CHAPTER ONE
GENERAL INTRODUCTION AND REVIEW OF LITERATURE
1.1. INTRODUCTION

After a century of major technological progress, one of the age old questions facing man kind is still with us. Will there be enough food for every one tomorrow. The world population is growing at an alarming rate. In the face of this, there is a pressing need to provide nutritional security to all, not only in terms of energy but also for vitamins and minerals (Kaul, 1994). The Malthusian fears of a widening gap between peoples need and food production are once more coming to the fore. The treat of median or long term hardship is directing public attention to the need for a new international effort to increase food production. Even though the present production and per capita availability go hand in hand, the total demand for cereals for human and animal consumption will need to have doubled by the year 2020 to about 1.7 billion tons. There is a great diversity of flora and fauna in the world. Still, there is enormous vegetable material which has not been explored for consumption. Consumption of such food materials are confined to the people living in the areas where they grow. Recognizing the need for identification, plants which are nutritious may help in achieving nutritional security. On the basis of their nutrient profile, efforts could be made to cultivate them on a commercial scale. This would contribute to overcoming the food shortage, ensuring nutritional security to all (Raghuvanshi et al., 2001).

During times of natural and man made disasters, populations suffering from severe food shortages can become heavily reliant on wild food plants for survival (Guinard and Lemessa, 2000; Leborgne et al.,2002).This association has given rise to the notion of “Famine foods” (Rahmato, 1998; World Food programme, 1996; Chopak, 2000). This category of plants, which is generally considered as only being consumed at times of severe nutritional stress, has been neglected by operational organizations that consider it a symptom of food insecurity (Olana, 2001) and not a
potential contributor to diet quality. It is clear that the investigation of wild food plants is multidisciplinary and involves: nutrition, enthnobotany, medicine, analytical chemistry, phytochemistry and anthropology (Onyechi et al., 1988; Salih et al., 1991; Kuhnlen and Turner, 1991; Martin, 1995; Grivetti and Ogle, 2000).

Adequate nutrition is fundamental to the maintenance of good health and optimum human performance. Health authorities in all countries are concerned about the nutrition of their population. Several United Nations conferences on food and nutrition have high-lighted the need to eliminate poverty and malnutrition among women and children (UN reports: UN, 1990; WHO, 1990, 1996, 1997; UNICEF, 1997; UNDP, 1998).

1.1.1 POPULATION AND GROWTH

Population growth continues to increase and as the main sources of food (farms and oceans) may be approaching maximum per capita out put, demand seems likely to out pace food production (Friedman, 1996). According to the world watch institute, world grain production has fallen 8% since 1984, population is increasing at a rate of 100 million per year. Expectation are that the present world population of about 5.5 billion will double by the year 2030. Famine, malnutrition and starvation result from the inability of large proportions of the world’s population to earn the means to buy food (Sen, 1993).

As the world population continues to grow geometrically, great pressure is being placed on arable land, water, energy and biological resources to provide an adequate supply of food while maintaining the integrity of our ecosystem. According to the world bank and United Nations, from 1 to 2 billion humans are now malnourished, indicating a combination of insufficient food, low incomes and inadequate distribution.
of food. This is the largest number of hungry humans ever recorded in history. In China about 80 million are now malnourished and hungry. Based on current rates of increases, the world population is projected to double from roughly 6 billion to more than 12 billion in less than 50 years (Pimentel et al., 1994). As the world population expands, the food problem will become increasingly severe, conceivably with the numbers of malnourished reaching 3 billion. Based on their evaluations of available natural resources, scientists of the royal society and the U.S. national academy of sciences have issued a joint statement reinforcing the concern about the growing imbalance between the world’s population and the resources that support human lives (RS and NAS, 1992).

Reports from the food and agricultural organization of the united nations, numerous other international organizations and scientific research also confirm the existence of this serious food problem. For example, the per capita 80 per cent of the world’s food, has been declining for the past 15 years (Kendall and Pimentel, 1994). Certainly with a quarter million people being added to the world population each day, the need for grains and all other food will reach unprecedented levels. If, as projected, the U.S. population doubles in the next 60 years (Pimentel et al., 1994), then its cereal and other food resources would have to be used domestically to feed 520 million hungry Americans. Then the U.S. would cease to be a food exporting country.

