INTRODUCTION

Onion (*Allium cepa* Linn.) is one of the oldest vegetables known to humankind and being consumed worldwide. Today, onion ranks sixth among the world’s leading vegetable crops in terms of overall production. Like other condiments it is widely used in culinary preparations and as a flavouring agent.
Now a days, it is available in fresh, frozen, canned, pickled and dehydrated forms. Onion can be used usually chopped or sliced in almost every type of foods. Onion is one of the fundamentals of Indian cooking. It is commonly used as a base for curries or made into paste and eaten as a main course or as a side dish. It is used both in green and matured stage for salad and spice in a variety of flavoured dishes and soups. It is very important in cookery and there is a constant demand throughout the year globally. Hence, it is called the “Queen of Kitchen” (Selvaraj, 1976).

ORIGIN AND HISTORY

As onion is small and its fossilised tissues leave little or no trace, there is no conclusive opinion about the exact location and time of its birth. It is reported to be a native of Asia, perhaps from Palestine to India (Thompson and Kelly, 1957). Linnaeus did not mention the original home of onion in “Species Plantarum.” It might have originated from north-west India, Afghanistan and Soviet republics of Tajikistan and Uzbekistan and Western Tiensham, though it is likely that onions may have been growing wild in every continent.

Dating back to 3500 BC onion was one of the few foods which were not spoiled during winter months. Our ancestors must have recognised the vegetables’ durability and began growing onion for food. It is presumed our predecessors discovered and started eating wild onion very early long before farming or even writing was invented. Many researchers agree the onion has been cultivated for 5000 years or more. Since, onion grew wild in various regions, they were probably consumed for thousands of years and domesticated
simultaneously all over the world. Ancient Egyptians worshipped the onion, believing that its spherical shape and concentric rings symbolized eternity. Of all the vegetables that had their images created from precious metals by Egyptians only the onion was made out of gold.

Egyptians believed that, if buried with dead, the strong scent of onion bring back the dead to life. Paintings of onion appear on the inner walls of the pyramids and in the tombs of both Old Kingdom and New Kingdom. The onion is mentioned as a funeral offering and depicted on the banquet tables of the great feasts. They were shown upon the altars of the gods. In the mummies, onions have frequently been found in the pelvic region of the body in the thorax, flattened against the ears and in front of the collapsed eyes. Flowering onions have been found on the chest and onions have been found attached to the soles of the feet and along the legs. In ancient Greece athletes ate large quantities of onion because it was believed that it would maintain the balance of blood. Roman gladiators were rubbed down with onion to firm up their muscles. In the middle ages, onions were such an important food that people would pay for their rent with onions and even give them as gifts. Onions were also prescribed by doctors in the early 1500s to help with infertility in women. Archaeological and literary evidence such as the Book of numbers 11:5 suggests the cultivation probably took place around 2000 years later in ancient Egypt. Onion is also mentioned in the Bible (Xi, 5) and in the Koran (Pt 1, p, 61). In India as early as the sixth century B.C., the famous medical
treatise Charaka Samhita celebrates the onion as medicine a diuretic, good for
digestion, the heart, the eyes and the joints.

BOTANICAL DESCRIPTION

Onion belongs to family Liliaceae of Coronarieae series and is
cosmopolitan in distribution. Genus *Allium* has 500 species, out of these
7 spp., are in cultivation. It is an herbaceous annual for the edible bulb
production and biannual for seed production. The edible portion is a modified
underground stem known as bulb (tunicated) with inner fleshy and outer dry
membranous scaly leaves. Bulbs have a typical flavour and aroma due to a
volatile oil known as allyl prophyl disulphide and red colour is due to pigment
anthocyanin.

Flowering stalks are given out by the bulbs after three months of sowing
and the number of stalks is 5-10 per bulb. There are 50-2000 small white
flowers per umbel. The flower consists of small superior pistil with six locules.
Cross pollination is encouraged by protandry. Self pollination is possible
because of individual flowers of onion umbel mature at different times.

Cytology of onion cell shows, 8 large pairs of chromosomes, in which 7
pairs are metacentric or sub-metacentric and 1 pair setallited sub-metacentric
with nucleolar region.

TYPES OF ONIONS

Six types of onions are grown in India.

1. Green onion are used for salads
2. Mild onion are used for cooking or salad
3. Pungent varieties are used as condiments for flavouring of a
number of foods

4. Pearl onion or small onion are used in pickles including vinegar pickles

5. White and Yellow onion are used for dehydration purpose and for manufacturing onion powder

6. Red onion and Yellow onion are used for general purposes for culinary uses

All the varieties are divided into three categories

1. Extensively cultivated bulbing type or common onion propagated by seed.

2. Multiplier type or Aggregatum type propagated by branching at the base.

3. Top onion type or Proliferum group forming bulbils in the inflorescence.

Of all these, the bulbing type onion is mostly cultivated commercially in India and constitutes the most important commercial bulb crop of India. There are several varieties of onion available in the market. These are known by colour, size, pungency, keeping quality etc. Three distinct colours are recognized in each class- Red, Yellow and White.

Approximately 88 per cent of the onion crop is devoted to yellow onion, with 7 per cent red and 5 per cent white onion. Yellow onions are full-flavoured and are a reliable stand by for cooking almost anything. Yellow onion turns a rich, dark brown when cooked. The red onion with its wonderful colour is a good choice for fresh uses.

In general, an onion variety which is liked by the public should be of medium size, tough in texture, strong in flavour, thin at the neck, globular in
shape, good keeping quality at ordinary storage conditions and no bolting at the bulb forming stage.

