



Vision 2050



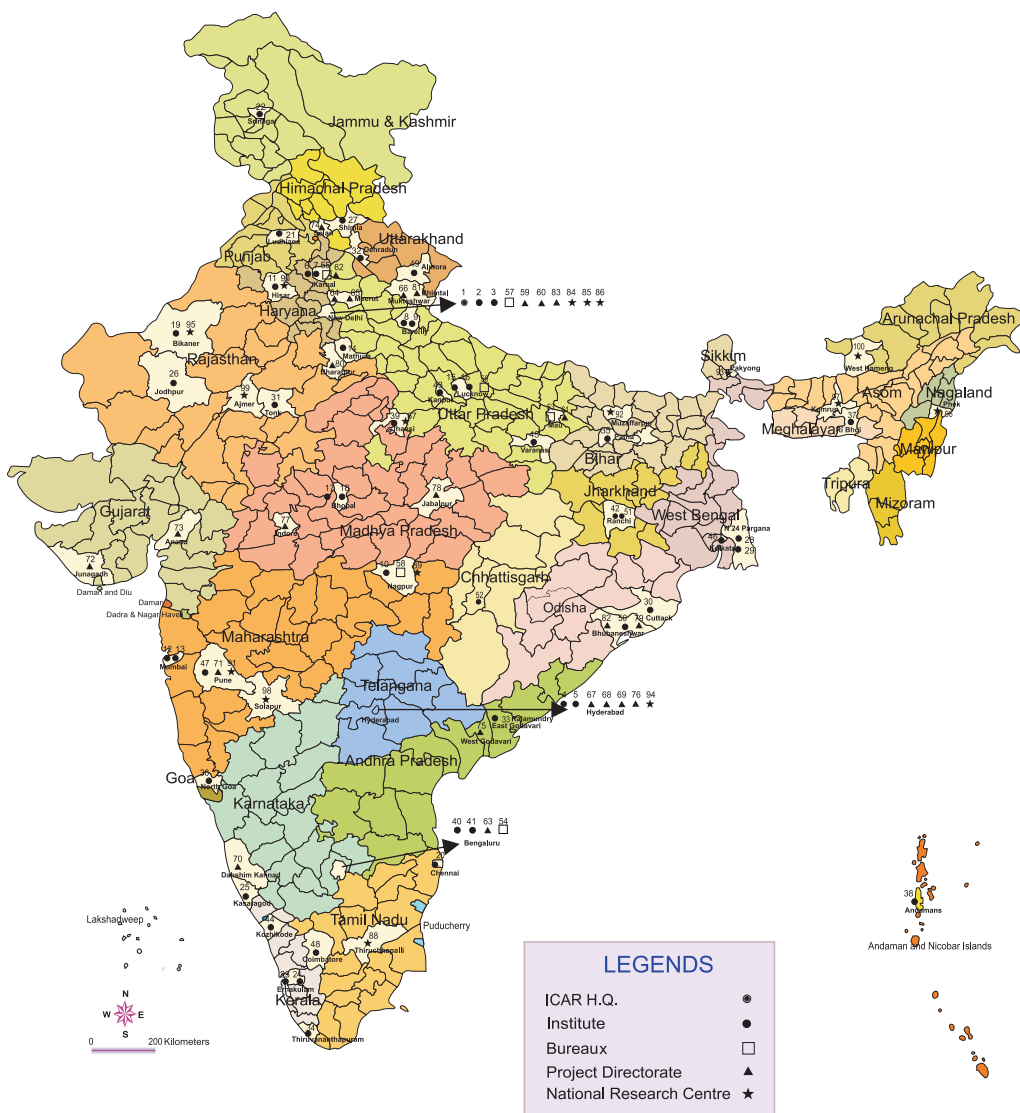
National Research Centre on Pomegranate
Indian Council of Agricultural Research





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Vision 2050



National Research Centre on Pomegranate

(Indian Council of Agricultural 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 कोई 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-परजीवी 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।

Ramesh Chandra Mehta

(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-National Research Centre on Pomegranate (NRCP), Solapur 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.



(S. AYYAPPAN)

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Preface

India is one of the leading countries in pomegranate production. Over the last one decade, the country has registered sizeable increase in area and production, respectively. The export of pomegranate from India has upsurged by 3.5 times during this period. There has been marked shift towards the consumption of pomegranate worldwide owing to its several nutritive, nutraceutical and medicinal properties. Although, pomegranate can be grown under varied climatic conditions of the country, it performs better in semi-arid and arid regions. In India, pomegranate is commercially cultivated in Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Telangana, Madhya Pradesh, Tamil Nadu and Rajasthan.

ICAR-National Research Centre on Pomegranate was established at Solapur, Maharashtra in 2005 by the ICAR to augment the production, productivity and utilization of pomegranate through basic, strategic and applied research. The Centre has a collection of 345 germplasm (both indigenous and exotic) at field gene bank. Bacterial blight is one of the major biotic threats to production and productivity of pomegranate in India.

An Integrated Disease and Insect Pest Management (IDIPM) schedule developed by ICAR-NRCP has resulted in successful management of bacterial blight in the states of Maharashtra, Karnataka and Andhra Pradesh. Technologies for maximum nutrient and water use efficiencies with respect to dry land horticulture are being developed. Tissue culture laboratory has been established by the ICAR-NRCP and protocol for mass production of healthy and disease free planting material has been standardized. Similarly, research programmes have also been initiated on post harvest technologies for value addition and total utilization of pomegranate. The centre is committed to tackle some of the core challenges like availability of healthy and disease free planting material, varieties resistant to biotic, abiotic stresses, processing and value addition of pomegranate.

The Vision 2050 document encompasses the salient research and development achievements of the Centre since its inception, growth of pomegranate during the last decade and future strategies to mitigate the challenges of climate resilient agriculture. The document depicts a clear roadmap of ICAR-NRCP as an International Centre of Excellence in research, teaching and extension of pomegranate in a holistic manner.

I express my profound gratitude to Dr. S. Ayyappan, Secretary DARE & Director General, ICAR and Dr. N. K. Krishana Kumar, DDG (Horticultural Science), ICAR for their valuable guidance in compiling and bringing out this document and support in carrying out R&D activities of the Centre. I wish to record my thanks to Dr. T. Janakiram, ADG HS-1 for giving critical suggestions in preparation of Vision 2050.

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Executive Summary of Vision 2050

Pomegranate is an important fruit crop of arid and semiarid regions of the world. It is believed to be originated from Iran. It has both cultivated (*Punica granatum* L.) and wild types (*Punica protopunica*). The cultivated types are adapted to the Mediterranean regions of Central Asia, Africa and Europe. The wild pomegranate (*Punica protopunica*) is confined to Socotra islands. Besides cultivated and wild types, ornamental forms (Eg. Japanese Dwarf pomegranate –*Punica granatum* var. *nana*) of pomegranate is also popular in south east Asian countries.

