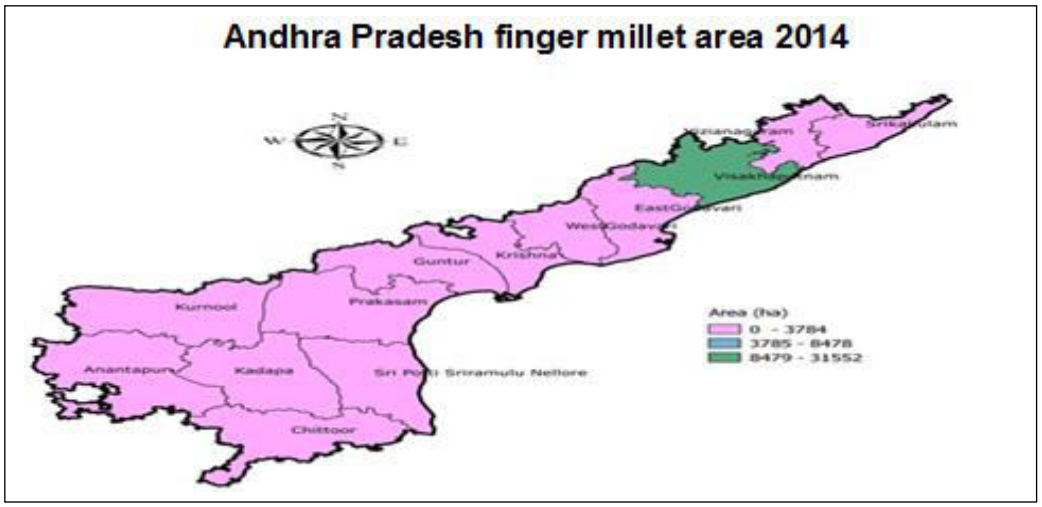

Fig. 4.75. Area under cultivation of finger millet in Andhra Pradesh (2014)

Table 4.26: Classification of the range of low, medium and high of total finger millet cultivated area in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area of finger millet (ha)		
		Low (0-3784)	Medium (3785-8478)	High (8479-31552)
1	2004	11	1	1
2	2009	11	1	1
3	2014	12	-	1
Total		34	2	3

Finger Millet cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.25 and Fig. 4.73, 4.74 and 4.75.

The finger millet cultivated area crop diversity map is shown in (Fig. 4.73 and Table 4.26) and found three ranges area in 2004. One is consisting of the eleven districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Kurnool, Cuddapah, Nellore, and Anantapur having (0-3784) low crop diversity and second range consisting of the one district Chittor showed (3785-8478) medium crop diversity, whereas the third range consisting of the one district Vishakapatnam having (8479-31552) high crop diversity.

The finger millet cultivated area crop diversity map is shown in (Fig. 4.74 and Table 4.26) and found three ranges area in 2009. One is consisting of the eleven districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Kurnool, Cuddapah, Nellore, and Anantapur having (0-3784) low crop diversity and second range consisting of the one district Chittor showed (3785-8478) medium crop

diversity, whereas the third range consisting of the one district Vishakapatnam having (8479-31552) high crop diversity.

The finger millet cultivated area crop diversity map is shown in (Fig. 4.75 and Table 4.26) and found three ranges area in 2014. One is consisting of the twelve districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Kurnool, Cuddapah, Nellore, Chittor and Anantapur having (0-3784) low crop diversity and it is not consisting range classify, whereas the third range consisting of the one district Vishakapatnam having (8479-31552) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in finger millet cultivated area reflected that thirty four districts having (0-3784) low crop diversity, two districts having (3785-8478) medium crop diversity and three districts showed (8479-31552) high crop diversity that is also shown in Fig. 4.73, 4.74 and 4.75 and Table 4.26 during 2004, 2009 and 2014.

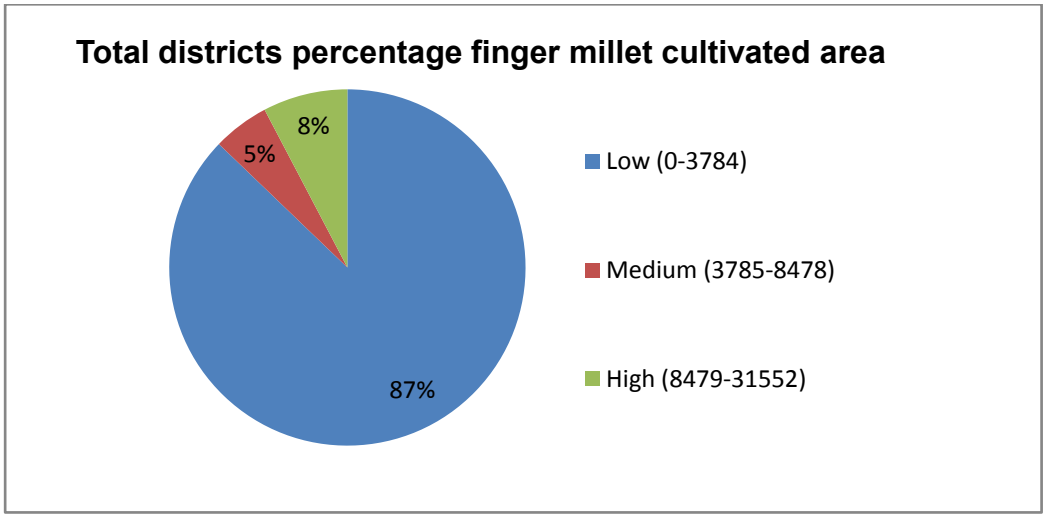

Fig. 4.76. Total districts finger millet cultivated area of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in finger millet cultivated area is found 87% low, 5% medium and 8% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.76.

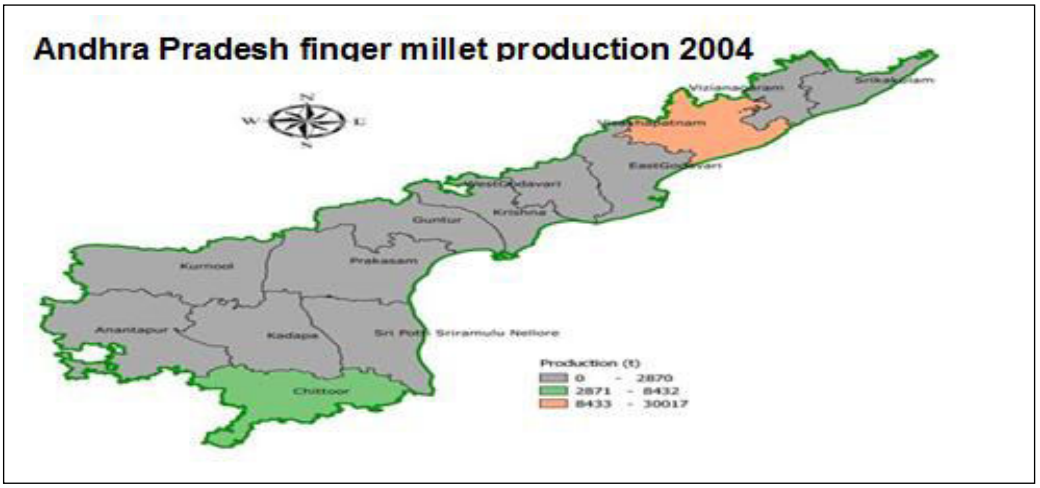

Fig.4.77. Production under of finger millet in Andhra Pradesh (2004)