In the future, when exporting nations must keep surpluses at home, Egypt, Jordan and countless other countries in Africa and Asia will be without the food imports that now help them to survive. China, which now imports many tons of food, illustrates this problem. As the world watch institute has pointed out, if China’s population increases by 500 million and their soil erosion continues unabated, it will need to import 200 – 400 million tons of food each year by 2050 (Brown, 1995). Yet none of these measures will be sufficient to ensure adequate food supplies for future
generations unless the growth in the human population is simultaneously curtailed. Several studies have confirmed that to maintain a relatively high standard of living, the optimum population should be less than 200 million for the U.S. and less than 2 billion for the world (Pimentel et al., 1994).

The terms “sustainable” and “sustainability” burst into the global lexicon in the 1980’s as the electronic news media made people increasingly aware of the growing global problems of over population, drought, famine and environmental degradation that have been the subject of limits to growth in the early 1970’s (Meadows et al., 1972). A great increase of awareness came with the publication of the report of the United Nations world commission on environment and development, the Brundtland report, which is available in bookstores under the title Our Common Future (Brundtland, 1987). The importance of quantitative analysis of population sizes was pioneered by Thomas Malthus two hundred years ago, but the attempted marginalization of Malthus goes on today at all levels of society (Appleman, 1976).

Migration of populations from rural to urban centres and the expansion of major metropolitan areas have had a significant and adverse impact on the quality of life of citizens. In the next 20 years most of the growth in urban population will be in Asia and Latin America. Urbanization and the resultant burden on limited natural resources is a major contributory factor to malnutrition (Iyengar and Nair, 2000).

1.1.2. Need for food

As we enter the new millennium, some statistics are truly alarming. It is estimated that nearly 800 million of the world’s population will remain chronically malnourished. And nearly 200 million children more than 150 million in Asia and approximately 27 million in Africa under 5 years of age are moderately to severely under weight suffering
from protein energy malnutrition, while 70 million are severely malnourished. And those who are yet to be born will be faced with the same set of circumstances that predispose them to malnutrition and its consequences. Eradication of nutritional deficiencies among women and children on a global scale are needed to ensure improved quality of life for the next generation of citizens. Everyday, 40000 children under the age 5 die, and mal nutrition is a major contributing factor. In other words, childhood mal nutrition and micro – nutrient deficiencies remain as a very serious problems on a global scale. Two billion people in more than 100 developing countries suffer from micro nutrient deficiencies that can lead to blindness, mental retardation, and even death (Iyengar and Nair;2000).

Hunger and malnutrition are among the most devastating problems facing the majority of the world’s poor and needy and this problem continues to dominate the health of the people living in vast stretches of the globe. Nearly 30 % of the human race infants, children, adolescents, adults and elderly in the developing world are suffering from one or more of the multiple forms of malnutrition. As aptly expressed in the WHO report (WHO, 1999), this remains a continuing travesty of the recognized fundamental human right to adequate food and nutrition and freedom from hunger and malnutrition.

Micronutrient malnutrition is at crisis proportion, globally affecting over 3 billion people mostly among women, infants and children in resource poor families in the global south (Mason and Garcia,1993; Kennedy et al., 2003). The consequences to human health, felicity, live hoods and national development are staggering, causing increased mortality and morbidity rates, decreased worker productivity, poverty and diminished cognitive ability in children with lower educational potential born to deficient mothers (Bhaskaram, 2002; WHO, 2002; WHO, 1999). Hunger, malnutrition, obesity and unsafe food- all cause disease, and better nutrition will translate into large
improvements in health among all of us, irrespective of our wealth and home country (WHO, 2002). Further, the world health organization’s 2002 world health report states that inadequate food and malnutrition leads to a downward spiral of increased susceptibility to illness, sickness and loss of livelihood ending in death.