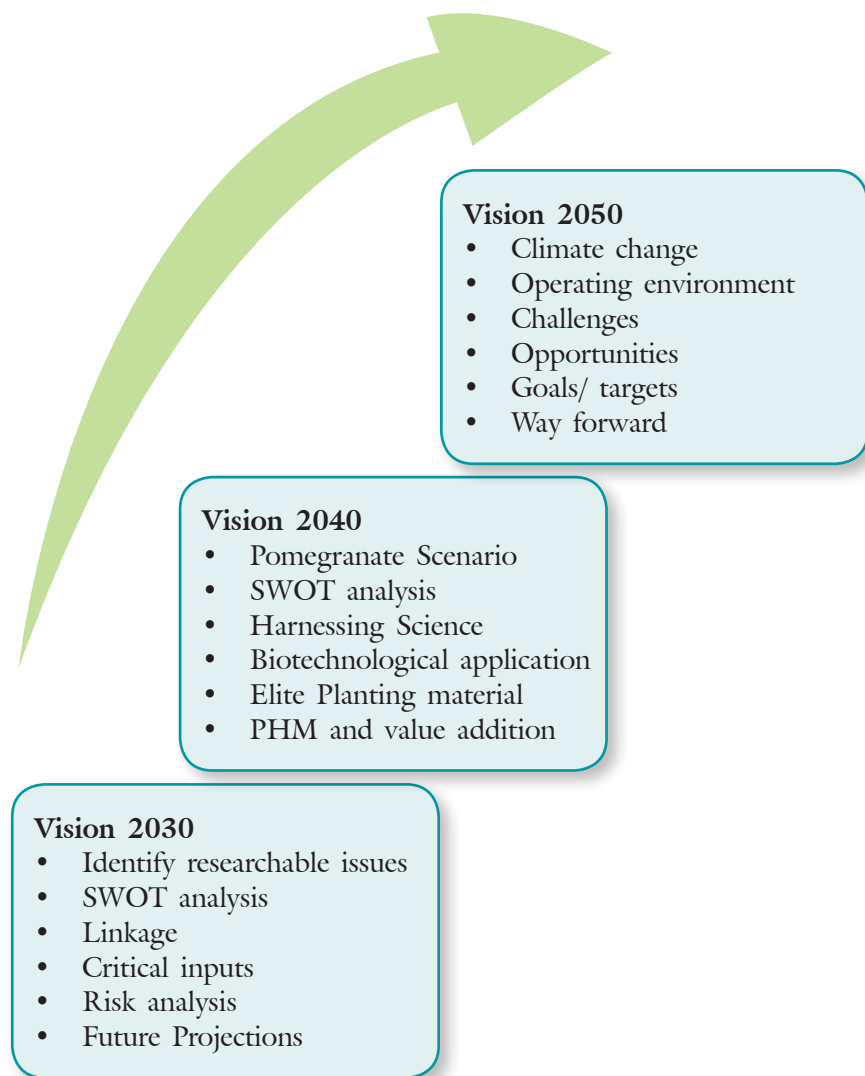
Pomegranate has several salient features unique to its credit. Pomegranate has ability to withstand harsh and hostile climate. It has built-in capacity to withstand heat, drought and moisture deficit. The versatile adaptability, hardy nature, low maintenance cost, steady but high yields, better keeping quality, fine table and therapeutic values and possibilities to throw the plant into rest period when irrigation potential is generally low, indicate the avenues for increasing the area under pomegranate in India. It has immense medicinal and nutritional value. Pomegranate is one of the richest source of antioxidants.

Pomegranate was domesticated in 2000 BC and was one of the first five fruit crops (date palm, fig, olive, grape and pomegranate) to be domesticated by mankind. The usage of pomegranate is deeply embedded in human history with references in many ancient cultures for its use as food and medicine.

India is one of the largest producers of pomegranate in the world. During 2013-14, pomegranate was cultivated over 1.31 lakh ha with an annual production of 13.46 lakh tonnes and productivity of 10.27 tonnes/ ha in India. At present, Maharashtra is the leading state in acreage covering about 68.7 per cent of the area under pomegranate. Similarly around 70.2 per cent of total production comes from Maharashtra. The other important states next to Maharashtra with respect to pomegranate cultivation are Karnataka, Gujarat and Andhra Pradesh. India is the only country in the world where pomegranate is available throughout the year (January – December).

Considering the present status of pomegranate cultivation and the current strength of India in global arena, the important points are suggested for Vision-2050 which encompasses the field of classical breeding, biotechnology, molecular biology, hi-tech horticulture,

integrated disease and insect pest management, postharvest technology and value addition, *etc.*



Introduction

Pomegranate is an important fruit crop of arid and semiarid regions of the world. It is believed to be originated from Iran. It has both cultivated (*Punica granatum* L.) and wild types (*Punica protopunica*). The cultivated types are adapted to the Mediterranean regions of Central Asia, Africa and Europe. The wild pomegranate (*P. protopunica*) is confined to Socotra islands. 'Daru' is a kind of pomegranate with small sized fruits, sour in taste which grows naturally as wild under Himalayan ranges of India. Besides cultivated and wild types, ornamental forms (Eg. Japanese Dwarf pomegranate –*Punica granatum* var. *nana*) of pomegranate is also popular in south east Asian countries. In general, pomegranates are diploids with chromosome number, $2n=2x=16$. But, some of them are reported to have $2n=2x=18$ chromosomes (Eg. Double Flower, an ornamental variety which bears only flowers).

Pomegranate was domesticated in 2000 BC and was one of the first five fruit crops (date palm, fig, olive, grape and pomegranate) to be domesticated by mankind. The usage of pomegranate is deeply embedded in human history with references in many ancient cultures for its use as food and medicine.

Pomegranate is truly an ancient cultural icon of the old world. Whether it is an Arabian Night story teller/ or the Spanish Alhambra palace garden/ or stories of Shirin Farhad of Persia, there runs a common thread of romance and beauty of this tree of life. Greek goddess Nike and goddess Tanit of Phoenicia, both revered around Mediterranean, are holding pomegranate fruit as symbol of fertility and prosperity in their hands. It is customary to consume pomegranate on Jewish New Year as Jewish tradition teaches that the pomegranate is a symbol of righteousness. Although the pomegranate is an ancient symbol steeped in tradition, it has re-emerged in contemporary culture, not only because of its beauty but because pomegranate is quite desirable for its healthy, antioxidant qualities. Grown in the Mediterranean region for several thousand years, this remarkable fruit is rich in symbolism. The erect

calyx of the fruit was an inspiration for designing king's crown. Blood red garnet stone is named after this fruit.

Pomegranate shrub flourished naturally in northern India, in the lower ranges of Himalayas and Kashmir valley but is relatively a new introduction in the horticulture sector for fruit cultivation, compared to other major fruits viz. Mango, Banana, Citrus etc. Indians considered it as one of the rarest fruits having high nutritive value from ancient times; its medicinal properties being described in Ayurveda. In our childhood, baskets of pomegranate fruits were offered as gift to near and dear ones suffering from critical illness or recovering from surgical operations to help them recuperate fast.