Fig. 4.78. Production under of finger millet in Andhra Pradesh (2009)

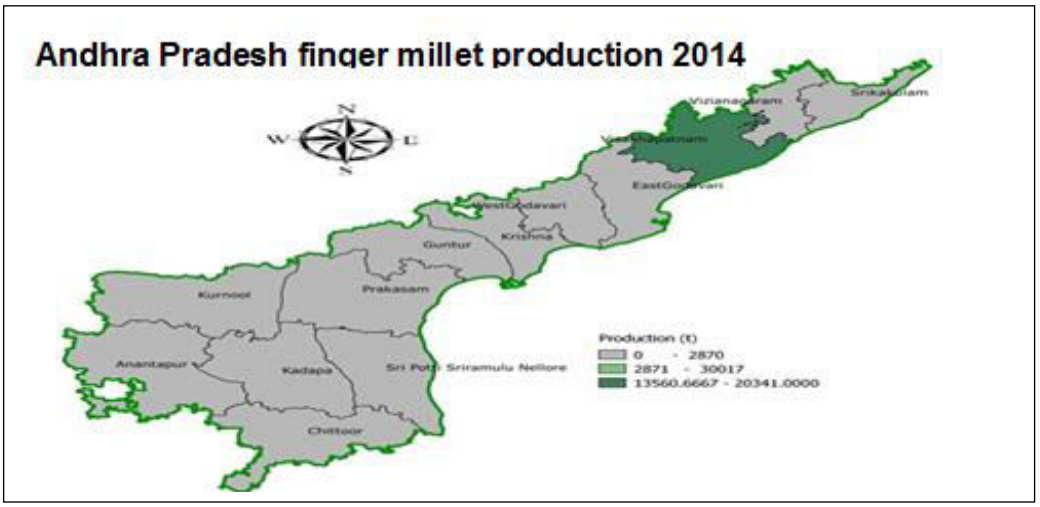

Fig. 4.79. Production under of finger millet in Andhra Pradesh (2014)

Table 4.27: Classification of the range low, medium and high of total finger millet production in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of finger millet (t)		
		Low (0-2870)	Medium (2871-8432)	High (8433-30017)
1	2004	11	1	1
2	2009	11	1	1
3	2014	12	-	1
Total		34	2	3

Finger Millet production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.25 and Fig. 4.77, 4.78 and 4.79.

The finger millet production crop diversity map is shown in (Fig. 4.77 and Table 4.27) and found three ranges production in 2004. One is consisting of the eleven districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Kurnool, Cuddapah, Nellore, and Anantapur having (0-2870) low crop diversity and second range consisting of the one district Chittor showed (2871-8432) medium crop diversity, whereas the third range consisting of the one district Vishakapatnam having (8433-30017) high crop diversity.

The finger millet production crop diversity map is shown in (Fig. 4.59 and Table 4.78) and found three ranges production in 2009. One is consisting of the eleven districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Kurnool, Cuddapah, Nellore, and Anantapur having (0-2870) low crop diversity and second range consisting of the one district Chittor showed (2871-8432) medium crop

diversity, whereas the third range consisting of the one district Vishakapatnam having (8433-30017) high crop diversity.

The finger millet production crop diversity map is shown in (Fig. 4.79 and Table 4.27) and found three ranges production in 2014. One is consisting of the twelve districts Srikakulam, Vizianagram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Kurnool, Cuddapah, Nellore, Chittor and Anantapur having (0-2870) low crop diversity and it is not consisting range classify, whereas the third range consisting of the one district Vishakapatnam having (8433-30017) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in finger milllet production reflected thirty four districts having (0-2870) low crop diversity, two districts having (2871-8432) medium crop diversity and three districts showed (8433-30017) high crop diversity that is also shown in Fig. 4.77, 4.78 and 4.79 and Table 4.27 during 2004, 2009 and 2014.

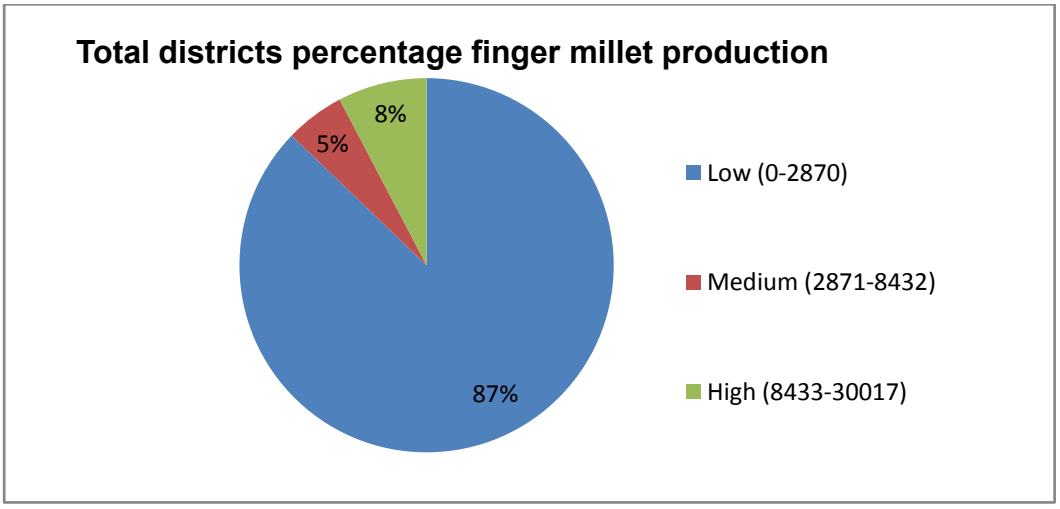

Fig. 4.80. Total districts finger millet production of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in finger millet production is found 87% low, 5% medium and 8% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.80.

