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Vision 2050

Directorate of Onion & Garlic Research

Indian Council of Agricultural Research

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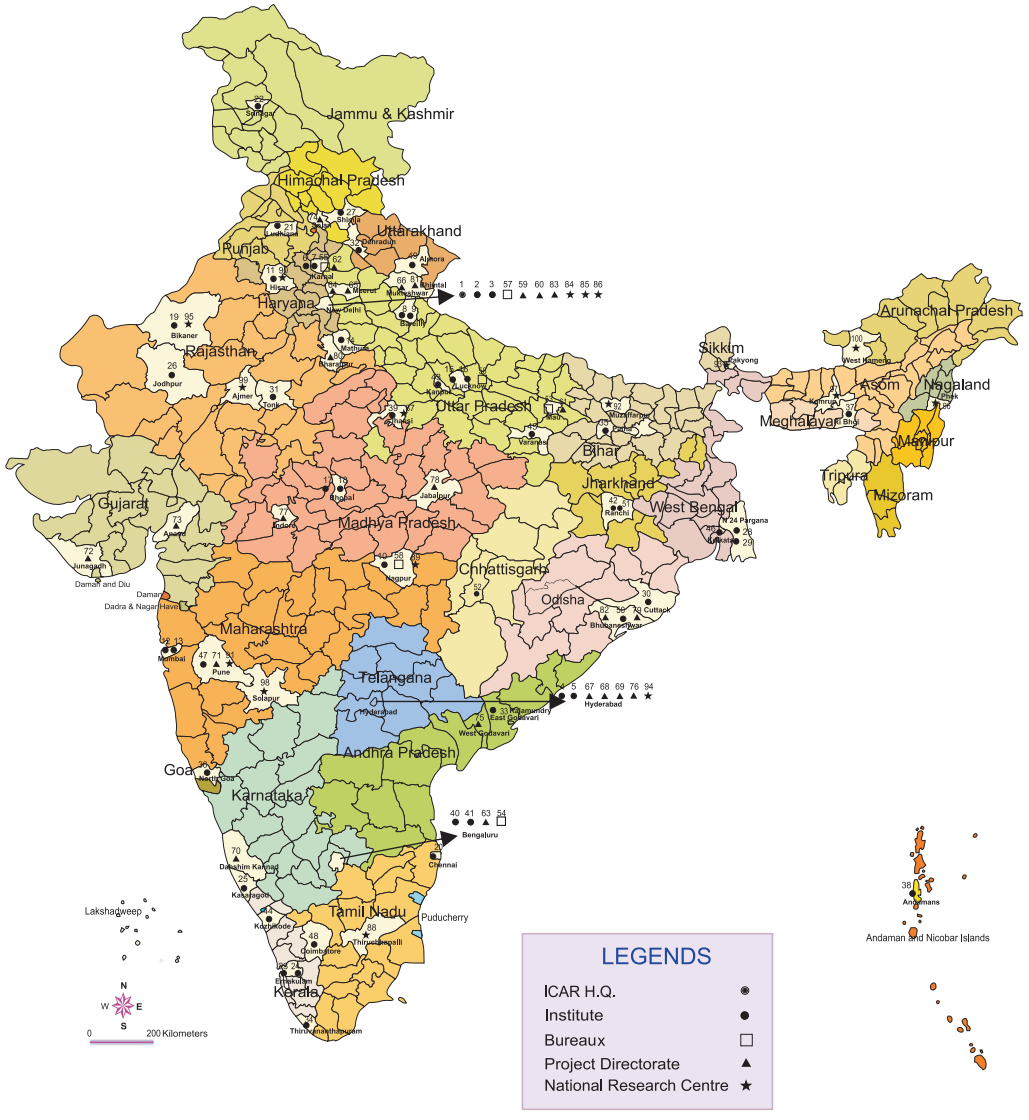

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Agricultural Universities

Vision 2050

Directorate of Onion & Garlic Research
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संदेश

भारतीय सभ्यता कृषि विकास की एक आधार रही है और आज भी हमारे देश में एक सुदृढ़ कृषि व्यवस्था मौजूद है जिसका राष्ट्रीय सकल घरेलू उत्पाद और रोजगार में प्रमुख योगदान है। ग्रामीण युवाओं का बड़े पैमाने पर, विशेष रूप से शहरी क्षेत्रों में प्रवास होने के बावजूद, देश की लगभग दो-तिहाई आबादी के लिए आजीविका के साधन के रूप में, प्रत्यक्ष या अप्रत्यक्ष, कृषि की भूमिका में कई बदलाव होने की उम्मीद नहीं की जाती है। अतः खाद्य, पोषण, पर्यावरण आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