It is believed that the pomegranate originated in Iran/Turkey; trees were grown over the whole Mediterranean region of Asia, Africa and Europe; later the plant migrated to Far East along silk route where it has been cultivated since the pre-Christian era. Theophrastus, whom Linnaeus called Father of Botany, provided description of this fruit tree about 300 years before the birth of Christ. Having its centre of origin in Mediterranean region, this fruit was always associated with various culinary and medicinal uses in these regions. Afghanistan was a major producer and exporter of the fruit in better times. Khaled Hosseini's stories often associate the better times with pomegranate trees lining compounds of affluent Afghans. While the crop still is an important one in Afghanistan, countries like India, Iran and some in the Caucasian and Mediterranean regions have emerged as some of the major commercial producers and exporters of pomegranate in modern times.

It is widely believed that Babar was responsible for planting a wide variety of fruit crops in India including the pomegranate – he brought the seeds all the way across the valleys and mountains from his homeland, Ferghana of Central Asia. Much later it was discovered that this temperate fruit tree does well even in semiarid tropical regions.

Pomegranate research in India dates back to 1932. At the Ganeshkhind Fruit Experiment station, Dr. G.S. Cheema, Father of Indian Horticulture, started working with local wild type pomegranate variety known as Alandi having deep pink coloured, highly acidic and hard seeded arils. In the year 1936 a selection from the seedling population of Alandi, bearing sweet aril type fruit with soft seeds was identified and released for commercial cultivation in Maharashtra in the name of cv.GBG-1. In the year 1970 the cultivar GBG-1 was renamed as Ganesh. Active research on pomegranate in India got a boost with release of several promising selections of cv Ganesh as G-017, G-132, G-13, G-134 and G-137. In the year 1984 G-137 was officially released

by MPKV Rahuri as an important commercial variety of Pomegranate in India. During the same time research was going on at TNAU that resulted in release of soft seeded pomegranate variety named as CO-1. Within one year of release of cv.G-137 the UAS Bengaluru came out with a variety by the name Jyoti-a selection from Bassein Seedless and Dholka. The journey for the quest of more and more new varieties of pomegranate particularly having soft seed and bright attractive colour of rind and arils was on. With the introduction of a Russian variety Gulesha Red having attractive colour attributes, new crosses have been made with cv. Ganesh at MPKV Rahuri in 1994. Selection from the hybrid population of Ganesh and Gulesha Red resulted in release of popular cultivars viz. Mridula, Bhagwa, Phule Arakta and Phule Bhagwa Super during the period between 1993-2013. Out of all these cv. Bhagwa has done really well in farmers' fields compared to other varieties thus becoming the leading cultivar both for domestic as well as export market primarily due to its wide consumer appeal for its soft seeds, bright red coloured arils and palatable blend of its brix-acid ratio. Real upsurge in pomegranate cultivation in India took place from 1990 onwards: area under cultivation grew from merely 4.6 thousand hectare to 1.31 lakh hectare in 2013-14.

During the last three decades innovative farmers took real initiative and pomegranate crop has been acclimatized from typically temperate zones to semi-arid and arid areas of India. Only few commercial varieties are regularly cultivated viz. Ganesh, Bhagawa, Ruby, Arakta, Mridula, Jalore Seedless. Super Bhagawa variety emerged only later. With the rapidly changing socio-economic scenario imposed by climate change, water scarcity, small land holding, etc. this crop is getting popular and thriving well due to its wider adaptability not only in Deccan plateau but also in terai regions of northern hills, and in the dry regions of North-East as it provides unmatched return on investment from unit area of land. Global warming has adversely affected apple cultivation in the lower hills of North India, where farming communities adopted climate resilient horticultural practices by replacing apple orchards with pomegranate crop.

In future the canopy architecture of pomegranate plant is expected to change from its current multi-stem to single stem shrubs: more suitable for ultra-high density planting system similar to meadow orchard in apples or tea gardens. With the rise in human development index projected for 2050, least number of people is expected to be engaged in farming sector; hence mechanization in all farm operations right from planting to harvesting will definitely be required in a big way. Advanced

research on use of robotics for harvesting, sorting and grading must begin in India. In future it is expected that more and more of non-conventional sources of energy viz. solar energy, wind energy or hybrid renewable energy system will be used in farm mechanization as price of fossil fuel would increase alarmingly with time.

It is interesting to note the wide adaptability of pomegranate from temperate regions to semi-arid agro eco system in India due to its xerophyte nature. However, the inherent immunity of these plants is getting hampered due to hi-tech and hi-input cultivation that resulted in severe impact on various biotic stresses. Bacterial blight, once endemic to one locality in India, gained epiphytotic proportions due to continuous monoculture of cv. Bhagwa and use of intensive and sometimes unnecessary inputs. As a result the pomegranate phylloplanes lost important micro-flora, that act as biological agents naturally protecting the plant from many biotic stresses. Unavailability of any resistant source due to only one cultivated species *Punica granatum* is the major bottleneck in breeding of resistant varieties since the wild form of *Punica protopunica* has become extinct now. Besides bacterial blight, it is expected that pomegranate production may experience a severe jolt in the coming years due to wilt infestation which is a complex phenomenon of infection by *Ceratocystis fimbriata*, root knot nematode and shot hole borer. Both bacterial blight and wilt are transmitted mainly through planting material. Lack of stringent nursery certification procedures has resulted in mushrooming of unhygienic, disease free pomegranate nurseries which have played major role in its epidemic spread. Establishment of genuine certified nurseries producing elite disease free planting material will boost pomegranate industry beyond imagination. It may not be impossible to have a breakthrough in mitigating several biotic and abiotic stresses through shift from open field cultivation to protected cultivation practices. Nevertheless, scientists should be ready to tackle new biotic and abiotic stresses as new pests/races and new abiotic stresses may be evolved with the changing hi-tech horticultural practices and changing global climate.

Although transportation by air will continue for export purposes, yet, it is expected that rapid road, rail and sea transport system will make this delicious fruit available at affordable price in every nook and corner of the country. This will also certainly result in reduced carbon fruit print.

Although pomegranate is a very attractive fruit having great visual appeal yet it is classified under difficult to eat category of fruits for fresh consumption (unlike the easy to eat fruits viz. banana and oranges).

Therefore, breeding of new fruit types having loosely attached arils for easy separation could be a possible line of research in near future. Alternatively, varieties with flexible rind, which can be squeezed to release juice from aril sacks *in-situ* for sipping fresh juice using straw just like sipping coconut water, can bring revolution in its fresh consumption. Research efforts all over the world are being focussed on minimal processing of pomegranate arils but additional challenges of this technology are big, with respect to extension of shelf life of arils and food safety. Minimally processed pomegranate arils packed in convenient user-friendly and environmentally sound packaging will emerge as a major commodity in the supermarket in India, possibly at affordable price.

While talking about value addition of pomegranate, sky is the limit. Opportunities for value addition are plenty for total utilization of pomegranate. For example, a farmer with all available modern agri-horticultural technologies can harvest approximately 80 per cent of fruits suitable for export and domestic market. Rest 20 per cent of the harvest is neither marketable nor will fetch any return even to meet the transportation cost for taking this produce up to the market. Potentiality of use of high value nutraceutical compounds and bio-colouring agent in pomegranate peel have not been exploited so far in commercial scale. Similarly, use of high value pomegranate seed oil in either pharmaceutical or cosmetic industries has not yet been explored in India. Formulation of dietary supplements from pomegranate for management of several important human ailments viz. atherosclerosis, diabetes and even cancer may be possible in the coming years.