Fig. 4.81. Productivity under of finger millet in Andhra Pradesh (2004)

Fig. 4.82. Productivity under of finger millet in Andhra Pradesh (2009)

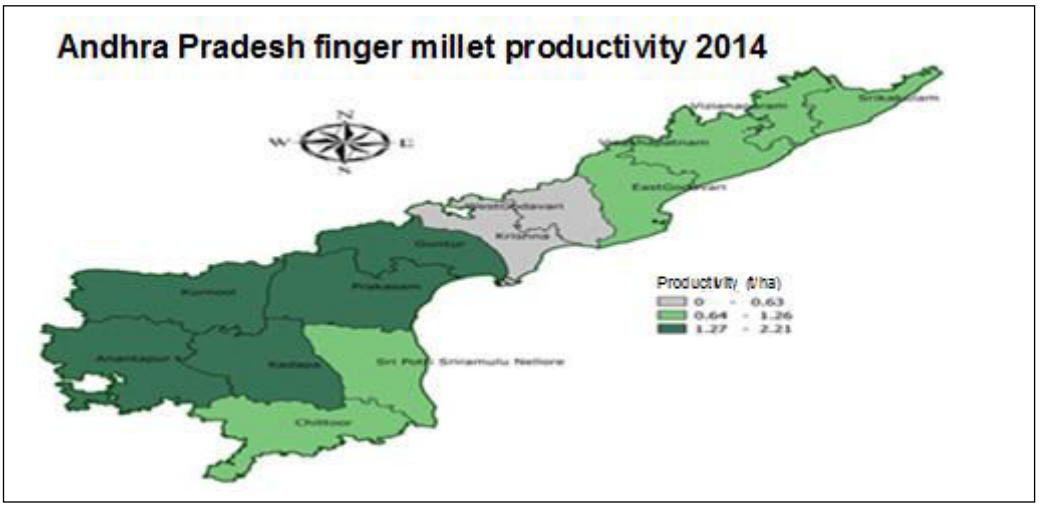

Fig. 4.83. Productivity under of finger millet in Andhra Pradesh (2014)

Table 4.28: Classification of the range of low, medium and high of total finger millet productivity in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of finger millet (t/ha)		
		Low (0-0.63)	Medium (0.64-1.26)	High (1.27-2.31)
1	2004	2	5	6
2	2009	2	4	7
3	2014	2	6	5
Total		6	15	18

Finger Millet productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.25 and Fig. 4.81, 4.82 and 4.83.

The finger millet productivity crop diversity map is shown in (Fig. 4.81 and Table 4.28) and found three ranges productivity in 2004. One is consisting of the two districts West Godavari and Krishna having (0-0.63) low crop diversity and second range consisting of the five districts Vizianagaram, Vishakapatnam, East Godavari, Kurnool and Chittor showed (0.64-1.26) medium crop diversity, whereas the third range consisting of the six districts Srikakulam, Guntur, Prakasam, Anantapur, Cuddapah and Nellore having (1.27-2.31) high crop diversity.

The finger millet productivity crop diversity map is shown in (Fig. 4.82 and Table 4.28) and found three ranges productivity in 2009. One is consisting of the two districts West Godavari and Krishna having (0-0.63) low crop diversity and second range consisting of the four districts Srikakulam, Vishakapatnam, East Godavari and Chittor showed (0.64-1.26) medium crop diversity, whereas the third range consisting of the

sevendistricts Vizianagaram, Guntur, Prakasam, Kurnool, Anantapur, Cuddapah and Nellore having (1.27-2.31) high crop diversity.

The finger millet productivity crop diversity map is shown in (Fig. 4.83 and Table 4.28) and found three ranges productivity in 2014. One is consisting of the two districts West Godavari and Krishna having (0-0.63) low crop diversity and second range consisting of the six districts Srikakulam, Vizianagaram Vishakapatnam, East Godavari, Nellore and Chittor showed (0.64-1.26) medium crop diversity, whereas the third range consisting of the five districts Guntur, Prakasam, Kurnool, Anantapur and Cuddapah having (1.27-2.31) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in finger millet productivity reflected that six districts having (0-0.63) low crop diversity, fifteen districts having (0.64-1.26) medium crop diversity and eighteen districts showed (1.27-2.31) high crop diversity that is also shown in Fig. 4.81, 4.82 and 4.83 and Table 4.28 during 2004, 2009 and 2014.

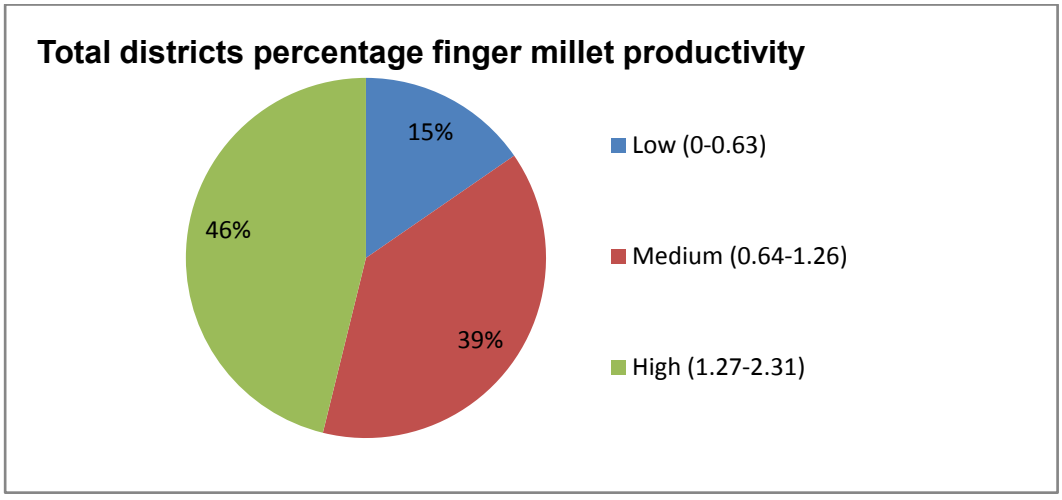

Fig. 4.84. Total districts finger millet productivity of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in finger millet productivity is found 15% low, 39% medium and 46% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.84.

Table 4.29: Classification Area, Production and Productivity of Small Millet in Andhra Pradesh state during 2004, 2009 and 2014.

District	District Id	2004-05			2009-10			2014-15		
		Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
Anantpur	2822	697	324	0.46	1045	63	0.06	738	647	0.88
Chittor	2823	1922	652	0.34	908	289	0.32	245	97	0.4
Cuddapha	2820	72	45	0.63	65	35	0.54	423	371	0.88
East Godavari	2814	1190	529	0.44	221	105	0.48	469	260	0.55
Guntur	2817	5	3	0.6	84	79	0.94	0	0	0
Krishna	2816	0	0	0	0	0	0	0	0	0
Kurnool	2821	14825	9444	0.64	5691	74	0.01	7233	6343	0.88
Nellore	2819	0	0	0	0	0	0	0	0	0
Prakasam	2818	1146	685	0.6	1027	928	0.9	1230	1344	1.09
Srikakulam	2811	194	103	0.53	87	60	0.69	18	40	2.22
Visakhaptnam	2813	2200	8537	0.39	14175	6282	0.44	9627	5426	0.56
Vizianagarm	2812	4187	2229	0.53	1822	1474	0.81	124	88	0.71
West Godavari	2815	0	0	0	0	0	0	10	5	0.5

Source: Institute for Social and Economic Change, http://www.isec.ac.in/databank.htm.