Nutrition transitions are also causing increased rates of chronic diseases in many rapidly developing nations where societies are switching from traditional diets to more calorie-rich diets derived from adopting developed nations food systems (Sobal, 1999; Clugston and Smith, 2002). In the coming century, the world will have to meet these challenges by careful planning and international co-operation (Iyengar and Nair, 2000). Cereals as normally eaten, only supply needed carbohydrates for energy and a small amount of protein but few of the micronutrients in required amounts. This change in agricultural production towards systems of cereal monocultures and away from more varied cropping systems and traditional foods, appears to be contributing to micro nutrient malnutrition by limiting food – crop diversity (Welch, 2001). Deficiencies of four nutrients (Fe, I, Vitamin A and Zn) are believed to be the most widespread and can hamper early brain development, weaken the immune system, increases both mortality and morbidity, and reduce one’s capacity to do work (Combs et al., 1996; Graham and Welch, 2000). As with chronic undernutrition, such deficiencies generally promote a cycle of poverty (Welch and Graham, 1999; Graham and Welch, 2000).

Both forms of malnutrition are confounding problems, and their causes are complex. They involve many of the factors implicated in the dietary problems. As (Kiess et al., 2001) explain all food security problems are the products of three determinants- food availability, food access, and food choices but the importance of each factor varies over time and location. The widespread agreement that poverty is a primary cause of chronic undernutrition and micro nutrient malnutrition (Hulse, 1995; Foster and Leathers, 1999). Indeed the relationship between hunger and poverty is
so strong that, as Haddad *et al.* (1997) point out, some consider agriculture has a critical role to play in alleviating both types of nutritional deficiency. First of all, though global per capita food availability improved over the latter half of the 20th century, the food supplies of many countries still lack sufficient calories to adequately feed all their people (Haddad *et al.*, 1997).

Sound nutrition can change children’s lives, improve their physical and mental development, protect their health and lay a firm foundation for future productivity to any strategy to reduce the global burden of disease (WHO, 2002).

**1.1.3. Gramineae and its significance**

Grasses dominate much of the world’s vegetation and certainly dominate the lives of mankind. There are over 9000 different types of grasses, forming one of the largest flowering plant families. Their distribution is cosmopolitan, from the equator to the polar circles occurring in every kind of habitat from mountain to the sea, in forests, savannas, deserts, rivers and marshes. In many vegetation types, grasses are the dominant component. Grasses are not a recently evolved group of plants but a long-established family. They are furnished with numerous growth points and are able to compete successfully with most types of plants. Their seeds are highly adapted for survival in demanding habitats and also establish rapidly when suitable conditions prevail. They are generally drought tolerant, and if they brown in dry weather rapidly regreen and resume growth with return of moist conditions. Of all the plants in the world, the grasses have made the greatest impact on man as the familiar cereal crops. Second importance to cereals is the use of grasses as pasture. The use of grasses as food offers many advantages; they can be harvested and handled easily, especially with mechanized tools; they can be sown densely providing a high yield area; they give a high return in terms of bulk food. The annual habit is economical.
agriculturally and ideal for breeding since there is a rapid turnover of generations. In terms of food value, grasses are unparalleled in the plant kingdom. They have an elaborate embryo and generous food reserve and can thus make a running start. They have a relatively streamlined growth habit and can proceed rapidly towards the reproductive phase (Chapman, 1996).

1.1.4. Weeds and their importance

Weeds comprise the more aggressive, troublesome, and undesirable, elements of the world’s vegetation. In the terms ‘troublesome’ and ‘undesirable’ resides the real core of our definition problem, as they are inherently or essentially anthropic. Plants growing where they are not wanted — cause high economic, social and environmental costs. Some weed species are so widespread and insidious that they have become a national menace. State and Territory governments have declared over 370 plant taxa as noxious weeds (National Weed Strategy Web Site, 1999), while around 25% of naturalised plant species are significant or potentially significant environmental weeds (Humphries et al., 1991). Weeds are one of the most commonly reported land-degradation problems on broad-acre and dairy farms (Mues et al., 1998). Ebbell’s detailed study (1937) identified large number of plants used principally as remedies, including mustard, pond-weeds, and the castor bean. Thompson’s (1949) Assyrian botanical study reveals no equivalents for weeds.