पिछले 50 वर्षों के दौरान हमारे कृषि अनुसंधान द्वारा सृजित की गई प्रौद्योगिकियों से भारतीय कृषि में बदलाव आया है। तथापि, भौतिक रूप से (मृदा, जल, जलवायु), बायोलोजिकल रूप से (जैव विविधता, हॉस्ट-परजीवि संबंध), अनुसंधान एवं शिक्षा में बदलाव के चलते तथा सूचना, ज्ञान और नीति एवं निवेश (जो कृषि उत्पादन को प्रभावित करने वाले कारक हैं) आज भी एक चुनौती बने हुए हैं। उत्पादन के परिवेश में बदलाव हमेशा ही होते आए हैं, परन्तु जिस गति से यह हो रहे हैं, वह एक चिंता का विषय है जो उपयुक्त प्रौद्योगिकी विकल्पों के आधार पर कृषि प्रणाली को और अधिक मजबूत करने की मांग करते हैं।

पिछली प्रवृत्तियों से सबक लेते हुए हम निश्चित रूप से भावी बेहतर कृषि परिदृश्य की कल्पना कर सकते हैं, जिसके लिए हमें विभिन्न तकनीकों और आकलनों के मॉडलों का उपयोग करना होगा तथा भविष्य के लिए एक ब्लूप्रिंट तैयार करना होगा। इसमें कोई संदेह नहीं है कि विज्ञान, प्रौद्योगिकी, सूचना, ज्ञान-जानकारी, सक्षम मानव संसाधन और निवेशों का बढ़ता प्रयोग भावी वृद्धि और विकास के प्रमुख निर्धारक होंगे।

इस संदर्भ में, भारतीय कृषि अनुसंधान परिषद के संस्थानों के लिए विजन-2050 की रूपरेखा तैयार की गई है। यह आशा की जाती है कि वर्तमान और उभरते परिदृश्य का बेहतर रूप से किया गया मूल्यांकन, मौजूदा नए अवसर और कृषि क्षेत्र की स्थायी वृद्धि और विकास के लिए आगामी दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

(राधा मोहन सिंह)

केन्द्रीय कृषि मंत्री, भारत सरकार

Foreword

Indian Council of Agricultural Research, since inception in the year 1929, is spearheading national programmes on agricultural research, higher education and frontline extension through a network of Research Institutes, Agricultural Universities, All India Coordinated Research Projects and Krishi Vigyan Kendras to develop and demonstrate new technologies, as also to develop competent human resource for strengthening agriculture in all its dimensions, in the country. The science and technology-led development in agriculture has resulted in manifold enhancement in productivity and production of different crops and commodities to match the pace of growth in food demand.

Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farms, rural-urban migration, coupled with new IPRs and trade regulations, are some of the new challenges.

These changes impacting agriculture call for a paradigm shift in our research approach. We have to harness the potential of modern science, encourage innovations in technology generation, and provide for an enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy, and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive. Our institutions of agricultural research and education must attain highest levels of excellence in development of technologies and competent human resource to effectively deal with the changing scenario.

Vision-2050 document of ICAR-Directorate of Onion & Garlic Research (DOGR), Rajgurunagar, Pune has been prepared, based on a comprehensive assessment of past and present trends in factors that impact agriculture, to visualise scenario 35 years hence, towards science-led sustainable development of agriculture.

We are hopeful that in the years ahead, Vision-2050 would prove to be valuable in guiding our efforts in agricultural R&D and also for the young scientists who would shoulder the responsibility to generate farm technologies in future for food, nutrition, livelihood and environmental security of the billion plus population of the country, for all times to come.

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Preface

India is the second largest producer of both onion and garlic in the world after China. In past 20 years, production of onion in India has increased more than four times and that of garlic more than two times. However, productivity has not increased at the same rate. The onion productivity has increased only by about one and half times from nearly 10 tonnes to 15 tonnes/ha and that of garlic only marginally from nearly 4 tonnes to 5 tonnes/ha. At world level, we are far behind in productivity compared to many countries. The highest productivity of onion has been reported to be 67 tonnes/ha in Ireland and in case of garlic it is 30 tonnes/ha in Tajakistan. There is thus an urgent need to improve the productivity of both onion and garlic in India. It is all the more important keeping in view the population growth rate and the expected increased demand of these important commodities in future. The increasing consumption of fast foods being observed these days require more of onions and garlic as these are the major and essential ingredients of most fast food items.

The inherent short day and sub-tropic conditions under which onions and garlic are grown in the country limit the productivity of these crops in India compared to European and other countries where these are grown under long day temperate conditions. However, computations on per unit available photoperiod and crop duration basis have shown that India has less than half of the productivity of some other countries. The major factors responsible for this and action plan to meet the requirements of 2050 for onion and garlic are presented in this document.

The five top researchable issues that need to be addressed on priority are:

1. Widen the genetic base of both onion and garlic improvement programmes. The present day onion as well as garlic varieties are just selections from the old cultivars and landraces and thus have narrow genetic base. All of these have limited yield potential and are susceptible to important diseases and pests and cannot withstand the climatic aberrations, if any. Thus, there is an urgent need of systematic search for abiotic and biotic stress resistance sources among Alliums, and their safe conservation and documentation. Inorder to facilitate their actual utilization in breeding programmes,

pre-breeding needs to strengthened, and both conventional and biotechnological tools employed for transfer of useful genes to agronomically acceptable backgrounds.This is a long-term activity, and normally not taken up by breeders in their quest to achieve immediate gains. Special projects thus need to be planned for such activities so that the interests of those working on long-term programmes are protected.