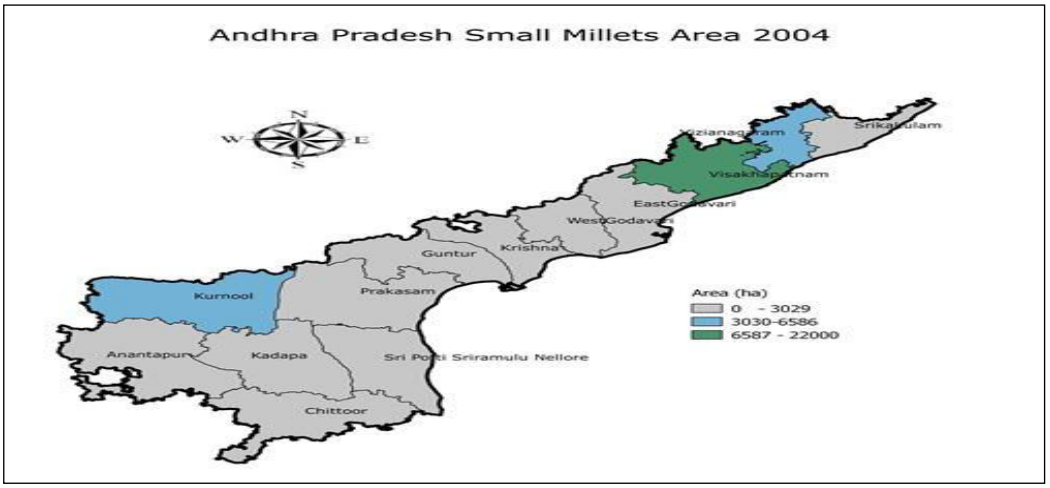

Fig. 4.85. Area under cultivation of small millet in Andhra Pradesh (2004)

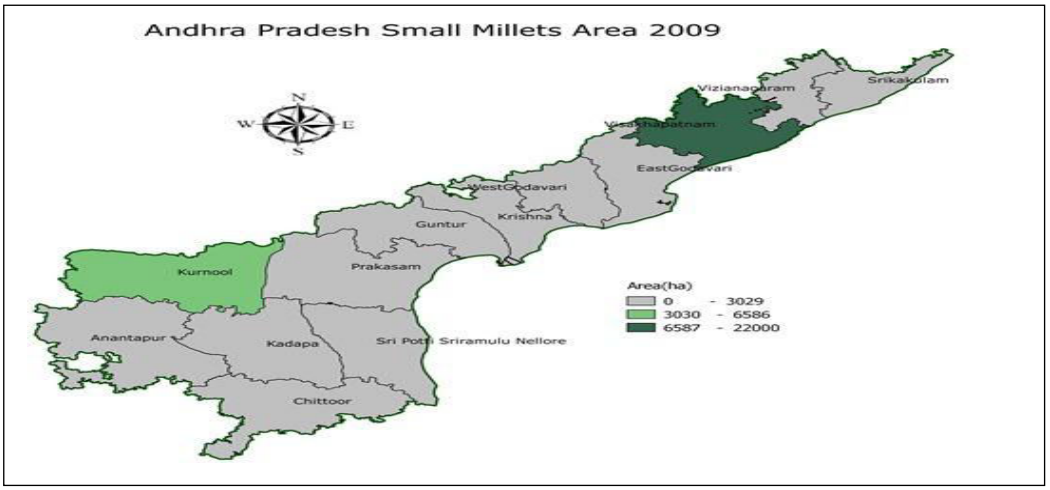

Fig. 4.86. Area under cultivation of small millet in Andhra Pradesh (2009)

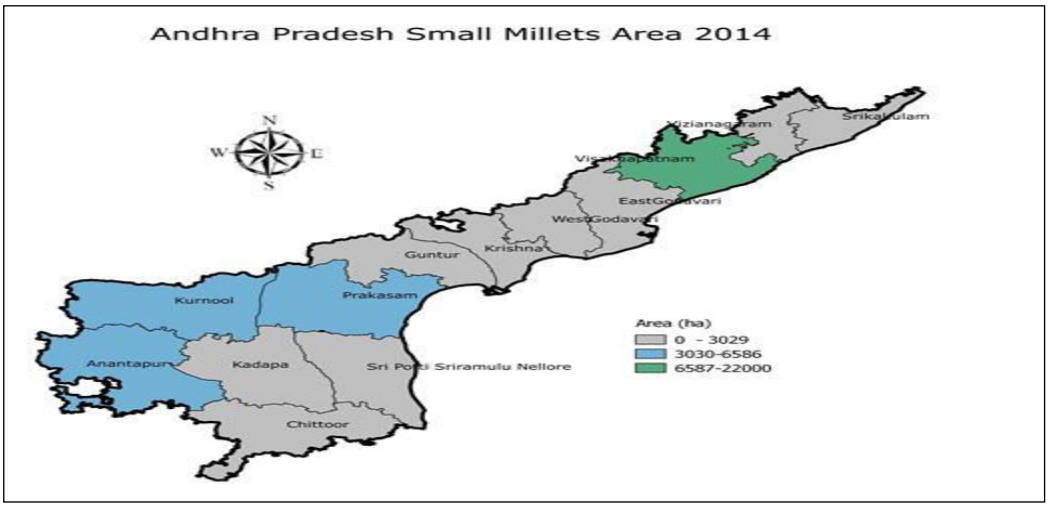

Fig. 4.87. Area under cultivation of small millet in Andhra Pradesh (2014)

Table 4.30: Classification of the range of low, medium and high of total small millet cultivated area in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of cultivated area of small millet (ha)		
		Low (0-3029)	Medium (3030-6586)	High (6587-22000)
1	2004	10	2	1
2	2009	11	1	1
3	2014	9	3	1
Total		30	6	3

Small Millet cultivated area map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.25 and Fig. 4.85, 4.86 and 4.87.

The Small Millet cultivated area crop diversity map is shown in (Fig. 4.85 and Table 4.30) and found three ranges area in 2004. One is consisting of the ten districts Srikakulam, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Anantapur, Cuddapah, Nellore and Chittor having (0-3029) low crop diversity and second range consisting of the two districts Vizianagaram and Kurnool showed (3030-6586) medium crop diversity, whereas the third range consisting of the one district Vishakapatnam having (6587-22000) high crop diversity.

The small millet cultivated area crop diversity map is shown in (Fig. 4.86 and Table 4.30) and found three ranges area in 2009. One is consisting of the eleven districts Srikakulam, Vizianagaram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Anantapur, Cuddapah, Nellore and Chittor having (0-3029) low crop diversity and second range consisting of the one district Kurnool showed (3030-6586)

medium crop diversity, whereas the third range consisting of the one district Vishakapatnam having (6587-22000) high crop diversity.

The small millet cultivated area crop diversity map is shown in (Fig. 4.87 and Table 4.30) and found three ranges area in 2014. One is consisting of the nine districts Srikakulam, Vizianagaram, East Godavari, West Godavari, Krishna, Guntur, Cuddapah, Nellore and Chittor having (0-3029) low crop diversity and second range consisting of the three districts Kurnool, Prakasam and Anantapur showed (3030-6586) medium crop diversity, whereas the third range consisting of the one district Vishakapatnam having (6587-22000) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in small millet cultivated area reflected that thirty districts having (0-3029) low crop diversity, six districts having (3030-6586) medium crop diversity and three districts showed (6587-22000) high crop diversity that is also shown in Fig. 4.85, 4.86 and 4.87 and Table 4.30 during 2004, 2009 and 2014.