Dinitroaniline resistant goosegrass (*Eleusine indica*) is the most widespread of these problem weeds, and now infest over 1000 cotton fields in the southern states of the USA (Mudge et al., 1984). Goosegrass is considered one of the five most troublesome weeds worldwide (Holm et al., 1977) and its control has become a major concern. Weeds are well adapted to adverse environmental conditions, are highly resistant to diseases and pests and exhibit good nutritional qualities. They can thrive
even in crevices of concrete. They have effective means of reproduction. Many of them bear tremendous quantities of seeds. Furthermore some weeds have remarkable devices for assuring wide spread dispersal of their seeds. Seeds of still others can remain dormant for many years until favourable conditions return. Some species can multiply by vegetative means as well as by seeds. Some can start new plants readily from broken-off bits of stems that have dried for a week or two (Jain, 2000; Siddhuraja et al., 2000).

1.1.5. Cereals, Minor Millets, Grains of still smaller size

Cereal grains are the seeds of domesticated grasses. It is the seed or kernel of the grass that is used as food. They constitute major food stuff in the diet of man and 70 - 80% of daily energy intake of majority of Indians. Cereals are more nutritious in the whole grain for when they contain greater levels of B-complex vitamins and dietary fiber. They are excellent sources of carbohydrates and also some protein, which is usually of good quality. Cereals are also source of some nutrients like iron and calcium. Cereals do not contain either vitamin A or vitamin C except that yellow maize and some varieties of sorghum contain small amounts of \( \beta \)-carotene. Cereals are generally considered to have low fat content. The total fat content in cereals may vary from 2 to 5gm per 100gm (Thorp and Lynch, 2000).

The millets are a group of small-seeded species of cereal crops or grains, widely grown around the world for food and fodder. They do not form a taxonomic group, but rather a functional or agronomic one. Their essential similarities are that they are small-seeded grasses grown in difficult production environments. It was millets, rather than rice, that formed important parts of prehistoric diet in Chinese Neolithic and Korean Mumun societies. The millets include species in several genera, mostly in the subfamily Panicoideae, of the grass family Poaceae. Millets are principally food...
sources in arid and semi-arid regions of the world. In Western India, millet flour has been commonly used with "Jowar" flour for hundreds of years to make the local staple flat bread. Millets are rich in B vitamins, especially niacin, B₆ and folacin, calcium, iron, potassium, magnesium, and zinc. Millets contain no gluten, so they cannot rise for bread. When combined with wheat or xanthan gum (for those who have coeliac disease), though, they can be used for raised bread. Alone, they are suited for flatbread. Millets including ragi are rich in minerals especially calcium and fiber.

Minor millets, also referred to as small millets (Seetharam et al., 1989) have received far less attention than sorghum in terms of cultivation and utilization. They include finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), kodo millet (*Paspalum scrobiculatum*), common or prove millet (*Panicum miliaceum*), little millet (*Panicum sumatrense*) and barnyard or sawa millet (*Echinochloa crus-galli* and *Echinochloa colona*). Minor millets account for less than one percent of the foodgrains produced in the world today. Thus they are not important in terms of world food production, but they are essential as food crops in their respective agro-ecosystems. They are mostly grown in marginal areas or under agricultural conditions where major cereals fail to give sustainable yields (Purseglove, 1972). Barnyard, Japanese barnyard or sawa millet *Echinochloa crus-galli* (L.) P.B. and *Echinochloa colona* (L.) are the fastest growing of all millets and produces a crop in six weeks. It is grown in India, Japan and China as a substitute for rice when the paddy fails. It is grown as a forage crop in the United States and can produce as many as eight harvests per year. The plant has attracted some attention as a fodder in the United States and Japan. (Thorp and Lynch, 2000).
1.1.6. Objectives of the Present Study

- To evaluate the proximate principles and fiber content in the six selected grass weeds.
- To analyse the minerals present in the above grass grains.
- To conduct phenological and physiological studies on the above grasses so as to get a better idea about their life cycle for optimum economic utilization.
- To conduct feeding experiment on rats to evaluate the nutritional quality and palatability of the grains.
- To develop recipes using promising members, thus formulating new and unconventional sources of food.