2. Work on development of onion hybrids having uniform bulb characters, high yield and good storability needs to be strengthened. At present only open-pollinated varieties are in cultivation in India, whereas hybrids are becoming popular in some countries. Our programme of onion hybrid development has lagged behind on account of non-availability of durable sources of male sterility and inbred lines with good general combining ability. Use of molecular markers and double haploid production technology can greatly facilitate these activities. Concerted efforts are needed in this direction.
3. The programme on production of somaclones in garlic to generate variability for selecting agronomically superior types and induction of flowering in garlic to promote garlic breeding through conventional hybridization need to be strengthened. Further selection in existing variability is expected not to lead to much improvement.
4. The seed production programmes both for onion and garlic need to be well organized, involving research institutes as well as seed multiplication and supplying agencies of both public and private sectors. The good quality seed of recommended varieties needs to be made available to the farmers at reasonable cost. At present nearly ninety percent onion seed is produced by the farmers themselves without following the seed production procedures and is thus of poor quality adversely affecting the productivity. In garlic, no healthy seed cloves/bulbs are available for commercial crop as a result degenerated virus infected cloves are being used by the farmers. Viruses are known to reduce the yield upto 70% in garlic. Thus special emphasis needs to be given on developing virus-free cloves/propagules on commercial scale for supplying to the garlic growers.
5. Post-harvest losses are of major concern both in onion and garlic. Under ambient conditions storage losses can be as high as 50% in onion and 30% in garlic in 5-6 months. These need to be minimized by developing ventilated atmospheric controlled cold storage structures, but having economic viability.

Besides the above listed five top priorities, the work on refinement of crop production and crop protection methods, and dissemination of the improved products and technologies to the farmers and other stakeholders should not lag behind.

At the Directorate of Onion & Garlic Research, Rajgurunagar, Pune, we have chalked our programmes keeping the above priorities in view. The research and development activities are being undertaken to promote these priorities. But, there is limitation of both quantity and quality of the man-power available. We are trying to overcome these limitations by having linkages with other organizations both of public and private sector and involving them into our R&D programmes. But keeping in view the importance of onion and garlic in Indian food, and increasing demand for these commodities and observed price volatility, these crops need better attention and inputs in terms of financial as well human resources.

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Contents

Context

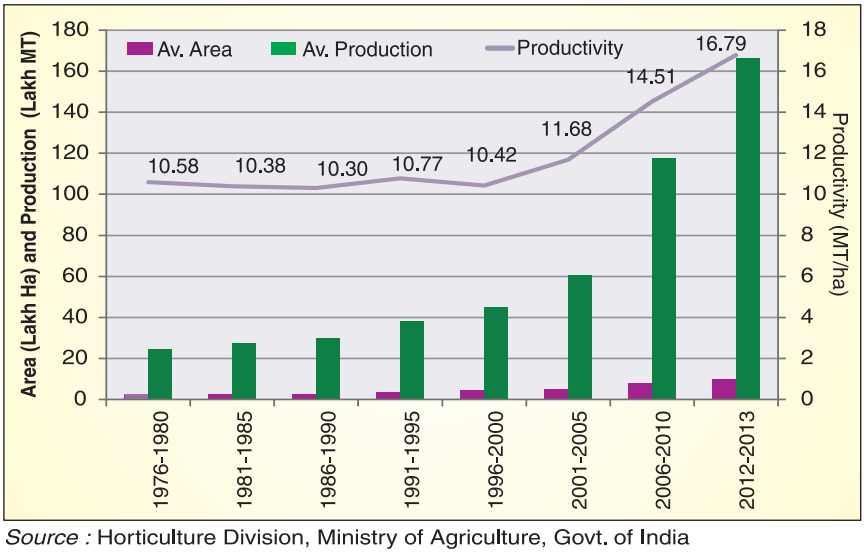
Onion and Garlic are the two most important culinary commodities grown in India for more than 5000 years ago. They can be eaten raw, cooked, fried, dried or roasted. No Indian food is complete without onion and/or garlic, although a little percentage of people does not eat these on religious grounds. Besides being used as food articles, both onion and garlic have a variety of medicinal effects. The importance of these bulb crops in treating diversified ailments, *viz*. lowering blood sugar, cardiovascular problems, improving gastrointestinal health, fighting cholera, preventing urinary disorders, blood clot etc. is well recognized. These are known to have antibacterial and aphrodisiac substances. Research and development activities in the past have helped in the growth of both onion and garlic in India.