Although pomegranate can never compete with other conventional and regularly available fruits in India yet in the coming years it may not be surprising to see large number of pomegranate based dietary supplements, cosmetic and pharmaceutical products being readily available on the supermarket shelves. Similarly, in the coming years urban Indian households would routinely include fruit juice or other fruit based RTS beverages in morning breakfast similar to that of the west. Here, pomegranate based products will play a key role due to more and more awareness about anti-ageing/anti-cancer properties of this mighty fruit. Research on total utilization of pomegranate viz. juice, wine, high value pomegranate seed oil and bio-colour and other pharmaceutical products from pomegranate rinds are in progress both in India and abroad.

Due to the tremendous expansion in area under cultivation, improvement in production and productivity in India, pomegranate

based industries must flourish in the vicinity of orchards similar to the wineries in France and other developed countries. The ICAR-National Centre on Pomegranate could reach to its pinnacle for its contribution to a stature of international status to serve as Institute of Pomegranate Research for the service of mankind.

India is one of the largest producers of pomegranate in the world. During 2013-14, pomegranate was cultivated over 1.31 lakh ha with an annual production of 13.46 lakh tonnes and productivity of 10.27 tonnes/ ha in India. At present, Maharashtra is the leading state in acreage covering about 68.7 per cent of the area under pomegranate. Similarly around 70.2 per cent of total production comes from Maharashtra. The other important states next to Maharashtra with respect to pomegranate cultivation are Karnataka, Gujarat and Andhra Pradesh. Considering the current scenario of pomegranate cultivation, the following points are suggested for Vision-2050.

The versatile adaptability, hardy nature, low maintenance cost, steady but high yields, better keeping quality, fine table and therapeutic values and possibilities to throw the plant into rest period when irrigation potential is generally low, indicate the avenues for increasing the area under pomegranate in India.

Area, Production and Productivity of Pomegranate in India:

Area:

India is one of the leading countries in pomegranate acreage and production worldwide. The area under cultivation of pomegranate(Fig.1) has grown up by 35.19 per cent during the last decade, as area increased from 96.9 thousand hectares(2003-04) to 131 thousand hectares(2013-14).

At present, Maharashtra with an area of 90.0 thousand ha is the leading state in acreage and accounts for 68.7 per cent of the total area under pomegranate in the country. Maharashtra experienced a very rapid growth in pomegranate area during the last 23 years from 4.6 thousand ha. (1990-91) to 90.0 thousand ha. (2013-14) (Fig.2). Other major pomegranate growing states are Karnataka (16.62 thousand ha), Gujarat (9.38 thousand ha) and Andhra Pradesh (6.00 thousand ha) (Table 1). In recent years, pomegranate cultivation has also been started in Rajasthan, Orissa, Chhattisgarh, Uttarakhand and Madhya Pradesh at small scale.

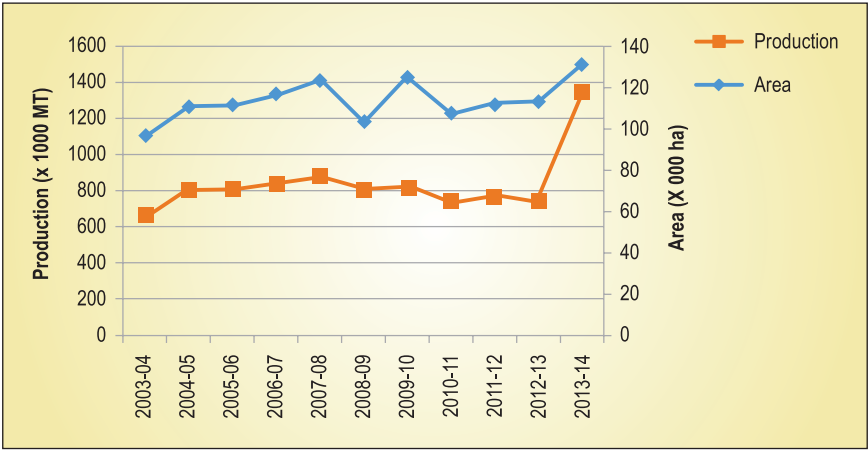


Fig. 1 Area and production of pomegranate in India

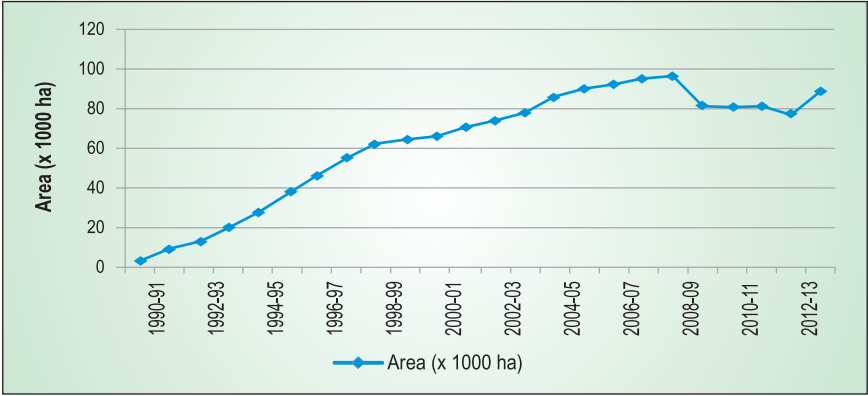


Fig.2 Pomegranate area (x 1000 ha) in Maharashtra from 1990-2014

Important pomegranate growing areas in India:

The important pomegranate growing states (Fig.3) in India are listed below:

Maharashtra: Mainly in Solapur, Nashik, Sangli, Satara, Ahmednagar and Pune and to a limited extent in Osmanabad, Jalna, Beed, Aurangabad, Jalgaon and Dhule districts.

Karnataka: Bijapur, Bagalkot, Koppal, Belgaum, Gadag, Bellary, Raichur, Tumkur, Chitradurg and Davanagere districts.

Andhra Pradesh: Anantpur

Telangana: Mahabubnagar.