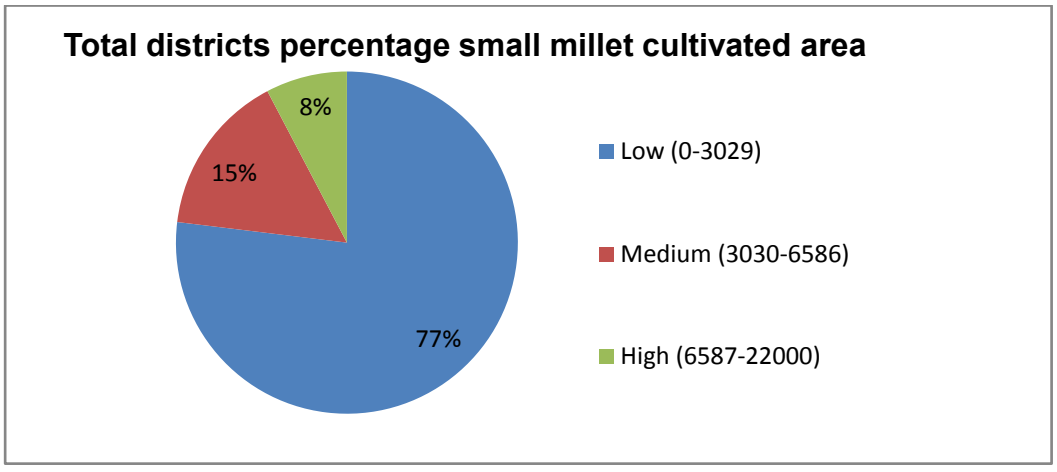

Fig. 4.88. Total districts small millet cultivated area of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in small millet cultivated area is found 77% low, 15% medium and 8% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.88.

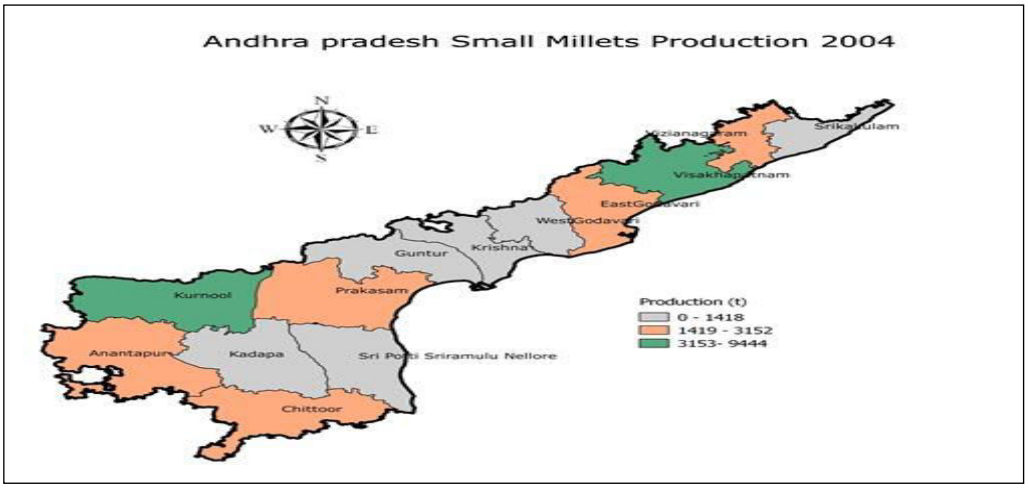

Fig. 4.89. Production under of small millet in Andhra Pradesh (2004)

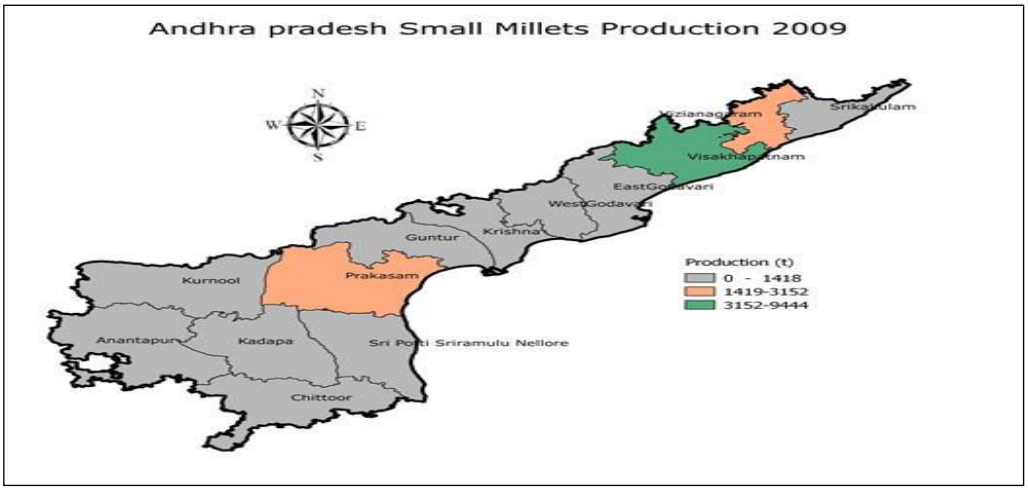

Fig. 4.90. Production under of small millet in Andhra Pradesh (2009)

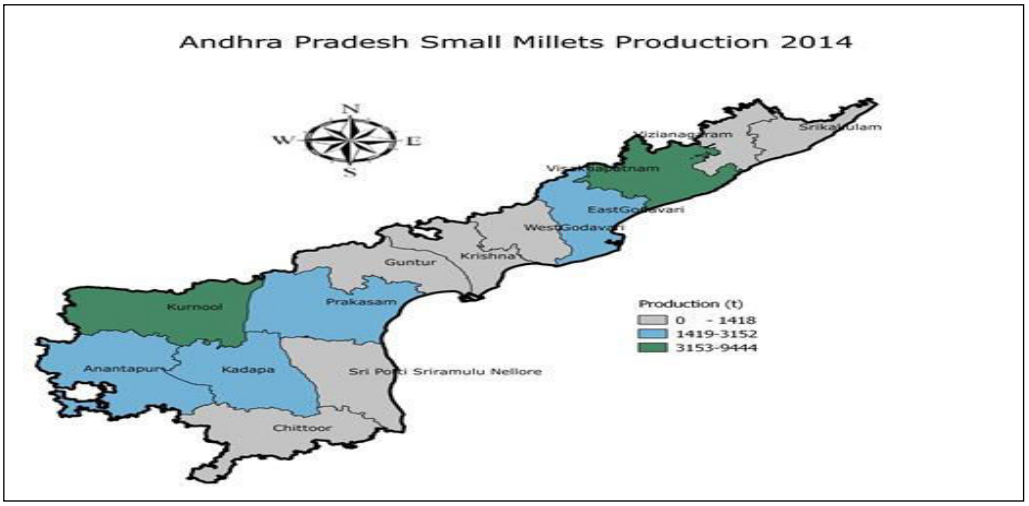

Fig. 4.91. Production under of small millet in Andhra Pradesh (2014)

Table 4.31: Classification of the range of low, medium and high of total small millet production in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of production of small millet (t)		
		Low (0-1418)	Medium (1419-3152)	High (3153-9444)
1	2004	6	5	2
2	2009	10	2	1
3	2014	11	-	2
Total		27	7	5

Small Millet production map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.25 and Fig. 4.89, 4.90 and 4.91.