**HUMAN HEALTH AND ONION**

For centuries consumption of fruits and vegetables has been attributed to beneficial health effects. Lowest quartile of fruit and vegetable consumption has twice the risk of cancer as do those in the highest consumption quartile (Block *et al.*, 1992). Biologically active plant chemicals other than traditional nutrients that have a beneficial effect on human health have been termed “Phytochemicals” (Hasler, 1998). Table-1 revealed the nutritional values per 100 gm of raw onion.

Phytochemicals in onion include the Organosulfur compounds such as cepaenes and thiosulfinates (Dorsch and Wagner, 1991; Goldman *et al.*, 1996), the large class of flavonoids including quercetin and kaempferol (Dorant *et al.*, 1994) and pigments such as anthocyanins found on red onions (Fitzpatrick *et al.*, 1993). Phytochemicals like flavonoids and organosulfur compounds are two major classes of secondary metabolites found in onions, believed to promote beneficial health effects. Beneficial health effects associated with these compounds such as coronary health diseases and different types of cancers are thought to be primarily from antioxidative activity including metal ion chelation and inhibition of lipid peroxidation (Formica and Regelson, 1995; Anonymous, 1998). In a review on the effects of quercetin (Hertog and Katan, 1998) noted that persons in the highest consumption category versus the lowest had a 50 per cent reduced risk of cancers of the stomach and alimentary and
respiratory tracts. Organosulfur compounds such as diallyl disulfide, S-
allicysteine and S-methylcysteine have shown to inhibit colon and renal
carcinogenesis (Hatono et al., 1996; Fukushima et al., 1997). High
consumption of allium vegetables may decrease the risk of helicobactor pylori
infection, which has been linked to stomach cancer through ulcer formation.

Quercetin was shown to be highly effective in inducing apoptotic cell
death in colorected tumour cells while sparing normal cells (Richer et al., 1999)
and had an anti-proliferative effect on the cells of ovarian carcinoma (Shen et
al., 1999).

Researchers from Switzerland (Levi et al., 1993) and France (Challier et
al., 1998) showed a significant decrease in the risk of breast cancer with
high intake (>16 times/week) of onions. Onion intake was responsible for
increasing bone mass, bone thickness and bone mineral density (Mahlbauer and
Li, 1999).

The use of organosulphur compounds S-methylcysteine sulfoxide
(SMCS) and S-allylcysteine sulfoxide (SACS) 200 mg/Kg/day gave results
comparable to treatment with insulin without the negative side effect of
cholesterol synthesis (Sheela et al., 1995). Quercetin exerts its beneficial effects
on cardiovascular health by antioxidant and anti-inflammatory activities
(Anonymous, 1998; Kuhlmann et al., 1998). Onions have long been known as
a blood thinner and part of reason for this is their ability to inhibit platelet
aggregation.
It has been reported that the percentage of quercetin absorbed from onion is approximately twice that of tea (de Vries et al., 1998). Therefore, high daily intake of onions may provide a nutritional benefit against the risk of cataract formation.

Mechanism of action of quercetin (major flavonoid) is free radical scavenging, chelation of transition metal ions and inhibition of oxidases such as lipoxigenase (de Groot and Rauen, 1998; Suzuki et al., 1998; Lean et al., 1999). The antioxidative effects of consumption of onions have been associated with a reduced risk of neurodegenerative disorders (Shutenko et al., 1999), ulcer development (Suzuki et al., 1998) and prevention of vascular and heart disease by inhibition of lipid peroxidation and lowering of low density lipoprotein, cholesterol levels (Fremont et al., 1998; Aviram et al., 1999; Kaneko and Baba, 1999).

Tea, onion and apples are the largest sources of dietary flavonoid contributing 48, 29 and 07 percent respectively (Hertog et al., 1993). Organosulfur compounds may reduce the rate of food borne illness. Carbohydrates of onion may offer useful probiotic effects in the human gut, including the improvement of intestinal flora, improved absorption of calcium and magnesium and other health benefits.

PROPAGATION

Onion crop is raised by three different methods.

1) By transplanting

2) By planting bulbs directly in the field

3) By broadcasting or dibbling the seeds in the prepared field
TRANSPLANTING METHOD

The seeds are planted in the nursery beds, and the seedlings, thus raised are then carefully lifted and planted in the field. As per the literature of cultivation practices seed beds are 125 cm wide and 300 cm long should be raised above the ground level. 5-6 Kg of seeds are broadcast uniformly or sown in rows for one hectare. After 6-8 weeks time seedlings are ready for transplantation (Plate-1 to 4). The spacing depends on variety and size of the bulbs (Lancaster et al., 1996; Kumar et al., 1998). Majority of the farmers transplant the seedlings in flat plots of different sizes which depending on level of the field (Plate-5 & 6). Very few farmers transplant the seedlings in ridge and furrow systems (Plate-7). Onion is also grown as intercrop with banana, spinach (Plate-8 & 9).
PLANTING BULBS DIRECTLY IN THE FIELD

To meet the demand of onions, when dry onion are priced very high, the green crop can be raised for marketing in the months of October. For this purpose small sized onion bulbs are planted in the field in August and September.

DIRECT PLANTING OR SOWING

Although most of the onion crop is grown through transplanting method, some onion can also be planted by direct sowing. 13-18 Kg seeds per hectare are sown in bands 30 cm apart. When plants are 6-8 weeks old, may be thinned 5 cm each way in moist condition. In this area some farmers grow onion as inter crop with other crops like banana, spinach, coriander etc.