Current Scenario

Onion

In India onion is grown under three crop seasons i.e. *kharif,* late *kharif* and *rabi.* Main crop is in *rabi* (50-60%), and *kharif* and late *kharif* contributes remaining about 20-25% each. Maharashtra, Karnataka, Gujarat, Bihar, Madhya Pradesh, Rajasthan, Andhra Pradesh and Tamil Nadu are the main onion growing states in India. In general, barring North Eastern states and Kerala, all other states grow onion. Country's 24% area and 27% production alone come from Maharashtra. There is critical shortage in arrivals of onion in the market during November to January. From May to November stored onions are used for domestic as well as export market. November to December, *kharif* onion is available in the market, whereas from January to March late *kharif* crop from Maharashtra is available. The productivity in late *kharif* and *rabi* is around 25 tonnes per hectare, whereas in *kharif* season it is 8-10 tonnes per hectare.

The area and production of onion has increased many fold since 1970s (Fig. 1). However, the productivity has not increased at that pace. Although second in onion production after China at world level,

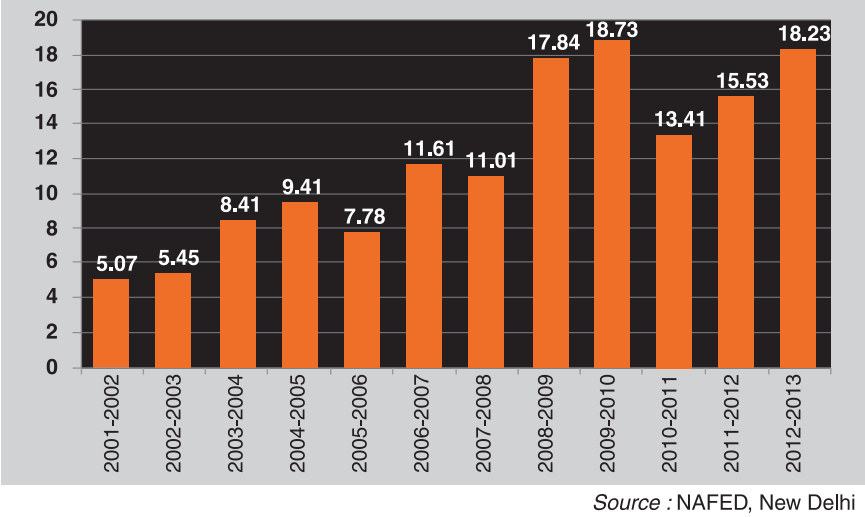


Source : Horticulture Division, Ministry of Agriculture, Govt. of India

Fig. 1 The growth in area, production and productivity of onion in India

India is far behind in productivity compared to many countries. The average productivity of onion in India in the past decade stood at only 13.78 t/ha, which is lower than world average of 18.75 t/ha (FAO Stat., 2013). The highest productivity of onion has been reported to be 67.33 t/ha in Ireland.

Global export trade of onion is to the tune of 6.77 million tonnes worth 2856.33 million dollars (FAO Stat, 2011). Netherlands is number one exporter with 1.32 million tonnes worth 522.29 million dollars followed by India (1.11 million tonnes worth 370.74 million dollars (Rs. 2512 crores). India exports onions mostly to Gulf and South East Asian countries. The onion export from India has increased from 5 lakh tonnes in 2001-02 to more than 18 lakh tonnes in 2012-13 (Fig. 2)