The small millet production crop diversity map is shown in (Fig. 4.89 and Table 4.31) and found three ranges production in 2004. One is consisting of the six districts Srikakulam, West Godavari, Krishna, Guntur, Cuddapah and Nellore having (0-1418) low crop diversity and second range consisting of the five districts Vizianagaram, East Godavari, Prakasam, Anantapur and Chittor showed (1419-3152) medium crop diversity, whereas the third range consisting of the two districts Vishakapatnam and Kurnool having (3153-9444) high crop diversity.

The small millet production crop diversity map is shown (Fig. 4.90 and Table 4.31) and found three ranges production in 2009. One is consisting of the ten districts Srikakulam, East Godavari, West Godavari, Krishna, Guntur, Kurnool, Anantapur, Cuddapah, Nellore and Chittor having (0-1418) low crop diversity and second range consisting of the two districts Prakasam and Vizianagaram showed (1419-3152) medium crop

diversity, whereas the third range consisting of the one district Vishakapatnam having (3153-9444) high crop diversity.

The small millet production crop diversity map is shown in (Fig. 4.91 and Table 4.31) and found three ranges production in 2014. One is consisting of the seven districts Srikakulam, Vizianagaram, West Godavari, Krishna, Guntur, Nellore and Chittor having (0-1418) low crop diversity and second range consisting of the four districts East Godavari, Prakasam, Cuddapah and Anantapur showed (1419-3152) medium crop diversity, whereas the third range consisting of the two districts Vishakapatnam and kurnool having (3153-9444) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in small millet production reflected that twenty seven districts having (0-1418) low crop diversity, seven districts having (1419-3152) medium crop diversity and five districts showed (3153-9444) high crop diversity that is also shown in Fig. 4.89, 4.90 and 4.91 and Table 4.31 during 2004, 2009 and 2014.

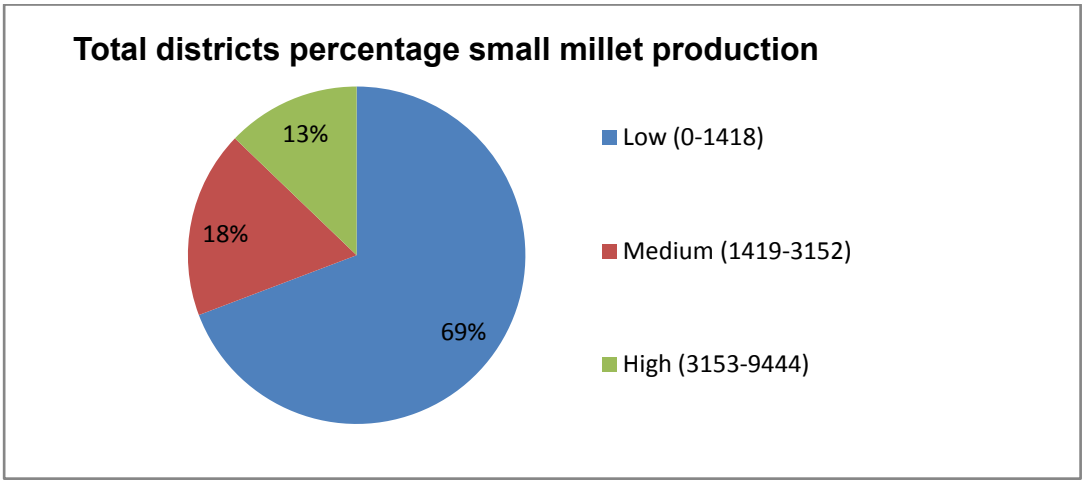

Fig. 4.92. Total districts small millet production of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in small millet production is found 69% low, 18% medium and 13% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig.4.92.

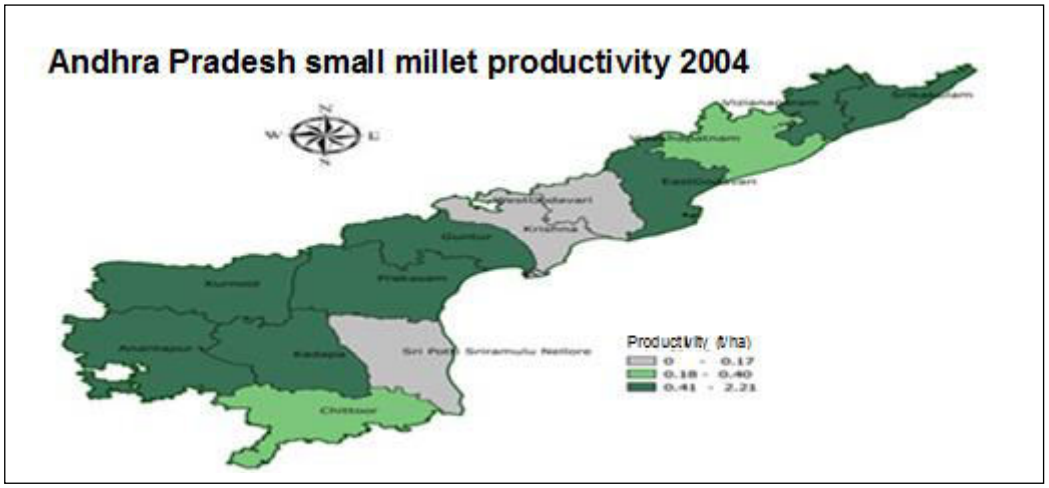

Fig. 4.93. Productivity under of small millet in Andhra Pradesh (2004)