Gujarat: Kutch, Banaskantha, Ahmedabad, Sabarkantha and Bhavnagar,

Rajasthan: Hanumangarh and Ganganagar

Tamil Nadu: Salem, Coimbatore and Periyakulam

Himachal Pradesh: Solan, Kullu, Sirmour

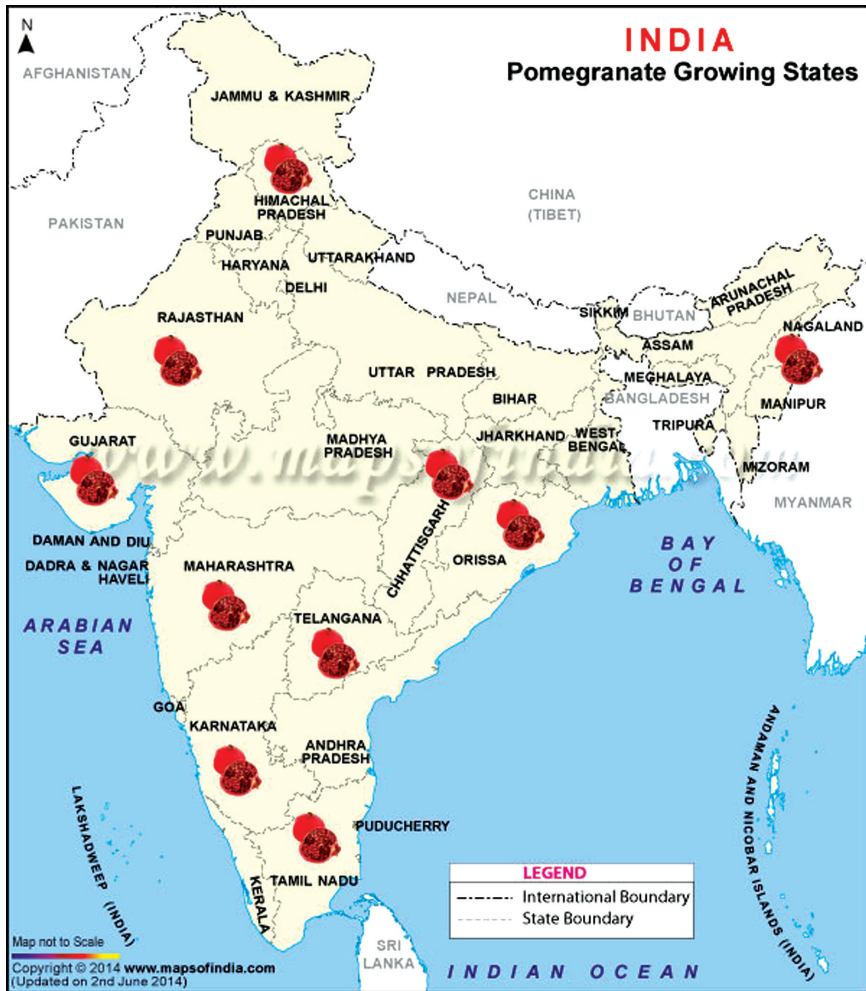


Fig. 3 Important pomegranate growing states in India

Production:

India is the largest producer of pomegranate in the world. During 2003-04 to 2013-14, pomegranate production in India has increased by 102.43 per cent. Production wise Maharashtra ranks first (9,45,000

tonnes) accounting 70.2 per cent of the country's total production, followed by Karnataka (1,34,180 t), Gujarat (99,330 t), Andhra Pradesh (90,010 t), Telangana (25,970 t), Madhya Pradesh (25,290t), Tamil Nadu (13,090 t) and other states contributing for the rest of the production (Table-1& Fig. 4).

Pomegranate was chosen as a “Symbol of the 18th International Horticultural Congress” held during 1970 to highlight its importance in various arenas.

Table 1 Production and productivity of pomegranate in India (2013-14)

Sl. No.	State	2013-14		
		Area (x1000 ha)	Production (x 1000 MT)	Productivity (MT/ha)
1	Maharashtra	90.0	945.00	10.5
2	Karnataka	16.62	134.18	8.07
3	Gujarat	9.38	99.33	10.58
4	Andhra Pradesh	6.00	90.01	15.00
5	Telangana	1.73	25.97	15.01
6	Madhya Pradesh	2.38	25.29	10.62
7	Tamil Nadu	0.40	13.09	32.72
8	Rajasthan	0.91	5.63	6.18
9	Himachal Pradesh	2.20	2.54	1.15
10	Odisha	0.23	0.87	3.78
11	Nagaland	0.12	0.73	6.08
12	Chhattisgarh	0.14	0.51	3.64
13	Mizoram	0.01	0.02	2.00
14	Andaman Nicobar	0.01	-	-
	Total	131	1346	10.27

- **Productivity:** Although India is leading in pomegranate area and production, its average productivity is 10.27 t/ha which is comparatively low. The productivity varies (1.15 -32.72 t/ha) amongst different states. Maximum(32.72 t/ha) productivity has been recorded in Tamil Nadu followed by Telangana (15.01 t/ha), Andhra Pradesh (15.00 t/ha), Madhya Pradesh(10.62 t/ha),Gujarat (10.58t/ha), Maharashtra(10.5 t/ha) and Karnataka (8.07 t/ha).

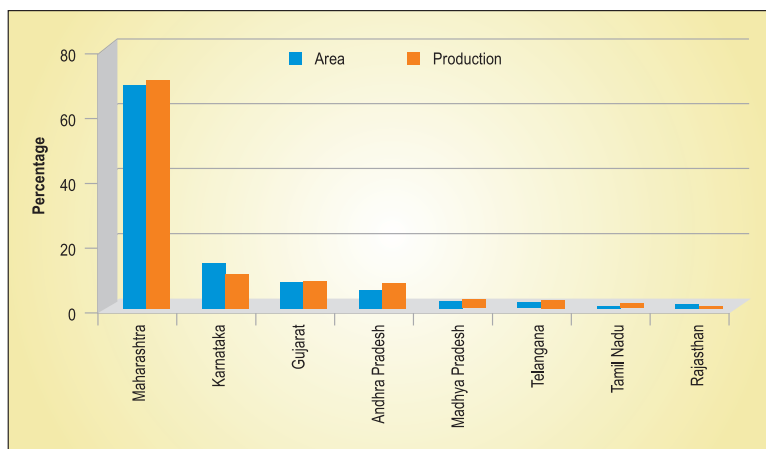


Fig. 4 Per cent contribution of major pomegranate growing states towards pomegranate area and production in India

- **Global status of area, production and export of pomegranate**

Although, the exact figures of area and production in the world are not available but as per approximate global estimates (Table 2), pomegranate production is around 20.55 lakh tonnes from an area of 3.00 lakh ha. At the global level, India is the world's largest producer of pomegranates (743.1 thousand tonnes) followed by Iran (650 thousand tonnes), Turkey (218 thousand tonnes), USA (100 thousand tonnes) and; Afghanistan and Spain (60 thousand tonnes each) during 2011-12. During 2013-14, it was produced over 1.31 lakh ha with an annual production of 13.46 lakh tonnes and productivity of 10.27 t/ha in India.

- **Pomegranate Productivity of different Countries**

Although India is largest producer of pomegranate in the world (Table 2), its productivity (6.9 t/ha) is far below than Turkey (27.25 t/ha), Spain (20.00 t/ha), USA (16.7 t/ha) and Israel (12.5 t/ha) during 2011-12. However, the productivity was increased during 2013-14 (10.27 t/ha).

Export: The major pomegranate exporting countries are Turkey (86,100 t), Iran (60,000t), USA (17,000t), Spain (14,000t) and Israel (4,000t) (Table 2). Despite a surge in the volume of exports from India over the years, the country exported only 4.05 per cent of its total produce (2011-12) which is quite below the export figures of other countries like Turkey (39.5%), Spain (23.2%), Israel (20.0%) USA (17.0%), and Iran (9.23%). During 2012-13, India has exported 35,000 tonnes of pomegranate.