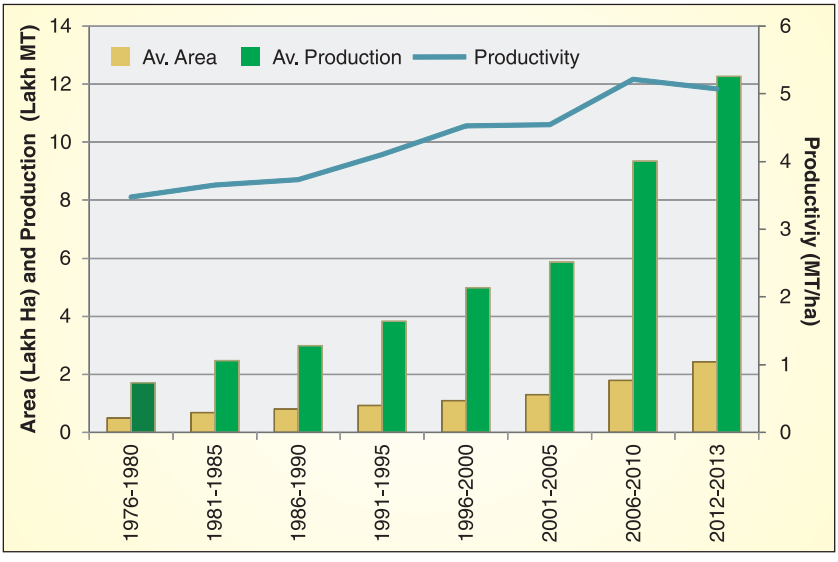


Source : NAFED, New Delhi

Fig. 2 Year-wise export (lakh tonnes) of onion from India

Garlic

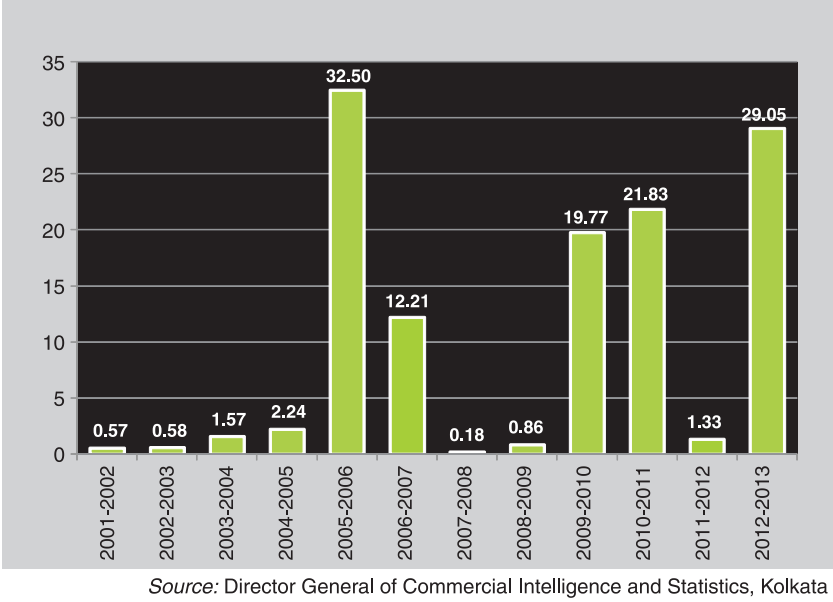
Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh, Assam, Punjab, Maharashtra and West Bengal are the main garlic growing states. Gujarat and Madhya Pradesh produce 44% of country's garlic. Karnataka, Bihar, Tamil Nadu, Himachal Pradesh and Andhra Pradesh also produce sizeable quantity of garlic in cooler regions of the states. Garlic in plains is grown from October to March. The genotypes mostly grown in plains are tropical type, which have very low productivity and small clove size. Himachal Pradesh, Uttarakhand and Jammu and Kashmir grow long day type garlic from September to June. Per unit yield of this type is high but due to limited area, total production is less.



Source : Horticulture Division, Ministry of Agriculture, Govt. of India

Fig. 3 The growth in area, production and productivity of garlic in India

Garlic has shown manifold increase in area and production in the country since 1970s, however, like onion the productivity of garlic too has not increased at the same pace, rather it is stagnating at about



Source: Director General of Commercial Intelligence and Statistics, Kolkata

Fig. 4 Year-wise export (thousand tonnes) of garlic from India

5 tonnes/ha from a decade. After China, India is the second highest producer of garlic, however, the productivity is much lower than the world average of nearly 14 tonnes/ha and the highest is 30 tonnes/ha in Tajakistan (FAO Stat., 2013).

The world trade of garlic through export is 1.97 million tonnes worth 2734.78 million dollars. China is number one exporter with 84% share by quantity (1.66 million tonnes) and 73% by value (2068.29 million dollars). Argentina (4.66%), Spain (3.28%) and Netherlands (1.47%) are the other main exporters of garlic (FAO Stat., 2013). Major importing countries are Indonesia, Brazil, Vietnam, Malaysia, USA, Thailand, Pakistan, Bangladesh, Russian Federation, Saudi Arabia, UAE and Netherlands. The export of garlic from India is frequently fluctuating over the years (Fig. 4) and many a times in the past India had to import garlic from China.

Projections 2050

India is projected to have population of 1.7 billion by 2050. To cater the requirement of this ever increasing population, and keeping per capita consumption, export, processing and losses at existing rate (consumption 7 kg/person/year, export 11%, processing 8% and losses 30%; base year 2012-2013), we will require 23.47 million tonnes of onion in 2050 against 16.81 million tonnes in 2012-13. This demands an increase in average productivity from 15.98 to 22.31 t/ha, which is 37% higher than that of in 2012-13 (Table 1). Efforts can be made to reduce losses up to 20%, and increase export and processing up to 20% each by 2050. The consumption/person/year may go up to 15 kg and area under cultivation may also increase by 20%. With these expectations, we have to increase productivity to 50.61 t/ha to get a production of 83.87 million tonnes. This means a 271% increase in productivity over the existing productivity of 15.98 t/ha.