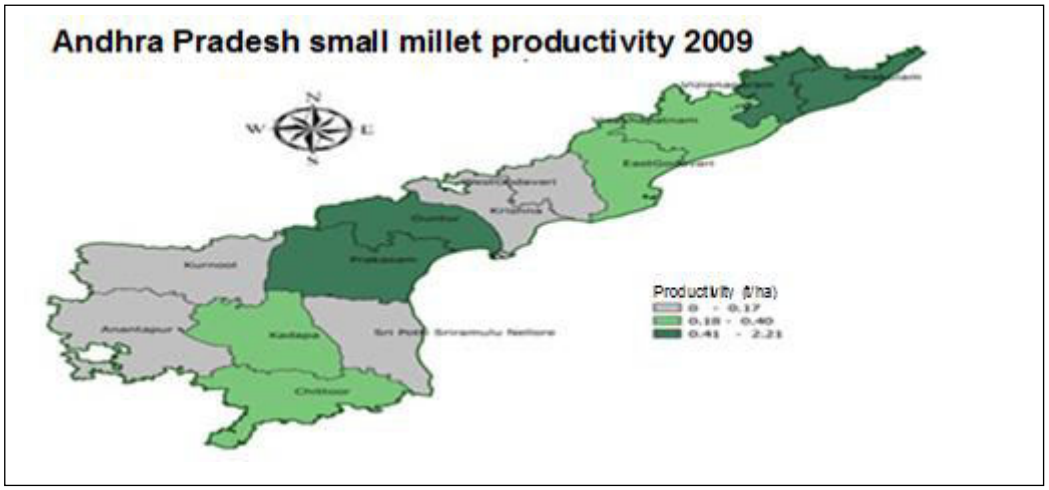

Fig. 4.94. Productivity under of small millet in Andhra Pradesh (2009)

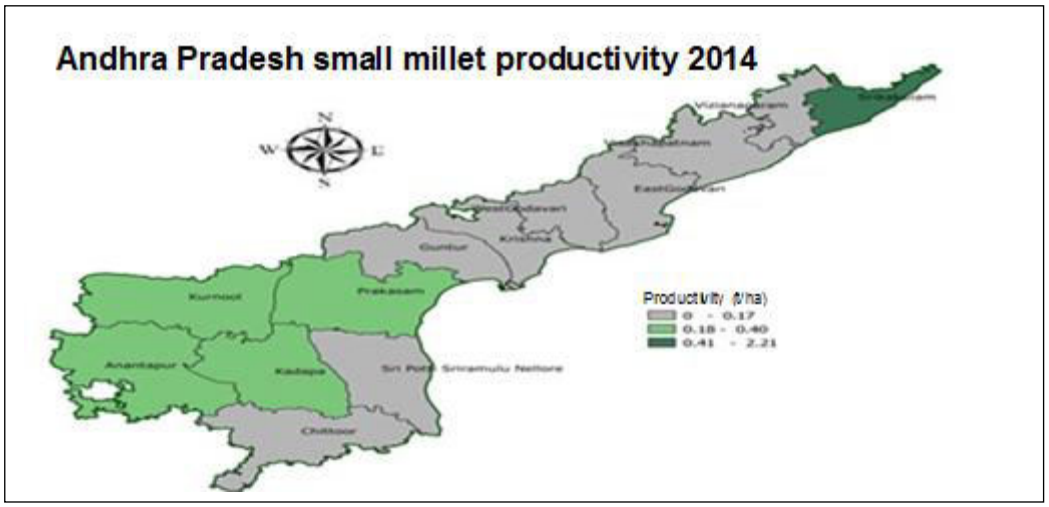

Fig. 4.95. Productivity under of small millet in Andhra Pradesh (2014)

Table 4.32: Classification of the range of low, medium and high of total small millet productivity in Andhra Pradesh state during 2004, 2009 and 2014.

S.No.	Year	Number of districts		
		The range of productivity of small millet (t/ha)		
		Low (0-0.17)	Medium (0.18-0.40)	High (0.41-2.21)
1	2004	3	8	2
2	2009	5	4	4
3	2014	8	4	1
Total		16	16	7

Small Millet productivity map was prepared using QGIS software to understand crop diversity for location distribution along the environmental gradients are shown in Table 4.25 and Fig. 4.93, 4.94 and 4.95.

The small millet productivity crop diversity map is shown in (Fig. 4.93 and Table 4.32) and found three ranges productivity in 2004. One is consisting of the three districts West Godavari, Krishna and Nellore having (0-0.17) low crop diversity and second range consisting of the two districts Vishakapatnam and Chittor showed (0.18-0.40) medium crop diversity, whereas the third range consisting of the eight districts Srikakulam, Vizianagaram, East Godavari, Guntur, Prakasam, Kurnool, Cuddapah and Anantapur (0.41-2.21) high crop diversity.

The small millet productivity crop diversity map is showed (Fig. 4.94 and Table 4.32) and found three ranges productivity in 2009. One is consisting of the five districts West Godavari, Krishna, Kurnool, Anantapur, and Nellore having (0-0.17) low crop diversity and second range consisting of the four districts Vishakapatnam, East Godavari, Cuddapah and Chittor showed (0.18-0.40) medium crop diversity, whereas the third range consisting of the four districts Srikakulam,

Vizianagaram, Guntur and Prakasam having (0.41-2.21) high crop diversity.

The small millet productivity crop diversity map is shown in (Fig. 4.95 and Table 4.32) and found three ranges productivity in 2014. One is consisting of the eghit districts Vizianagaram, Vishakapatnam, East Godavari, West Godavari, Krishna, Guntur, Nellore and Chittor having (0-0.17) low crop diversity and second range consisting of the four districts Prakasam, Kurnool, Cuddapah and Anantapur showed (0.18-0.40) medium crop diversity, whereas the third range consisting of the one district Srikakulam having (0.41-2.21) high crop diversity.

The classification of the Andhra Pradesh state for total districts crop diversity in small millet productive reflected that sixteen districts having (0-0.17) low crop diversity, sixteen districts having (0.18-0.40) medium crop diversity and seven districts showed (0.41-2.21) high crop diversity that is also shown in Fig. 4.93, 4.94 and 4.95 and Table 4.32 during 2004, 2009 and 2014.

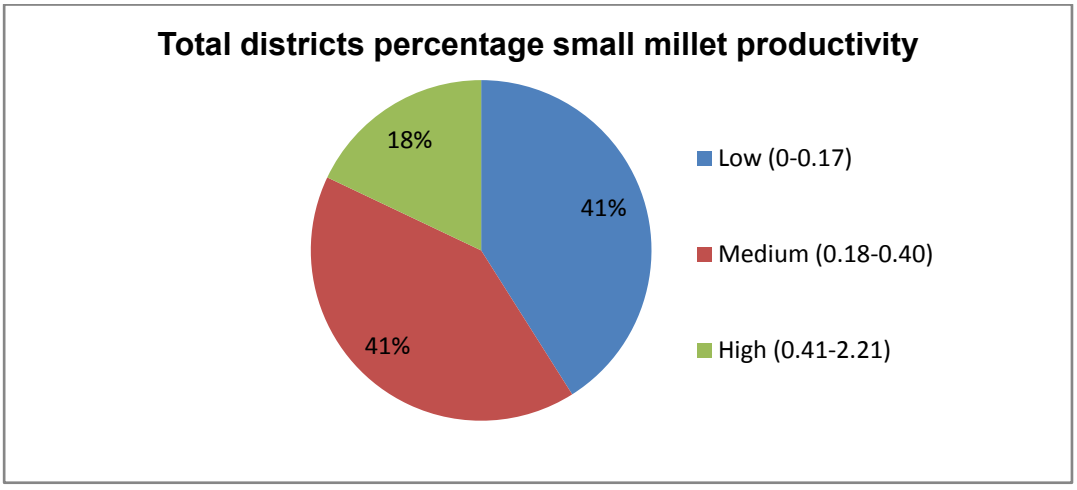

Fig. 4.96. Total districts small millet productivity of Andhra Pradesh state in three years (percentage).