AGE OF SEEDLINGS

Crop growth and bulb production is greatly influenced by age of seedlings for planting. Optimum physiological maturity of seedlings for transplanting is an important criterion for bulb production in onion (Vacchani and Patel, 1988; Singh and Chaure, 1999). 7 weeks old seedlings significantly influence the growth parameters, like plant height, number of leaves, and fresh and dry weight of plant (Anant Bahadur and Raghavendra Singh, 2005). Increase in yield by the use of older seedlings may be attributed to their better field establishment and capacity to withstand the adverse weather conditions (Patel et al., 1958; Mohanty et al., 1990).
IRRIGATION

Among different factors water will exert a profound effect on growth. Onion being a shallow rooted bulb crop is highly responsive to better irrigation (McGillivray, 1961). The bulb size and yield were significantly affected by irrigation. 40 per cent highest bulb yield (188.4 q/ha) was recorded under the highest level of irrigation 7 cm depth (Lal et al., 2002).

Irrigation will depend on soil and climatic conditions with 5-8 days interval (Plate-10). Once the plants have started growing, they must not suffer from shortage of water. Application of water, after a dry spell, would initiate new growth in onion bulbs, which would cause splitting and doubling of bulbs. The soil must not be wet; otherwise the crop will suffer from nitrogen deficiency, as nitrogen becomes temporarily unavailable in wet soil. Irrigation is stopped when the tops mature and start falling (Chopade et al., 1998). Water, now a days is becoming one of the major limiting factors for rabi and summer onion crops. Erratic load shedding is also contributing a lot for low average yield.

NUTRITION

Plant nutrition refers to the need for basic chemicals for plant growth. Adequate soil fertility is the only one of the many soil related growth factors. The basic strategies for enhancement yield are to increase the supply of plant nutrients. Fertilizers will increase the desirable plant growth. To maximize productivity, our soils need routine applications of organic matter to improve soil tilth. For vegetable gardens it is desirable to raise the soil organic content
over time, 4 to 5 percent. Majority of the farmers depend upon unreasonable fertilization such as excess manuring, delayed supplementary and unbalanced manuring. These fertilization methods are the main factors, which decline the quantity of onions.

Organic matter not only supplies plant nutrients, but it also improves the soil texture and water holding capacity (Rayar, 1984). The application of FYM played significant role in the improvement of growth, bulb development and yield of onion (Lal et al., 2002). Purewal (1954) suggested a dose of 24.7 to 49.4 t/ha of FYM along with 5.5 q/ha of ammonium sulphate for onion. Kale and Kale (1984) opined that onion crop requires 40 to 50 tons of well-decomposed FYM, 50 to 150 kg of nitrogen, 25 to 135 kg of potash/ha. In the cultivation of onions, management of fertilizing is very essential to improve the quality and the yield of onion. Nitrogen plays a vital role in growth and development of plants and potassium helps in translocation of photosynthates from site to sink (Shrawan Singh et al., 2004). Potassium encourages root development, formation of carbohydrates, regulation of water and translocation of photosynthates (Singh and Verma, 2001). Integration of individual organic manures and inorganic fertilizers in equal proportion is superior to sole application of organics, inorganic and organic integrations with respect to growth, yield and nutrient uptake in onion.

Improvement in growth, yield and nutrient uptake due to inorganic fertilizers is due to quick and ready availability of plant nutrients Mallangouda et al. (1995). In the recent years farmers are habituated in using the readily and
easily available chemical fertilizers regularly with decreased use of organic manures, due to shortage of their availability in bulk quantities, as well as transport and labour cost.

VAM inoculation to onion fields has a significant effect on the absorption of N.P.K. and S elements. Vijay Kumar and Mangal observed higher level in the contents of N.P.K. and S due to VAM inoculation in onion. Application of bio fertilizers (Azotobactor) to the onion fields showed enhanced growth, yield and quality of onion significantly. Azotobactor inoculation in the onion fields recorded maximum dry matter content of bulbs and total soluble solids (Gurubatham et al., 1989). Foliar application of fertilizers is a method to apply nutrients to crops. Urea has small molecular size, non-ionic nature and high solubility; it is taken up rapidly through the cuticle. It can be supplied to plant through the foliage, facilitating nitrogen movement, minimizing nitrogen losses to the environment (Arjona et al., 2004). Application of boron 2.24 kg/ha in soil increases the growth and yield of onion. Highest level of boron gave maximum yield of bulbs 314.92 q/ha. Maraya and Lal (1975) showed that even the lowest level of boron has significant response on vegetative growth and yield of onion. Fritz (1978) reported that repeated application of small amounts of urea to foliage stimulates plant metabolism and an increased nutrient uptake.

WEEDING

Weeds are plants which grow unwanted or are not useful, often profile and persistent, interfere with agricultural operation, increase labour cost and
reduce the crop yield. The management of weed is one of the most serious problems during kharif which limits the crop yield and decrease the profits. Weed management is of utmost importance in the successful production of onion crop. In general monocot weeds are found more in number than dicot weeds.

Shallow root system, comparatively low density and a canopy of short upright leaves indicate that the onion plant is very susceptible to weed competition. Onions are poor competitors against weeds. Unchecked weeds can reduce the production of onion. Onion crop suffers heavily from weed infestation and the rainy season was very conductive for weed emergence, their growth and development. Yield losses in kharif onion due to weeds have been reported to the extent of 10-70 per cent (Phogat et al., 1989). Mani et al. (1968) observed 67 per cent loss in yield of rabi onion due to weed infestation. Hussain et al. (2007) suggested integrated weed management for better weed control. Repeated manual weedings are becoming uneconomical and difficult due to non availability of labourers. Singh and Singh (1993) observed that weedicide application once followed by manual weeding is more effective in bulb yield (Plate-11 to 13).