Fig. 5 Export of pomegranate from India

- However, India occupies third position in terms of global export share (22.75%) after Turkey (39.84%) and Iran (45.35%).

Exports from India are mainly to ASEAN, Gulf, European Union and Pacific Rim countries (Japan, South Korea, China), USA and Canada. During the year 2011-12, India exported 30,150 tonnes of pomegranate valued at Rs 1472.68 million. India has witnessed growth of 532.07 per cent in its pomegranate export (Fig. 3) over a period of 10 years (2001 to 2011) but it is only 4.05 per cent of its total production which is quite below the figures of other countries.

Table 2 Global area, production, productivity and export of pomegranate (2011-12)

Country	Area (1000 ha)	Production (1000 MT)	Productivity (MT/ha)	Export (x1000MT)	Per cent Export share	
					Country wise	Global Market
India*	107.3	743.1	6.9	30.1	4.05	22.75
Iran	60.0	650.0	10.8	60.0	9.23	45.35
Turkey#	8.0	218.0	27.25	86.14	39.51	39.84
Afghanistan**	8.0	60.0	7.5	3.0	5.0	2.26
USA	6.0	100.0	16.7	17.0	17.0	12.84
Israel	1.6	20.0	12.5	4.0	20.0	3.02
South Africa	1.3	4.0	3.1	-	-	-
Spain	3.0	60.0	20.0	14.0	23.33	10.58
Tunisia	2.6	25.0	9.61	2.0	8.0	1.51
Australia	0.25	1.0	4.0	-	-	-

Country	Area (1000 ha)	Production (1000 MT)	Productiv- ity (MT/ha)	Export (x1000MT)	Per cent Export share	
					Country wise	Global Market
Argentina	0.80	2.0	2.5	-	-	-
Others	101.15	616.9	6.09	-	-	-
Total	300.00	2500.00	9.36	216.2	-	-

Source: International Trade Probe, Jan.31, 2011. Published by the National Agricultural Marketing Council (NAMC) in cooperation with the department of Agriculture, Forestry & Fisheries, Republic of South Africa. *Chronica Horticulture*, 48 (3). 2008, 12-15.

*Indian Horticulture Database (2010-11)

** International Symposium on Pomegranate and other Minor Mediterranean Fruits, Dharwad, India, 2009.

Republic of Turkey –Ministry of Economy, 2012. Fresh Fruits and Vegetables (production and export).

Changing consumer preference towards pomegranate

- In recent years, the dietary preference to pomegranate has increased manifold due to its enormous health benefits against diabetes, intestinal and cardiovascular disorders. Pomegranate fruit and its juice are well known for its antioxidant capacity and hence becoming popular to prevent cancers of different tissues and organs. This has led farmers to diversify their cropping system with pomegranate cultivation for domestic consumption and export. The concept that pomegranate is a super food has been spreading rapidly among people who are constantly looking for natural products to meet the emerging challenges of many life style diseases. Several processed products *viz.* pomegranate juice, wine and tea are found to be very high value products in the International market particularly due to their nutraceutical properties.

Demand for new technology

- Total utilization of plant biomass for production of value added products from pomegranate is the major challenge ahead. Developing desirable varieties suitable for processed products like juices, RTS beverage, *anardana*, concentrates and wine are of great significance. However, the competitive market economy entails not only improvement in production technology, but also development of post harvest management system to enhance shelf-life, retain quality of the fruit and reduce post-harvest losses. An integrated system, considering both crop and post-harvest management needs to be evolved for capacity building of pomegranate growers. Quality standards for international market have to be improved to step up the export of the fruit.

Export potential

- There are great prospects for increasing the pomegranate export to different countries. As compared to other countries where pomegranate supply is for a restricted period (fall and early winter), India can supply pomegranate to international market throughout the year due to multiple sessions of *bahar* (*Ambia*, *mrig* & *hasth bahar*). In India, the peak production season is during December – March and it continues up to June-July. Thus, India can export pomegranate from February to July when there is no competition from other countries. To enhance export, increasing production of exportable quality fruits and providing postharvest handling facilities are required to be priority areas.



Actions and Achievements of other Sectors

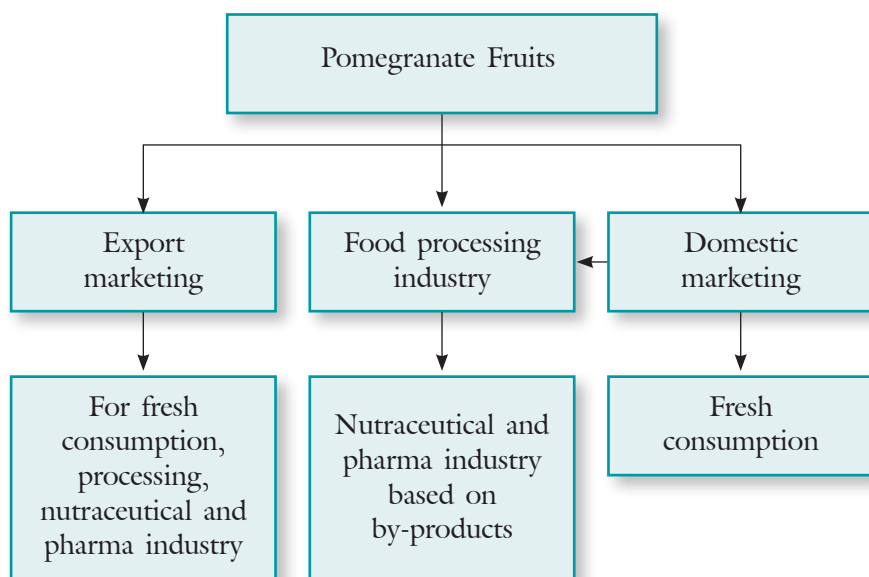
- **National Horticulture Mission (NHM):** The mission envisages an end-to-end approach covering production, post harvest management, processing and marketing to ensure appropriate returns to growers and producers. The NHM has financed the following package/project for the management of bacterial blight disease. i). **Financial package to pomegranate farmers for mitigating bacterial blight:** Visualizing the drastic losses inflicted by devastating bacterial blight disease, Ministry of Agriculture, had approved and sanctioned a financial package of Rs 50,000/ha to the pomegranate growers of the states of Maharashtra, Karnataka and Andhra Pradesh for adopting Good Agricultural Practices (GAP) for blight management for three years during 2007-2010. ii) **Network project on mitigation of bacterial blight:** Ministry of Agriculture approved a Network project for mitigating bacterial blight in the states of Maharashtra, Karnataka and Andhra Pradesh with ICAR-NRCP Solapur as its coordinating centre. After approval it was financed by the NHM under operation in respective states. The other sub-centres included MPKV Rahuri, MAU Parbhani, IIHR Bangalore, UAS Dharwad, and APHU Andhra Pradesh. The project initiated in 2008, was initially for two years; however, was further extended to third year and concluded in October 2012. The network project resulted in effective management of bacterial blight with increased yields in adopted orchards through adoption of Integrated Disease and Insect Pest Management (IDIPM) schedule.
- **Agricultural and Processed Food Products Export Development Authority (APEDA):** APEDA is an autonomous organization with main function to establish links between Indian producers and consumers in the global market. It is mandated with responsibility of export promotion and development of horticultural and other agricultural product. ICAR-National Research Centre on Pomegranate, Solapur, has provided all relevant inputs to APEDA on pomegranate production and protection for promotion of exports.