The total districts crop diversity in small millet productivity is found 41% low, 41% medium and 18% high in year wise classify during 2004, 2009 and 2014 as depicted in Fig. 4.96.

The GIS mapping also helped in present study of low, medium and high range of sorghum, pearl millet, finger millet and small millet classification of the area, production and productivity in diversity areas in Andhra Pradesh and Telangana state.

CHAPTER-5
SUMMARY AND CONCLUSION

Agro biodiversity can be defined as all the components of biological diversity that are relevant to food and agriculture, including agricultural ecosystems forming a pragmatic perspective. Agro biodiversity is the result of the interaction between the environment, genetic resources and management systems and the practices used by people from diverse cultural backgrounds and is an integral part of overall biodiversity. It comprises the variety and variability of animals, plants and microorganisms at the genetic resources, species and ecosystem levels that are used for food and agriculture, including crops, livestock, forestry and fish culture. The local knowledge is an essential part of agro biodiversity because it is the human activity of agriculture that affects and shapes the biodiversity. In other words, Agro biodiversity is the result of natural selection and human intervention over millennia and it plays a key role in sustainable development including processes for and in support of food production and food security. Some part of this biodiversity is directly managed to supply the goods and services that people need: however, most of it is not directly intended for production purposes and remains for ecosystem services such as pollination, control of greenhouse gas emissions and soil dynamics. The diversity in crops consists of the crops, landraces and cultivars grown by farmers. The world is currently facing serious environmental problem due to loss of biological diversity at alarming rates. Intensive agriculture reduces agricultural biodiversity and this loss of genetic diversity in agricultural is known as cause of genetic erosion of crops. This may effect the urbanization and modern agricultural practices. Climate change and environmental degradation also contributes to change in cropping pattern and the disappearance of traditional varieties. The spread and adoption of modern crop varieties has

implications for genetic erosion and a decline in crop genetic diversity. Conservation of crop genetic resources is therefore a prerequisite for future generation organized and well-focused exploitation and conservation strategies of biodiversity will allow users to breed crops varieties to improve food security and face new challenges in the era of climate change.

The millet crops are grown in most of part of India is growing widely. The millet crops are rich source of protein, carbohydrates vitamin etc. The study of millet crops biodiversity in project of Telangana and Andhra Pradesh states and there 9 cultivated species of millets. The millet crops biodiversity in the study year 2004, 2009 and 2014 are cultivated area, production and productivity are calculated. The crop diversity in millet crops in the present study is concentrate on how much area is grown sorghum, pearl millet, finger millet and small millet cultivation in the year 2004, 2009 and 2014. Firstly started the comparison of biodiversity conservation of millet crops including protection of wild varieties (species). The plant population and preserved of inter and intra specific diversity in gene bank and botanical garden. The cultivated millet crops required special effort at the level of scientists, individual, department and institutions in particular state agriculture board, state biodiversity board should coordinate to protect the natural wealth. There are intensive surveys of the type of locations, environmental condition of all the millet crops for their in on-site and off-site conservation. There has been increasing research interest in exploring the conditions under which native species can survive in tropical agricultural areas. A very encouraging general conclusion reached by many of these studies is that many more native species remain in agriculture than previously thought, under the right conditions. There is a need of establishing mechanism of control on introduction of exotic species in natural habitats. The aim is to strengthen

the legislation on the use of biodiversity and to establish a research programme to explore the economic potential of local flora and fauna as an alternative to introduction of exotic species. It is concluded that the future of this study will be very much useful to the researchers and policy makers.

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Agro Biodiversity for Millet Crops Resource in Andhra Pradesh and Telangana

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Abstract

Crop diversity plays an important role in sustainable development in agriculture. The millet crops species was found cultivated in large area of Telangana and Andhra Pradesh states and were belonging to many genara and families. The mostly millet crop species belongs to graminnee family. The present and past study on millet crops biodiversity were observed that many more native species remain in crop cultivation than previously thought under the crop cultivation. There is a need to establish mechanism to control on introduction of exotic species in natural habitats. Crop diversity analysis was applied and crop diversity available in Telangana and Andhra Pradesh and the located distribution was brought out throught using QGIS software modules. The analysis shows that there is an agro biodiversity of millet crops in most of the districts in Telangana and Andhra Pradesh except the southern and eastern part of the state. The crops like sorghum, pearl millet, finger millet and small millet constituted as four crops diversity in Telangana and Andhra Pradesh. The detailed information about the agricultural biodiversity of millet crops and grid the species distribution mapping was done using GIS. The study will be very much useful to the researchers and the policy makers.

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बारीक अनाज वाली फसलों की जैव विविधता के ससांधन का आन्ध्रप्रदेश एवं तेलगांना में अध्ययन

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अनुक्षेपण

जैव विविधता का कृषि के सम्पूर्ण विकास में महत्वपूर्ण योगदान है । बारीक अनाज वाली फसलों का भारत में क्षेत्रफल का बहुत बड़ा हिस्सा तेलगांना एवं आन्ध्रप्रदेश में पाया जाता है । तेलगांना एवं आन्ध्रप्रदेश में बारीक अनाज वाली बहुत सी फसलों की जातियॉ बोयी जाती है । बारीक अनाज वाली फसलों में वंश परिवार कुल से सम्बन्धित है । जैव विविधता का अध्ययन पहले एवं वर्तमान में इसलिए किया जाता है कि ये जातियॉ प्रतिकुल परिस्थितियों में जीवन चक्र पूरा कर सकती है ताकि उनका क्षेत्र बढ़ाया जा सके ।

जैव विविधता का अध्ययन तेलगांना एवं आन्ध्रप्रदेश की स्थिति में क्वांटम भौगोलिक सुचना प्रणाली से करने पर बारीक अनाज वाली फसलों का वितरण एक मानचित्र में विभिन्न जिलों उच्च, मध्यम एवं कम रंगो से प्रदर्शित किया गया है । जिससे पता चलता है कि तेलगांना एवं आन्ध्रप्रदेश के विभिन्न जिलों में बारीक अनाज वाली कुल की फसलों का क्षेत्रफल, उत्पादन एवं उत्पादकता कितनी है ।

इससे सिद्ध होता है कि ये बारीक फसलें प्रकृति की प्रतिकुल परिस्थितियों में जीवन चक्र पूरा करती है । जिससे उत्पादन भी बढता है । अतः सभी बारीक अनाज फसलें जैसे ज्वार, बाजरा, रागी, एवं अन्य फसलें उगाने और जैव विविधता को ध्यान में रखते हुए इन फसलों को बोने पर बढ़ावा देना चाहिए । इस अध्ययन का उपयोग शोधकर्ता एवं नीति निर्माताओं के लिए है ।

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