Herbicidal weed control was more economical than other manual weeding particularly due to higher wages (Singh et al., 1992). Maximum yield was recorded in weed free till harvest, while the minimum was found in control.
All herbicides either alone or in combination with hand weeding 45 days after transplanting gave significantly higher bulb yield as compared to weedy check (Singh et al., 1987; Patel et al., 1986). Weed free fields till harvest produced the maximum plant height, number of leaves per plant, bulb diameter, fresh weight of bulb, dry weight of leaves and bulb and bulb yield with herbicide Pendimethelin and Oxadiazon with one hand weeding. Prabha and Challa (1997) showed that a critical weed free period is essential to get economically sound yields in onion. Some weeds affect vegetative growth by releasing toxic substances into the soil (allelopathy). About ninety weed species have some type of allelopathic effect.

**HARVESTING**

The duration of local varieties is about 5.5 months (45 days in the nursery and 4 months after transplanting in the field). If sown directly in the field the crop is ready by about 15 days early than the transplanted ones. When the bulbs mature, the green tops weaken just above the bulb and fall over (neck fall). When neck fall begins, irrigation is stopped. When more than 50 per cent of the tops are down, the bulbs are harvested along with leaves by hand-pulling from beds. After 3-4 days of curing, the roots and tops are clipped (Plate-14 & 15). Curing is the drying of neck, roots and outer scale tissue. Afterwards based on the size bulbs are sorted out and bagged (Plate-16 & 17).

**STORAGE**
Onion is a seasonal crop and has comparatively low storage ability and bulbs are usually stored until the harvest of next season crop or for longer period due to seasonal glut in the market. Significant losses in quality and quantity of onion occur during storage. Proper storage is crucial for retaining bulb quality. Cool, dry and well circulated air will keep onion bulbs in good condition for many months. Critical factors in successful storage include variety, methods of culture, harvest, field curing, temperature and humidity control, storage and sprout inhibition. Storage of onion bulbs has, therefore become a serious problem in the tropical countries like India. The post harvest losses viz. sprouting, rotting and physiological loss in the weight pose a great problem. It is reported that annual storage losses were over 40 per cent (Bhagachadani et al., 1980) and between 40 and 60 per cent (Maini et al., 1984) in India. This results in rise in their price to the tune of four to five times when they are in short supply. Onion should be completely matured, cured and dried before being stored.

The losses, where no bottom ventilation is provided, are estimated to the extent of 30-35 per cent, 10 to 12 per cent by decay and 8 to 12 per cent on account of sprouting, depending upon the relative humidity and temperature during rainy season (Maini and Chakrabarti, 2000).

Onions are traditionally stored by conventional methods in various parts of the country. These include hanging in bunches along with tops particularly in various types of godowns known as Ilars or Hilars in Gulbarga regions, Chawls in Maharashtra, Kup or Tat in Haryana, Delhi and Meda in Gujarat (Plate-18).
Normally in Karnataka, the bulbs are stored in thin gunny bags and kept in a room, which results in quick spoilage. Storage temperature and relative humidity have been found to be correlated with sprouting, rotting and physiological loss in weight and these are further correlated with storage periods.

The storage losses of onion have been reported to reduce considerably by treatments with maleic hydrazide (Shafi, 1981), ultra-violet radiation (Bochkareu and Krasnostanova, 1982), low temperature storage and controlled atmospheric storage (Thompson et al., 1972).

In Gulbarga region only 20 per cent farmers are capable to store the onion in their own unscientific store sheds made of either cotton or red gram plant stocks. Most of the farmers bring onion directly to the market after harvest as proper storage facilities are not available with them. Although many techniques have been found to be feasible methods for controlling post harvest losses of onion, most of these require a considerable amount of cost investment and equipments. Therefore, these are not economically feasible methods for control of storage losses in the developing countries like India. The present storage capacities are quite inadequate and most of the available units are traditional and unscientific. Fearing losses, farmers usually unload their entire stock within a month of harvest. Low cost farm level technology is, therefore, required to be developed to extend the shelf life of onion.

Because of the storage problems, during the seasonal glut, the farmers are forced to sell the crop immediately after harvest at very low prices.
Many a time, they will be in distress to sell the produce as the storage of crop would further enhance the losses due to rotting, sprouting, weight loss, etc. There are many instances when the farmers could not recover the transport cost from the sale of produce which has led them to debt trap and suicides.

SEASONS

Onion is grown in all three seasons of the year

1. Kharif (Monsoon) crop………………………… June-October
2. Rabi (winter) crop …………………………… October-January
3. Summer crop …………………………… January –June

In Karnataka, onion is mainly grown during kharif season. As major onion growing districts are distributed in dry belts of the state, the people depend on monsoon rains for their crop. But quality and storability wise rabi onion is far better.

ONION AREA, PRODUCTION AND PRODUCTIVITY

At global level, onion area, production and productivity has been increasing year after year. Onion is grown in about 175 countries under temperate, sub-tropical and tropical conditions. Onion is basically a cool season crop. Yields are affected significantly by temperature, 20-25°C for best seedling growth, 13-24°C for vegetative growth and 20-25°C for bulb development. Furthermore, suitable soils can be loamy and alluvial with a pH of 5.8 to 6.5. In terms of area India ranks first in the world with over 10 lakh hectares spread over entire country accounting for around 18 per cent of the world area planted with onion. Globally, the country occupies the second
position after China in onion production with a share of 11 per cent. In 2001 the area under onion cultivation was 29,23,462 hectares with the production of 5,17,73,852 metric tons, whereas the onion area during 2011 was 42,90,645 hectares which is 146.76 per cent more, when compared to 2001 (Table-2).