1.1.7. Relevance of the study

The relevance of present study is that it may provide a new energy source of food which is more available, cheaper and easily accessible. For a country like India with numerous mouths to feed, the search for new food sources should be a thrust area. The plants for the present study is selected based on the following observations:

- All the plants are available as weeds.
- They can form an alternate energy source.
- They can be easily propagated and cultivated.
- Fertilizer requirements are minimum.
- They can tolerate a wide range of stresses.

There are constraints and inabilities for increasing the food production. To meet this challenge, we have to think about the alternative sources of food which are yet to be explored and utilized. New food plants which are commonly and abundantly occurring
around us, at the same time unutilised or underutilized need to be tried for the future purpose. So in this context, there is a need to boost the utilization of new and unconventional grains as a food source. In an effort to achieve this alternative, the present work is an attempt to explore and analyse the nutritive value of the grains of some common graminaeaceous weeds.

1.1.8. Review of Literature

Milton (1999) studied the nutritional characteristics of wild primate foods. He also discussed their relevance in human nutrition. Glew et al. (2004) investigated the nutritional content of the waxy pit of the wild fruit *Sclerocarya birrea*. Importance and possibilities to introduce alternative grain and cereal food products in Slovenia, were discussed by Modic et al. (2001). Ventanilla in 2004 investigated the possibility of improving mineral availability in rice bran and incorporating the bran in food products as potential source of fiber and other nutrients. Beta-Glucans and nutrient contents of several cereals and legumes grown in Turkey were investigated by Demirbas (2005).

Content and functional properties of benniseed (*Sesamum radiatum*), pearl millet (*Pennisetum typhoides*) and quinoa (*Chenopodium quinoa*) were studied by Oshodi et al. (1999). The chemical and nutritional composition of 2 flours obtained from food subproducts (multimixtures) available in Brazil, based on rice bran and wheat bran, was studied by Blondet et al. (1999).

Hitze et al. (1997) analysed the essential nutrients in wheat, rice and oat brans and confirmed their high nutritional values. Nutrient composition of the edible parts of 7 bamboo species was studied by Bhargava et al. (1996). Nutritional and physical properties of 4 buckwheat flours were studied and compared with those of Meneba wheat flour by Wei et al. (1995). Al-Kanhal in 1994 studied the nutrient composition and nutritional quality of 6 Saudi Arabian dishes based on wheat. Biochemical composition
of seven high yielding var. of *triticale*, namely Badger PM-118, UPT 72142, UPT 75182, UPT 76001, UPT 74304, UPT 7440 and UPT 75233 were analysed by Kulshrestha and Usha (1992). Nutritional value of wild rice grown in China (*Zizania latifolia*) was investigated and compared with that of wild rice grown in North America (*Z. aquatica*) by Zhai *et al.* (2001). In 1992 Adeyeye, and Ajewole investigated the Proximate composition, mineral and fatty acid contents of the major cereal grains (sorghum, millet, maize and rice) cultivated in Iree, Oyo State, Nigeria. The functional properties and nutrient composition of raw, blanched (pre-treatment) and dry roasted maize (corn) were studied by Aminigo and Oguntunde (2000). Bartnik and Rothkaehl (1997) proposed oat as a desirable cereal. Nutrient compositions of under-utilized cereals (spelt, emmer, einkorn, millet, foxtail millet, semiperennial rye, naked oat and naked barley) and buckwheat were examined by Gabrovska *et al.* (2002). The nutrient composition, toxic factors, nutritional and toxicological value of *Lupinus splendens*, *L. rotundiflorus*, *L. elegans*, *L. stimulans*, *L. exaltatus*, *L. reflexus*, and *L. madrensis* from Mexico were analysed by Ruiz and Sotelo (2001).