- **Regulation of Export of Fresh Pomegranate to the European Union through Control of Pesticide Residue:** The document contains detailed procedure for export of pomegranate from an orchard to export destination including information on 'Pesticides recommended for the control of various diseases and insect-pests of pomegranate' along with their maximum residue limit (MRL) and pre harvest interval (PHI) values. ii) Anarnet: Anarnet is an internet based electronic service offered by the APEDA to the stakeholders for facilitating testing and certification of pomegranate orchards for export from India to European Union in compliance with the standards identified by the National Referral Laboratory of NRCG, Pune.
- **Maharashtra Pomegranate Growers' Research Association, Pune, Maharashtra:** It is an association of pomegranate growers with head office in Pune. It looks after the welfare of pomegranate growers with respect to promotion of pomegranate cultivation by helping them in procurement of agricultural inputs, disease free planting materials and other technical consulting services. It publishes quarterly pomegranate news magazine (*Dalimbvritta*) in Marathi language. Apart from this, recently an All India Pomegranate Growers Research Association has been formed for the benefit of all the stakeholders associated with cultivation/trading of pomegranate in India and abroad.



Value Chain Management

Pomegranate production will be highly organized with large scale contract farming through various modes to offer assured supply to the international market or domestic processing industry. This contract farming will assure constant supply in international, domestic market, processing and other allied industries dependent on pomegranate.



Predicted Outcome

The following outcome are probably expected in the pomegranate sector in the days to come. The phase-wise changes likely to happen during 2030, 2040 and 2050 are enlisted below.

Year 2030:

- Area expansion : the area under pomegranate is expected to increase to around 7.5 lakh ha.
- Production: production may go upto 15 million tonnes
- Productivity : Productivity may go up to 20.0 t/ha
- Export : 1.5-2.0 lakh tonnes
- Value addition: Pomegranate seed oil, pomegranate candies, oral health care products & other novel products
- Price: price per kg would come down due to surplus production
- Cost Benefit Ratio : The cost benefit ratio may go from the current 1: 5 to 1:10
- Reduction in risk of coronary diseases due to increased intake of pomegranate

Year 2040:

- Area expansion: the area under pomegranate is expected to increase to around 9.0 lakh ha
- Production : production may go upto 22.5 million tonnes
- Productivity: Productivity may go upto 25.0 t/ha
- Export : 2.5-3.0 lakh tonnes
- Value addition : new value added products, viz., Pomegranate seed oil capsules, pomegranate tea, pomegranate mouthwash, antiseptic solutions, digestive medicines, dermal health care products, seed oil derived products, etc
- Price: price per kg would come down due to surplus production and enhanced productivity
- Below poverty line: Due to rise in standard of living, the proportion of below poverty line population would diminish.
- Cost Benefit Ratio : The cost benefit ratio may prevail around 1:13

- Reduction in risk of coronary diseases, cancer, *etc.*, due to increased intake of pomegranate

Year 2050:

- Area expansion: the area under pomegranate is expected to increase to around 10.0 lakh ha
- Production : production may go upto 30 million tonnes
- Productivity : Productivity may go upto 30.0 t/ha
- Export : 4.5-6.0 lakh tonnes
- Value addition : Pomegranate mixed juice, pomegranate flavoured products, pomegranate supplemented pharmaceutical products, rind powder derived products
- Industrialization : Pomegranate processing industries viz., juice plant, RTS plant, packaging plant, etc
- Employment opportunities: The number of households dependent on pomegranate based industries may increase sizeably.
- Price: price per kg would come down due to surplus production and enhanced productivity. Pomegranate.
- Cost Benefit Ratio : The cost benefit ratio may prevail around 1:16
- Reduction in risk of coronary diseases due to increased intake of pomegranate
- Threat of new insect pests, strains of pathogen due to extensive cultivation of pomegranate



Impact on African Countries

Pomegranate industry in African countries is in its infancy and the growers are facing problems like pests (thrips) and diseases (bacterial blight). The varieties like Wonderful and Herschkovitz are suitable for African conditions. Realizing the importance of pomegranate cultivation in supporting the economy of the nation, The South African Pomegranate Producers' Association was already established in 2010. The quality standards and phytosanitary standards were developed in 2012.

Presently, the industry is further constrained by the still-underdeveloped local market. Mostly, fresh fruits are exported to the EU, UK, Russia, Canada and Middle East, besides processing-grade fruits are exported for aril extraction to EU and UK fresh pack markets. Although pre-packed fresh arils are consumed in South Africa, the local market is still relatively small and the price for fresh arils in punnets is relatively high.

Exports can be lucrative early in the season (February to March). However, later in the season, fruit from South American countries such as Peru and Chile enters the market, which drives the price down. While it is anticipated that the popularity of pomegranates will continue to climb due to the health benefits. Sound technological support on pomegranate cultivation would strengthen the economy of African countries. African countries could become major exporters if they can optimize the production quality of fruits in large volume.

The shrinking land resources in India will lead to land leasing in African continent for horticultural activities by large industrial players this will generate numerous opportunities of employment generation in African continent.



Science based endowment for pomegranate in Maharashtra

ICAR-NRCP was established in 2005 for development of scientific management practices. The package of practices developed for scientific pomegranate cultivation is available for the pomegranate growers and other stakeholders. Some of them include,

- Standardization of *in vitro* propagation cum bio-hardening technique
- Deficiency symptoms for identification of micronutrient deficiencies
- Exploitation of bio-agents for crop management
- Integrated Nutrient Management & Fertigation technique
- Water management through micro-irrigation system
- Canopy management in pomegranate
- Integrated disease and insect pest management
- Total utilization through Post harvest management and value addition
- Transfer of technology (including on-campus and off-campus training, scientific seminars, etc.)



Other Concerns

- **CO₂ emission per unit area**

Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. Total organic carbon (TOC) is a sum measure of the concentration of all organic carbon atoms covalently bonded in the organic molecules of a given sample of water. TOC measurement is achieved by oxidizing a sample of water, thus converting the organic constituents to carbon dioxide (CO₂).

Pomegranate cultivation is expected to bring desirable changes in the CO₂ emission over unit area. Thus, it is of immense use in protecting from the risks of global warming and in preserving the environment.

- 6.76 t CO₂ emission per ha of presently cultivated land is the CO₂ emission rate of pomegranate.
- Organic carbon need to be enhanced by at least 15-20% in order to reduce CO₂ emission by 2050.

- **Average ROI per unit area**

The average ROI per unit area may be around 4:1 to 6:1 by adopting scientific management practices and post harvest management. By 2050, the benefit cost ratio may vary from 10:1 -15:1 due to the usage of technological interventions and improved varieties.