Onion, an important vegetable grown in India, is used either in raw or dehydrated form to add flavour and taste to Indian cuisine. The agro-climatic condition enables India to produce onion round the year. For India onion is a consistent earner of foreign exchange and the exports of onion and onion products reach several destinations. In India during 2001 onion area was 4,52,100 hectares with the production of 48,31,000 metric tons (Table-3, Fig. 1). Average yield was very less (11.38 t/ha) compared to world’s average. When compared to 2001 the area increased 240.49 per cent during 2011 (10,87,260 hectares). Onion price has increased from Rs. 5,000 to 18,000.00 per ton during 2001-2012 (Fig. 2).

Maharashtra state, being a leading onion producer in India during 2011-12 contributed 33 per cent, followed by Karnataka (17%), Madhya Pradesh and Gujarat in the national production (Table-4). Karnataka state accounted for 20 per cent of area. In the state of Karnataka, north Karnataka accounts for the bulk of the total onion production and is distributed throughout the country. Bulk of the onion exported from India also originates from north-Karnataka.

The average yield in Karnataka is still lower (5.34 tons) in 2011-12.

The above increasing trend is also seen in Karnataka state. In 2001 the area 1,25,800 hectares with the production of 7,21,000 metric tons and
average yield was very low (5.73 t/ha) comparatively (Table-5). The cultivated area of onion in 2011 was 1,77,000 hectares which is 140.69 per cent more when compared to 2001. The major onion growing districts in Karnataka are Gadag, Dharawad, Chitradurga, Bagalkote, Bijapur, Belgaum, Gulbarga, Bellary, Haveri and Koppala (Fig. 3).

In Gulbarga district, there is a negative trend in onion area. The area during 2011 was 1626 hectares which is 57 per cent less when compared to 2005 it was 2851 hectares (Table-6). The average yield in Gulbarga district was comparatively higher 12.96 t/ha compared to state average during 2011-12.

Low production in India is however due to the following reasons.

1. No availability of good quality planting material.

2. Traditional agricultural practices like lack of knowledge of spacing, chemicals, fertilizers, their dosages, diseases and their control measures, heavy weed infestation and no idea about weedicides etc.

3. Loss due to diseases and pests

4. Inadequate storage facilities

5. Difficulties in transport and marketing

Most of the time, adverse weather conditions affect the crop to a great extent. The crop has been found to be highly sensitive to the climatic conditions, such as temperature, relative humidity, soil moisture and rain fall during the time of maturity which affect the bulb development, production, productivity, quality, thereby reducing the storability of bulbs.
There are good prospects for increasing the export of onion, provided storage facilities, market survey, easy transport facilities, adopting post harvest techniques, export market etc are strengthened.

**EXPORT**

Agricultural commodity exports account for nearly 20 per cent of the total export earnings of the country. Different institutes, engaged in research on onion have developed 34 varieties. Besides these some local varieties are also grown by the farmers. India is a traditional exporter of fresh onion. Exports of onions from India are not free, but are permitted only through certain designated analyzing agencies. Foremost among these agencies is the National Agricultural Cooperative Marketing Federation of India, Limited (NAFED). NAFED is responsible for fixing of minimum export price of onions. The stored onion is used for supply of bulbs for export and to distant markets for retail trade during off season. The export market mix for onions change from year to year, but India’s Exports cater mainly to the neighbouring South East Asian countries and some Middle East nations. Malaysia, UAE, Sri Lanka, Bangladesh, Singapore and Saudi Arabia account for the major share of exports from India. Onion export however has gone up from a level of 57,000 MT in 1951-52 to about 16.9 lakh MT in 2012-13. The export value has increased from Rs. 105 mil. to about 17.87 bil. in 2012-13. However, the highest export (20.1 lakh MT) was recorded during 2009-10 (Table-7 & Fig. 4). Maximum (15.36%) onion export was recorded during 2009-10 of the total national production and least 8.8 per cent during 2010.
SEED PRODUCTION

Seed is the basic and crucial input in agricultural production. The most important aspect in maintaining continuous supply of high quality seeds to cultivator is to produce genetically pure seeds and to preserve the quality of seeds from harvest to next sowing. Seed’s quality plays an important role as the crop yield is directly dependent on seedling emergence and establishment.

The estimated requirement of quantity seeds of onion was 5,954 tons during 2012 (assuming seed rate 6 kg/ha). Most of the demand of the quality seeds was either met by private sectors or unorganized program or own produced seeds. The quality of seeds, supplied by the private or unorganized sector in most cases is not good enough. The problem is worsening by the short shelf life of onion seeds which lose viability more rapidly than the seeds of other crops. Onion seeds viability for 6 to 12 months under ambient conditions. Onion seeds have poor storage capacity and lose viability within a year. Seed vigour and yield are poor, as farmers harvest seeds from their own onion crop because of poor maintenance. Owing to these, onion growers are using more quantity of seeds per hectare as opposed to the recommended rates. Because of this farmers incur more cost, besides the ever increasing price of onion seeds on the local markets. These become obstacles for the advancement of onion production. Therefore, it is necessary to increase the supply of quality seeds through the efficient use of technology and participation of private sectors and farmers of onion seed production. Hence, in this regard it is utmost important that the government extension agents and private producers’
knowledge and skill be improved in the areas of seed production technology. Only small percent of the demand is fulfilled by public sector organizations viz., NSC, NHRDF, ICAR (IIHR, IARI). In India, the short day type of onion is cultivated on large scale in vast areas like central, southern and northern plains. Therefore, the seed production of the short day type of onion is undertaken in central part of the country, particularly in Mandore and Khandawa region of Madhya Pradesh, Nasik and Pune of Maharashtra and Rajkot district of Gujarat. But in states like Punjab, Haryana and Rajasthan seed industries are not preferred due to severe attack of diseases (Stemphylium and Purple blotch) and average lower seed yield.