Table 1 Projected onion scenario in 2050

Present Status (2012-13)		Expected for 2050	
		At current rates	At increased rates
122 Crores	Population	170 Crores	170 Crores
7 Kg/year	Consumption/Person	7 Kg/year	15 Kg/year
85.58 Lakh tonnes	Total consumption	119.26 Lakh tonnes	255.00 Lakh tonnes
18.23 Lakh tonnes*	Export @11%	25.81 Lakh tonnes	127.75 Lakh tonnes @20%
50.44 Lakh tonnes	Losses @ 30%	70.40 Lakh tonnes	127.75 Lakh tonnes @20%
0.42 Lakh tonnes	Seed production	0.42 Lakh tonnes	0.50 Lakh tonnes
13.46 Lakh tonnes	Processing @8%	18.77 Lakh tonnes	127.75 Lakh tonnes @20%
168.13 Lakh tonnes** (Area – 10.52 L ha)	Total requirement	234.67 Lakh tonnes	638.75 Lakh tonnes (Area - 12.62 Increased by 20%)
15.98 t/ha	Required Productivity	22.31 t/ha % Increase = 37%	50.61 t/ha % Increase = 271%

* NHRDF, Nashik ** Department of Agriculture and Co-operation, Min. of Agri., India

In case of garlic in 2012-13, export was about 2%, processing about 5% and post harvest losses up to 15%. If we keep the export, processing and losses at same rate, then in 2050 the garlic requirement will increase to 1.68 million tonnes from 1.26 million tonnes at present. To achieve this target average productivity per hectare needs to be increased to 6.79

t/ha compared with the existing productivity of 5.06 t/ha (Table 2). There is a lot of scope and need to increase production and productivity of garlic.The per capita consumption of garlic is expected to go up to 1.5kg per year, the export target can be 5%, processing target 12% and the losses may reduce to 10%. The area under garlic may increase by 10% by 2050. In this situation there is need to increase the production to 3.68 million tonnes and productivity to 13.48 t/ha i.e. an increase of 165% over the productivity of 5.08 t/ha in 2012-13.

Table 2 Projected garlic scenario in 2050

Present Status (2012-13)		Expected for 2050	
		At current rates	At increased rates
122 Crores	Population	170 Crores	170 Crores
0.700 Kg/year	Consumption/person	0.700 Kg/year	1.5 Kg/year
8.54 Lakh tonnes	Total consumption	11.90 Lakh tonnes	25.50 Lakh tonnes
0.29 Lakh tonnes *	Export @2%	0.34 Lakh tonnes	1.84 Lakh tonnes @5%
1.89 Lakh tonnes	Losses @15%	2.53 Lakh tonnes	3.68 Lakh tonnes @10%
1.24 Lakh tonnes	Seed production	1.24 Lakh tonnes	1.37 Lakh tonnes
0.63 Lakh tonnes	Processing @5%	0.84 Lakh tonnes	4.41 Lakh tonnes @12%
12.59 Lakh tonnes** (Area – 2.48 L Ha)	Total requirement	16.84 Lakh tonnes	3.68 Lakh tonnes (Area – 2.73 L Ha increased 10%)
5.08 t/ha	Required productivity	6.79 t/ha % Increase = 34%	13.48 t/ha % Increase = 165%

*NHRDF, Nasik, **Department of Agriculture and Co-operation, Min. of Agri. India

The substantial estimated required increase in productivity of both onion and garlic over the existing yield levels can be achieved only if innovative measures are adopted. The challenges, gaps & initiatives and way forward for 2050 of onion and garlic cultivation are analyzed below. ❑

Challenges

Onion and garlic have the following challenges from research and development points of view.

(a) Onion is a biennual crop which takes two years to complete one cycle.
(b) It is a highly cross pollinated crop and commercial seed production of onion requires isolation distance of about 1.5 km to maintain purity.
(c) Development of inbreds is difficult as onion suffers high inbreeding depression upon selfing.
(d) Crossability with wild sources is difficult.
(e) Storage losses are high and there are chances of loss of germplasm and stocks due to rotting or sprouting of bulbs.
(f) Viability of onion seed is hardly up to 15 to 18 months under ambient conditions.
(g) Crop is very sensitive to abiotic stresses and climate change.
(h) Problem of flowering in garlic is a big hindrance in improvement.

Besides the research related challenges, market sensitivity leading to large fluctuations in onion prices is a big challenge. *Kharif* onion which is harvested in October-November fill the gaps in supply of onion as by this time the stored *rabi* onion produce is exhausted. But the productivity of *kharif* onion crop is very low because the crop is rain-fed and prone to many foliar and soil borne diseases. The market sensitivity is likely to increase further in years to come due to expected increase in demand of both onion and garlic as fast food and processed products consumption is increasing.

The water scarcity and erratic rains as being observed now are likely to become more severe and thus detrimental to production of both onion and garlic as these crops are highly sensitive to water stress as well as excess water. Drought and flooding are becoming more frequent due to climate change. Insect vectors of onion and garlic viruses are increasing, whereas pollinators are decreasing due to dry spells and high temperature. These are likely to affect not only the bulb production both in onion and garlic, but also seed production in onion. Likely increase in soil degradation and atmospheric pollution will further limit the production and productivity of both onion and garlic.