Nutrient composition and physiochemical characteristics of black-grained wheat 76, a large scale planted spring wheat cv. Jinchun 9 and two American cv., Klasic and Yecorn, were analysed by Bai-Yunfeng *et al.* (2000). Nutritional content of wild plant species commonly consumed in Nigeria (*Bombax costatum*, *Boscia senegalensis*, *Capsicum* spp., *Entada africana*, *Hibiscus esculentus* mesocarp and seed, *Hyphaene thebaica*, *Leptadenia hastata*, *Parinari macrophylla* mesocarp and exocarp, *Parkia biglobosa* mesocarp and seed and 1 unknown species ‘ataruhi’) were evaluated by Cook *et al.* (2000). Investigations were carried out to assess the nutrient content of 7 edible wild plants by Sena *et al.* (1998). Two species of Echinochloa millets and their direct wild ancestor species were analysed for proximate composition, amino acid, Ca and Fe content by Mandelbaum *et al.* (1995). Beseth *et al.* (1994) studied the nutrient composition and nutritional value of wild gathered foods from the Gourma area.
of northern Mali. Nutrient composition of 5 minor millets produced and consumed in dryland regions of Andhra Pradesh, India was evaluated by Geervani and Eggum (1989).

Germinated malt samples of sorghum, pearl millet and finger millet were analysed for proximate principles, and amino acids by Malleshi and Klopfenstein (1998). Twenty five food plants cultivated and consumed by the tribals of Andhra Pradesh, India were collected seasonally from 20 tribal villages and analysed for proximate composition, vitamins and minerals by Rajyalakshmi and Geervani (1994). Role of wild plants in maintaining the nutritional adequacy of traditional diets was reviewed by Grivetti and Ogle (2000). Malnutrition (including both under-and overnutrition) and the consequences of socioeconomic disparities on worldwide nutrition and health was reviewed by Darnton and Coyne (1998). Efforts to defeat world famine was discussed with particular reference to the importance of cereals and other plant foods for overcoming famine by Glattes (1997).

Chemical composition of the grain of a number of wild grasses used as food in times of famine in western Sudan was reported and compared with those of the local staple cereals by Salih et al. (1992). The nutritional role of wild plants in the Nigerian diet was investigated by Freiberger et al. (1998). Genc et al. (2005) presented a review paper exploiting genotypic variation in plant nutrient accumulation to alleviate micronutrient deficiency in populations. Welch and Graham (2005) discussed the possibility for enhancing bioavailable micronutrients in food crops. Global outlook on nutrition and the environment was presented by Iyengar and Nair (2000). Further studies (Juntunen et al., 2000; Karppinen et al., 2003; Rieckhoff et al., 1999) have shown that cereal grains contain constituents that have demonstrated health benefits for humans, such as antioxidants and anti-disease factors. Plaami (1997) investigated that phytic acid play a major role in the treatment of cancer, hypercholesterolemia, hypercalcuria and kidney stones. Antioxidant activity and nutrient composition of selected
cereals were investigated for food use by Ragaee et al. (2006). Physico-chemical Characterisation of Grain Tef was estimated by Bultosa et al. (2002). The nutritional value of seeds of mukheit (*Boscia senegalensis*) and maikah (*Dobera roxburghi*) widely used as food in times of famine in western Sudan was investigated by Salih et al. (1991).

De Waal (1989) reported that the wild foods were undoubtedly the major factor in survival of people in northern Darfur throughout 1984-85. Dirar et al. (1985) and Elfaki et al. (1991) reported the preparation, chemical composition and nutritional quality of various fermented leaf and seed products utilized in the Sudan and Salih et al. (1992) compared the composition and nutritional qualities of the grains derived from a number of wild grasses utilized as famine foods in the Sudan. The nutritional composition of African wild food plants from compilation to utilization was reported by Burney et al. (2004).