**METHODS OF SEED PRODUCTION**

There are two methods of seed production.

1. Seed to seed method
2. Bulb to seed method

Both the methods of seed production are in practice. But bulb to seed method is most commonly used method.

**SEED TO SEED METHOD**

In this method seedlings are transplanted in the late kharif, and over wintering at the same place and allowing flowering. This method does not allow examining the mature bulb characters and so also, the seed characters. Seed to seed method is not popular because all the varieties are not suitable for annual seed production due to poor bolting ability and lower seed yield. The seeds produced in this method are not suitable for further multiplication.
BULB TO SEED METHOD

In this method the seeds are sown in the first (kharif) season. When the seedlings are 12-15 cm in height and attained 45-50 days are transplanted to the main field, to raise healthy bulb crop. The bulbs are harvested when 75 per cent plants show neck fall or top die down. After curing, damaged, twin bulbs and long necked bulbs are discarded. The medium (50-80 gm) and large (100 gm) sized bulbs are selected and stored. These selected and stored bulbs are called mother bulbs. The optimum temperature about 12°C is the best for the storage of mother bulbs. The plants from such bulbs produce early and higher seed yield. The bulb to seed method requires the same cultivation practices as a commercial bulb crop.

LAND REQUIREMENT

The selection of land is the first and foremost task of seed production. A fertile and healthy seed plot will certainly produce quality seeds. The field selected for seed production must not have been sown with onion in the previous season. This is done to avoid volunteer plants that cause admixture. Fields, continuously cultivated with onion may harbour root rot or wilt pathogens. Onion seeds can be produced in wide range of climatic conditions and in different types of soils. Sandy loam or clay loam soils are best suited. Higher organic matter will lead to production of vigorous seed. The land should be ploughed three times and the field to be prepared well with twenty five tons of farm yard manure (FYM). The pH should maintain 6-7 and sowing may be
done in plots. In Gulbarga region, seed production is practiced in plot system. Majority farmers grow their own seeds in small areas and in small quantity.

**BULB PLANTING TIME; SELECTING THE RIGHT SEASON**

Quality of seed depends on season in which it is grown. The time of planting has great impact over seed yield and incidence of disease. When the seed crop is planted in the second week of October, it leads to heavy incidence of diseases and resulting poor seed yield. The higher seed yield 1,251.6 kg/ha with complete escape from the incidence of disease in cv. Pusa Red was recorded during 2000. If late planting is done, vegetative growth is less and due to this there are lesser number of flowers and also the seeds in umbel and attack of thrips is also more.

**SELECTION OF PLANTING BULBS**

Based on the colour, shape and size of the bulb and confirming to varietal characters bulbs should be selected for sowing. The bulb weight has markedly influenced the seed production. The increase in bulb weight will increase the seed yield. Bulbs weighing 50 to 80 gm and measuring 4-5 to 6.5 cm in diameter should be selected for planting. About 25-30 quintal bulbs are required to plant one hectare area or one hectare of bulbs from the first year will plant 3-5 hectares for seed production. The increase in seed yield under large sized bulbs was due to increase in seed yield per plant, which was highest in large bulbs. Large sized bulbs may give seed yield up to 10.0 q/ha. Bigger bulbs contain more sprouting initial leaves and reserve food material; those might be responsible for producing more leaves. The mother
bulb size considerably influences the umbel diameter. Plants from large bulbs produce the highest umbel diameter (5.37 cm). Number of flowers per umbel is also influenced by size of bulb. Large bulbs on an average produce 228.3 flowers.

**BULB TREATMENT**

The top 1/3rd portion of the bulb has to be cut down. Then the bulbs are to be treated with Carbendazim or Mancozeb @ 2 gm /l for 5-10 minutes and dried in sunlight at least 15 min. This will protect the bulb from soil borne pathogens until its germination. The cut bulbs if, treated with Gibberlic acid (GA-3) at 50 ppm, seed weight will increase.

**SPACING**

Bulbs can be planted in double row or single row per ridge. Onion producers mostly use single row per ridge with 50 cm between row and 20 cm between plants. But in Gulbarga region bulbs are planted in plots (flat beds) very densely (Plate-19). The recommended spacing is 45 x 30 cm between bulbs. However the spacing was maintained 12 -15 cm and farmers were not aware of the benefit of proper recommended spacing. Bulb size and plant spacing are the two key factors for producing quality onion seeds. Majority of the seed producers grow onion seed crop as main crop. But some farmers grown seed crop as inter crop with sugarcane (Plate-20).

**ISOLATION OF SEED CROP TO AVOID GENETIC CONTAMINATION**

Isolation of onion seed fields is more important to maintain genetic identity, because of variation in onion bulb colours and also it is a cross
pollinated crop mainly by honey bees and other beneficial insects. Onion seed crop should be provided a minimum isolation distance of 500-1000 meters from other varieties. So that genetic contamination can be avoided.