❑

Opportunities

1. Demand of onion and garlic is increasing due to urbanization and increase in fast foods consumption. An analysis has shown that the per capita availability of onion has tripled in the past one decade. The demand for the processed products of onion and garlic is also increasing particularly for export. The domestic as well as export demand of onion and garlic is further likely to increase particularly due to increase in the working female population and rising purchasing power of the Indian population. Thus there is opportunity to promote R&D activities of onion and garlic for meeting both domestic and export demands.
2. Onion can be grown during *kharif*, late *kharif* and *rabi* in plains of India and during summer in hills. Round the year cultivation is becoming possible due to development of varieties and technologies for various agro-climatic conditions and seasons. Garlic is mainly grown in *rabi*, but *kharif* garlic is also grown in some parts of India. The possibility of extending cultivation of garlic to more areas under varying seasons is an opportunity that can be harnessed by strengthening R&D activities in this direction. This would help in increasing production and productivity of both onion and garlic.
3. Onion and garlic are short duration crops (120-140 days) and fits well in various cropping sequences. Legume in *kharif* followed by onion/garlic in *rabi* has been found to be remunerative crop sequence. Possibility exists to have 2-3 crops on the same piece of land by growing onion/garlic as one of the crops in the sequence. These crops can also be grown as inter-crop with sugarcane. Further studies in this direction can promote onion and garlic cultivation.
4. Both onion and garlic are low input crops and result in high benefit: cost ratio. These crops are particularly suitable for small and marginal farmers who have family labour. Since the land holdings are decreasing due to land divisions in the family, the cultivation of onion and garlic is likely to increase.

❑

Goals and Targets 2050

1. Increase productivity (270% for onion; 165% for garlic)
2. Improve quality (TSS 14-16% for onion; big cloves in garlic, and low reducing sugars and high content of pyruvic acid in both onion and garlic)
3. Reduce storage losses (to < 5%)
4. Extend to non-traditional areas (at least by 20%)
5. Harness functional aspects (medicinal/ therapeutic)

❑

Initiatives Required

Keeping in view the above goals/targets, the inherent problems of these crops and the changing ecological, environmental, and socio-economic scenario the technological initiatives required for meeting domestic and export market requirements are presented below.

Seed: Seed of recommended onion varieties is not available in required quantity and quality. Old local genotypes still predominate and seed is produced by the farmers themselves without observing the required isolation distance.There is no organized system for production and distribution of quality onion seed. The seed produced by a few research organizations is sold to the farmers in limited quantity. Need is that good quality/breeder seed from research organizations should be procured by the state and national seed certification agencies for multiplication and distribution to the farmers at reasonable rates.

Since garlic is vegetatively propagated, degeneration due to viruses is a big problem in garlic. Viruses cause significant reduction in yield. There are no virus-free stocks for commercial production of garlic. Seed stocks presently being used by the farmers for garlic production are infected with viruses. For making virus-free seed available to the farmers need is to develop commercial scale protocols for virus-free seed production through virus elimination and rapid multiplication.Tissue culture protocols of meristem culture and microprogation need to be developed on commercial scale. Subsequent multiplication of virus-free stocks can be done under protected or vector-free conditions. Such hi-tech seed production technology as available in some other vagetatively propagated crops like potato needs to be replicated on priority for garlic.

Storage: India needs storage of onion from May to November and garlic from April to March. For domestic supply, export as well as seed bulbs, about 40 lakh tonnes of onion and 5 lakh tonnes of garlic need to be stored at present. Storage of onion and garlic bulbs for long periods is problematic. *Kharif* onion crop is rain-fed and physiologically immature when harvested. Its produce cannot be stored even for a month and needs to be utilized immediately after harvest. Storage losses in onion can be as high as 40-50% under ambient conditions. These range between 15-20% in garlic. There is need to develop genotypes having good storage life. Refinement of cultural practices to minimize storage losses and designing of bottom and side ventilated storage

structures by which storage losses can be reduced by 10-20% has been done. There is an urgent need for popularization of such storage structures and providing financial assistance to the onion growers in different states for this purpose.

Cold storage of onion and garlic with back up of irradiation for suppression of sprouts would be new area of research. Cold-storage technology is now picking up particularly with private sector. These cold storages are ventilated types with controlled atmosphere wherein gases particularly carbon dioxide, which is the product of bulb respiration, is monitored and controlled regularly. The storage losses in such stores are not more than 5%. This technology is, however, expensive and not in the reach of small and marginal farmers. It needs to be made economical and perfected so that it is available on large scale for routine use by the farmers. The development of technology package for pre-cooling and establishment of cool chain for overseas trans-shipment is imperative to boost the export. The innovations in the designs of referred containers will also be crucial to reduce the transit losses. Development of these facilities in strategic production areas would help reduction in post-harvest losses remarkably. There is need to develop and standardize technology for storing onion and garlic in controlled atmosphere cold storages where there is scope to reduce storage losses drastically in both the crops.

Export: Red and light red onion varieties from India are exported to Gulf and South East Asian countries. Rose and multiplier onion from Andhra Pradesh, Karnataka and Tamil Nadu are also exported. Yellow onion is in demand in European market. Onion export can be increased to the tune of about 125 lakh tonnes in 2050. Presently Europe imports onion from New Zealand, Tasmania, South Africa, which are far off. India is half way nearer to Europe. Further, we can grow good quality yellow onion from October to February. There is critical gap in supply in Europe from February to June whereas India has ample production during these months. Hence, development of export quality red, white and yellow onion bulb varieties is required. A lot of market-oriented research would be needed in production, grading, packing and shipment of onions.