FERTILIZERS

Among the most important factors that influence the flowering and seed production is fertilization. After the preparation of land the recommended doses of N, P and K (nitrogen, phosphorous and potassium) fertilizers has to be given. Seed crops need 80-100 kg of N, 60 kg of P and 50 kg of K /ha.

Addition of nitrogen significantly influences the seed yield through its beneficial effect on yield attributes like number of scapes per plant, seed yield per umbel and number of seeds per umbel. Sam Ruban and Samlind Sujin (2007) have shown that application of Azotobactar 10 per cent gave maximum number of umbels (7.6) followed by Biophos 10 per cent (7.3).

IRRIGATION

The methods of irrigation also greatly influence the seed yield and seed quality of onion. High soil moisture content contributes to high seed yields. Up to full flowering, irrigation is given at 7-10 days interval and then at every 10 days interval followed by 10-15 days near maturity depending on soil types.

Tomar (2004) observed that drip irrigation gave higher seed yield (894.9 q/ ha) than the flood irrigation (648.9 q/ha) in onion cv. Pusa Madhvi. The seed vigour index is also higher in drip (876.5) than surface (663.7) irrigation.

WEEDING
Weed is any plant that is a hazard, nuisance or causes injury to man or his desired crops. Effective weed control is often more difficult to obtain in onion than in any other crops, because, onion crop grows more slowly, less competitive with weeds, sparse canopy and shallow roots. Weeds can also harbour destructive insects and diseases that can severely damage the crop. If weeds are not controlled timely, they greatly reduce yields. Weed stress to the mother plants significantly affected the seed quality parameters for onion seed crop. Significantly low 1000 seed mass was recorded in season long weedy fields, weedy for 100 days due to weed competition compared to season long weed free (Nisha Chopra et al., 2010). Seed germination is maximum in weed free conditions.

Seed crop, badly infected by weeds, produce seeds with lowest test weight and usually produce low vigour seeds because of smaller size and lower food supply. The traditional method of weed control is commonly practiced in India with rapid industrialization and mass migration of rural populations to urban areas, labour availability is becoming increasingly scare and costlier. The mechanical cultivation in onion seed crop is difficult due to high plant density. In Gulbarga region seed producers were not aware of weedicides and the impact of weeds on the seed production. Weedicides like Pendimethalin at 2.5-3.5 l/ha or oxyflorofen at 0.15-0.25 l/ ha with one hand weeding at 45 days gives good control of weeds. Even after 2-4 hand weeding, the seed plots were not free from weeds. Because of scare and costly labourers the production cost of seeds is increasing day by day.
PLANT PROTECTION MEASURES

Pest control is very critical in seed production. Careful monitoring of fields and early detection, control of pests is crucial for healthy flower production and higher seed yield. Thrips attack was very common during dry months and it is very difficult to control the thrips. Thrips attack can be controlled effectively by cultivation practise like deep ploughing of the fields immediately after harvesting to eliminate resting conditions of the pest. Crop rotation is also one of the tools to combat the pest. Rotating fields with unrelated crops reduces build up of insects.

Important diseases of onion seed crops are umbel blight, downy mildew, pink rot disease and fusarium basal rot. Fungicides like Mancozeb, Bovistan spray may reduce the disease incidence and reduces the loss.

ROGUING

Sometimes we are noticing abnormal difference in growth habits in some of the plants in the field and this shows the admixture of some other varieties. This may very much affect the genetic purity of that particular onion seed crop and ultimately the crop will not be fit for seed production. Hence, in the onion seed field, removal of off type plants, weeds and disease infected plants is to be done scrupulously before it comes to harvest to avoid the genetic contamination.

FLOWERING

Flowering induction is sensitive to temperature, photoperiod and number of leaves. Optimum temperatures required for vernalization are 7-12
C. In the tropics, cultivars generally are vernalized even at temperature as high as 15-21°C. For the flower induction, onion plants must have 5-9 leaves. Plants at a younger juvenile stage do not respond to temperature and bulb diameter from 10-15 mm. The larger the bulb size, the more easily it is to induce flowering.

**POLLINATION**

In onion seed crop cross pollination is common and self pollination cannot occur because of protandry and sticky pollen. Large number of insects visits onion flowers both for pollen and nectar. Among these honey bees play major role in cross pollination of onion crop (Jadhav, 1981).

Singh and Dharanawal (1970) noted the increase of 21.8 per cent in yield and better seed germination with insect pollination of onion crop.

Being a protandrous flowering crop onion requires cross pollination and for that it is necessary to increase honey bee visit (Plate-21). Few honey bee hives should be placed when 50 per cent of the umbels have opened flowers. Germination capacity of the seeds also increased in the fields with bees. Chandel et al. (2004) reported that seed germination in the bee pollinated crop is high.

Insecticides should not be applied during noon time when the beneficial insect activity is high. High potassium concentration in the flower nectar has been associated with reduced attractiveness of flowers to bees.

**HARVESTING**
All umbels of a plant do not mature at one time due to difference in the stalks to flowering. The best time of the harvest is when 50 per cent of the seeds in the umbel are exposed. Harvesting may be done 3-4 times. The cut heads should be supported in the palm of hand and held between fingers to avoid seed shattering. The best seed quality is obtained when seed moisture content is between 50 and 65 per cent.

**DRYING OF UMBELS**

The harvested umbels should be dried by spreading the umbels on canvas and putting under shade or in the morning or late afternoon sun for few days. The seeds must be properly separated from the umbels. Seeds can be threshed by moving or by rubbing of dried umbels and then cleaning the seeds by winnowing followed by seed separation by floatation.