India is traditional exporter of garlic in sizable quantity to neighboring countries. However, garlic productivity in India has remained almost static. Thus, due to increase in domestic demand, now sometimes we import big cloved temperate garlic from China. However, nutritional quality and flavoring component wise Indian garlic is much better and has better demand in certain countries e.g. Singapore, Indonesia,

Bangladesh, Sri Lanka, and Philippines. Thus there is need to develop varieties and technology to increase the productivity of Indian garlic.

Onion hybrids: At present only open-pollinated varieties are in cultivation in India. Some exotic hybrid varieties are being promoted by some private seed companies, but those are not much adapted to short-day conditions of India and thus have little advantage over the commercial open-pollinated varieties and have higher seed cost. Thus development of hybrid onion varieties adapted to Indian conditions is urgently needed for production of uniform high yielding bulb crop of onion. However, non-availability of inbred lines and durable male sterile lines are hampering hybrid production. These areas of onion hybrids development need urgent attention.

Genetic improvement in garlic: Genetic improvement of garlic is hampered because garlic rarely flowers and is sterile.Thus, development of improved varieties of garlic by conventional methods is limited to only clonal selections from the existing natural variability. Due to this not much headway could be made in improving garlic productivity. There is need to induce genetic variability through innovative approaches like somaclones so that selection for improved types can be made effective. Such approaches need to be explored urgently. Induction of flowering in garlic and production of true seed, though a difficult task also need to be looked into and can be adopted as a long term challenge. This will help in creating variability through sexual reproduction for fast genetic improvement.

Disease and pest resistance: Both onion and garlic are affected by many diseases. Among them, more important diseases are purple bloch, anthracanose and *Stemphillium* blight, and pest like thrips, which besides causing direct damage to the standing onion and garlic crops, are also the vectors of a number of viruses. All onion and garlic varieties presently in cultivation in India are susceptible to various diseases and pests. Thus, breeding for disease and pest resistance is an area which needs an urgent attention. But, sources of durable resistance to various diseases and pests are not well known. There is need to screen all available germplasm including the wild *Allium* species for various diseases and pests, systematically. Resistant or the tolerant types so identified need to be adopted and used in breeding for developing disease and pest resistant varieties of onion and garlic. Marker assisted selection and cloning of resistant genes can also be made use of for accelerating the development of disease and pest resistant varieties.

Processing and value addition: Both onion and garlic have high processing potential. Flakes, granules, powder, and oils are the products

prepared out of onion and garlic. Further, onion and garlic blended food products have enormous commercial potential in domestic and export markets. Processing industries are emerging at a faster rate and would demand more raw materials in future. The processing units are facing problems of year round supply of high TSS white onion (>18%) varieties. Varieties with low reducing sugars, high pyruvic acid and allicin content are required to develop value added nutritionally rich products. However, development of onion and garlic varieties rich in medicinal and functional food value is a challenge requiring urgent attention.

***Kharif* production technology:** Production of successful onion crop during *kharif* is still a challenge as productivity in *kharif* is quite low (8-10 t/ha) as the crop is mainly rainfed and is severely attacked by many diseases and pests. *Kharif* production technology thus needs to be further refined.

Mechanization: Emerging labour problem is becoming a big hindrance for small and medium scale farmers. There is demand for development of machines and tool for small and medium level farmers besides the large one to minimize labour use with increase in efficiency. Direct seeding can substantially reduce the labour cost involved in traditional transplanting method. The available seed drills are not precise in terms of maintaining plant population and spacings. These need to be improved by using pneumatic seed drill technology available in advanced countries, which at present is expensive and of use for large farms. Similarly, work on transplanters, harvesters etc. also needs to be undertaken seriously.

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Way Forward

Considering the aspects of natural resource degradation, climate change and associated stresses the following strategies would help to carry forward the technological initiatives for meeting the domestic and export requirements.

- Combine conventional breeding with biotechnological approaches for introgression of genes from wild species for resistance/tolerance to biotic and abiotic stresses, male sterility, high T.S.S., and for creation of variability.
- An organized system for production of quality seed in sufficient quantity and its distribution at reasonable rates needs to be developed by involving research organizations, state and national seed certification agencies and also private sector.
- Development of low-cost cold storage technology is essentially needed to minimize storage losses.
- Robust recommendations need to be given based on long term multilocational trials on INM, IPM, & IDM for enhancing & sustenance of productivity.
- A more flexible public-private partnership (PPP) needs to be developed wherein basic and strategic research should be undertaken by research organizations and applied aspects like variety/hybrid development, agronomic recommendations and extension activities should be through PPP mode.
- Government should do crop planning for effective supply chain management and price control. A firm policy on promotion of export is needed. Facilities for quick transport, provision of ventilated containers, and cargo clearance through agri-export zones need to be strengthened.

NOTES

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