The extracted seed must be dried under shade for 8 to 10 hours after spreading over the gunny bags. Then it can be dried further under open sunlight between 8 to 12 noon and 3 to 5 pm.

After seed extraction, they should not be dried under direct sunlight and also seeds should not be dried continuously from morning to evening. These two factors will affect the germination.

**PROTECTING SEEDS DURING STORAGE**

Care must be taken for proper storage of seeds until next season:

1. Seed quality mainly depends on the seed moisture. Major factors affecting the seed quality during storage are temperature and relative
humidity. For short term storage seed moisture content should be reduced to 7 to 8 per cent and can be stored in cloth bag. For long term storage, seed moisture content should be reduced to 6 per cent and stored in moisture and vapour proof containers.

2. Onion seed is a poor storer and it loses its viability very rapidly. Deterioration of seed is associated with ageing phenomenon which is an irreversible degradation change in the quality of a seed after it has reached a certain stage. Its maximum quality level and the seed deterioration also start immediately after attaining the physiological maturity on the plant itself. In order to prevent the quantitative and qualitative loss during storage several methods are being adopted such as seed treatment with suitable chemicals or plant products and storing in safe containers besides sanitation of the storage place. Onion seeds should not be stored in plastic bags for long time.

MARKET ANALYSIS

Prices play a vital role predominantly in agricultural economy like India. It determines not only what shall be produced but also how much to be produced. The price system is a powerful tool to transmit essential economic information and stimulate appropriate decision by producers and consumers. Similarly, price is the most important determinant of profit or loss in the farm enterprise. In agriculture, time factor is very important. While crops are grown in one period and these are harvested in another period. This long gestation
period exercises significant influences on price determination. Therefore, the
price, prevailing during the marketing period is of great consequences.

The study of relationship between arrivals and prices is very useful. Larger production and larger arrivals reflect adversely on the prices; as a result, the prices go down. But in a mixed economy, a certain amount of direction given to the market forces may aim at resulting market supplies or consumption or both, particularly in the case of commodities in the short reactions among the sellers and buyers and of this reaction at once are reflected in supply and price position. Thus, in mixed economy it would be necessary to study the market arrivals and prices and to know the factors influencing them.

The variations in market arrivals and prices can be classified into two kinds.

The first one comprises fluctuations observed overtime and are generally referred as “temporal variations” and is the result of complex mixture of changes associated with trend, cyclical, seasonal and irregular components.

The second comprises fluctuations over space and are referred as “spatial variation” it is the outcome of differences in location and seasonality of production, transportation etc. These factors in turn lead to changes in the cropping pattern and the income of the farmers.

The seasonal variation is a regularly recurring pattern i.e., completed once in twelve months. Such seasonality is seen in the arrivals as well as in the prices of farm products. It arises from the nature of product, supply to the markets and the demand and price formations for crops. The seasonal variations
arise from climatic factors and biological growth processes of crops. Following the seasonality in production and arrivals, the prices also exhibit seasonal variations. Normally the prices of storable produce are lower at harvest time and then rise as the season progresses, reaching their peak just prior to the next harvest.

The study seasonal variation is considered to be important as a guide to the producer to market his produce and to the consumer to purchase his needs at the right time. It also serves as a guide to the government to operate its policy measures (Procurement and Buffer release) at appropriate times.

The trends in arrivals and prices are the changes over years and observed in the long run. The trends in arrivals are associated with development in technology of production, input supply and infrastructure. The trends of prices are associated with increase in population, money supply, increased purchasing power and generally with inflation or depletion observed in the economy. The study of trends enables us to indicate the direction of change in arrivals and prices in different markets.

**IMPORTANCE OF MARKET ANALYSIS**

Agricultural marketing plays an important role not only in stimulating production and consumption, but also in accelerating the pace of the economic development. An efficient marketing system ensures higher levels of income for the farmers and widens the markets for the products by taking them to remote corners of the country.
Analysis of price and market arrivals overtime is important formulating a sound agricultural price policy. Fluctuation in the market arrivals largely contribute to the price instability of the produce. In order to devise an appropriate ways and means for reducing price fluctuation of agricultural commodities, there is a need to have a thorough understanding of price behaviour over times and over space. Such an analysis is also useful to farmers in order to decide the optimum time for disposing of their produce to their best advantage. It has been noticed that when a major portion of the produce reaches the market during the peak seasons, the prices generally will be low which depress the farmer’s income to a great extent. Proper planning in disposing of the produce by the farmer alone can considerably increase their income without incurring much additional cost.

Realising the above mentioned facts, although Gulbarga district is one of the important onion growing areas extension work, profile onion growers, and seed producers, knowledge level on cultivation practices, production problems facing by the onion growers, marketing behaviour of the farmers, suggestions and marketing analysis was not undertaken in this area. Hence, the present study was conducted to analyse the above mentioned problems and the dynamic behaviour of arrivals and prices of onion in ten major onion markets across the country.

In the light of above facts, the present study, entitled “Bulb Onion: Cultivation and Seed Production Practices” of Gulbarga region was undertaken with following objectives.
OBJECTIVES

1) To study the profile of onion growers.

2) To find out the knowledge and adoption level of recommended cultivation practices by the onion growers.

3) To study the economic analysis of onion growers in Gulbarga region.

4) To know marketing behaviour of onion growers.

5) To ascertain the constraints, experienced by the onion growers and their suggestions in onion production and marketing.

6) To study the relationship between price and arrival in the selected markets.

7) To forecast or predict the prices of onion.

8) To suggest appropriate policy measures based on findings of the study.