- **Fate of organic carbon status in 2050**

The soil organic carbon (SOC) pool is a key indicator of soil quality as it affects essential biological, chemical and physical soil functions such as nutrient cycling, pesticide and water retention, and soil structure maintenance. The information on the SOC pool, and its temporal and spatial dynamics is unbalanced. However, it is highly possible to improve the organic carbon content of the soil through organic cultivation of pomegranate, Use of compost/ vermicompost, use of green manuring, intercropping with leguminous crops, organic mulching, etc. in the year 2050.



Strength of India

- In India, pomegranate is cultivated over 1.31 lakh ha with a production of 13.46 lakh tonnes and a productivity of 10.27 t/ha.
- Pomegranate is currently ranked 10th in terms of fruit consumed annually in the world. India is the only country in the world where pomegranate is available throughout the year ie. From January to December. It is cultivated in 3 seasons (*Ambia bahar*, *Mrig bahar* and *hasth bahar*) in Deccan plateau of India.
- India is endowed with wide agro climatic conditions that offer immense scope for cultivation of various kinds of fruit crops. This provides an excellent platform for the country to emerge as a leading producer of fruit crop.

Pomegranate fruit is symbol of abundance and prosperity and very much liked for its cool, refreshing juice and valued for its medicinal properties. Its popularity is also due to the ornamental nature of the plant which bears bright red, very attractive flowers.

- At global level, India is the world's largest producer of pomegranates, followed by Iran.
- The versatile adaptability, hardy nature, low maintenance cost, steady but high yields, better keeping quality, fine table and therapeutic values and possibilities to throw the plant into rest period when irrigation potential is generally low, indicate the avenues for increasing the area under pomegranate in India.

India is the only country in the world where pomegranate is available throughout the year (January – December).



Necessity for Vision 2050

Considering the consumption of pomegranate, average age of orchard, number of persons dependent, reducing cropping duration, etc., there is an urgent need to trigger new areas of research which remains untapped.

- Consumption: Pomegranate consumption would be increased manifold (5-10 times more) whereas the cereals/ other food items intake may fall (50%)
- Average age of orchard: The average age of orchard may prolong from the current 8-10 years to 15-20 years
- No. of persons dependent: Not less than 10% of the Indian population may become dependent on pomegranate cultivation and processing industries.
- Reducing cropping duration: Using Doubled Haploidy (DH) lines of improved varieties, new varieties would be developed by reduced breeding cycle. Precocious varieties of 2-3 months may become available for cultivation.
- Pomegranate is a high value crop. Its nutritive and therapeutic properties can be of immense use in the pharmaceutical and nutraceutical industries and hence it requires long-term strategy.
- In order to mitigate the challenges of climate change and global warming, climate resilient technologies are required to be developed.
- Pomegranate being a perennial crop, breeding resistant varieties against biotic and abiotic stresses requires long-term strategy. Breeding of short duration varieties would help overcome the problems of fruit cracking due to weather extremes in Rajasthan, etc.
- Development, assessment and refinement of production/protection/post harvest technology, their validation and final adoption needs more time for sustainable economic benefits to stakeholders.
- In order to expand pomegranate cultivation to non-traditional potential areas having marginal and degraded lands, long term strategies are essential.
- To harness the integrated benefit of science with particular reference to biotechnology, nanotechnology, information and communication technology *etc.* long-term vision is required for improvement in pomegranate production and productivity.

- Generation of new ideas and achieving breakthroughs with respect to development of innovative technologies/new products, are both long-term processes.
- New areas of research may include, Doubled Haploidy for development of homozygous lines; Resistance breeding for development of multiple disease resistant variety; Marker Assisted Selection for screening the germplasm and crop improvement; Development of new value added products, etc.



Way Forward

Considering the present status of pomegranate cultivation and current strength of India, the following points are suggested for Vision-2050.

- Introduction of *Punica protopunica*, wild pomegranate from Socotra Island and its conservation for further utilization in breeding programme. This has to be used for screening against bacterial blight disease and may also be used for widening the genetic base of pomegranate by interspecific hybridization
- Harnessing of natural biodiversity: Survey, collection and conservation of 'field variants/ off-types' of pomegranate with desirable traits (high yield, better quality, tolerant to diseases etc.) from farmer's field.
- Identification of resistant/ tolerant source for bacterial blight disease of pomegranate caused by *Xanthomonas axonopodis* pv. *punicae* through rigorous screening of all indigenous collection (IC), exotic collection (EC), etc. using challenge inoculation method and / or suitable molecular techniques.
- Large scale raising of seedling population of the probable source of tolerance (Nana, Daru) to bacterial blight and rigorous screening against bacterial blight.
- Development of hybrids resistant/ tolerant to bacterial blight through hybridization between commercial cultivars and bacterial blight tolerant genotypes available in the field gene banks (FGB)
- Development of wilt resistant varieties of pomegranate and screening the germplasm for wilt tolerance.
- Development of transgenic pomegranate variety resistant to pests (pomegranate fruit borer) and diseases (Bacterial blight, wilt)
- Development of varieties/hybrids free from physiological disorders viz., fruit cracking, internal breakdown, sunscald
- Development of pomegranate varieties / hybrids suitable for table purpose with enhanced yield and better quality.
- Development of pomegranate varieties/ hybrids suitable processing purpose: Varieties with better juice recovery for juicing purpose; Varieties with soft seeds, high acidity (>3.0%) suitable for *anardana* purpose; varieties with high sugar content and moderate acidity suitable for wine making.

- Identification and involving of pomegranate varieties with highly pliable rind for development of hybrids resistant to cracking.
- Development of pomegranate varieties bearing fruits of multi-coloured arils (so that it is preferred over monocolour arils).
- Varieties for hostile climate: Development of pomegranate varieties withstanding the challenges of climate: tolerant to frost, hailstorm injury; tolerant to flood/ water stagnation.
- Development of pomegranate varieties with only hermaphrodite flowers (without male flowers & intermediate flowers) so that fruitset occurs in all the flowers after pollination / fertilization and ultimately boost the yield.
- Development of pomegranate varieties with less sugar content (suitable for diabetic patients) so that juice and arils are suitable for diabetic patients.; Development of pomegranate varieties rich in carotenes (so that it helps aged people for vision); Development of pomegranate varieties with more affinity for specific nutrients and that results in fruits rich in specific nutrients: calcium rich fruits for lactating mother; iron, iodine rich fruits for pregnant women;
- Value added products from pomegranate: Pomegranate flour for use as baby food (similar to banana flour); Pomegranate tonic for growing children; pomegranate candies / fruit bars; pomegranate chewing gums; tablets for preparing instant pomegranate tea; with high carotenes for aged people with blurred vision;
- Development of ornamental pomegranate varieties: Double flower, Nana type, bonsai types etc suitable for indoor gardening, hanging baskets, *etc.*
- Development of short, medium duration varieties of pomegranate by hybridizing with 'precocious' early types so that ROI is quicker;
- Special pomegranate varieties : Development of extra-dwarf varieties suitable for 'meadow orchard'; Development of varieties suitable for protected cultivation in shadenet house, polyhouse;; Development of varieties suitable for hydroponics technology
- Development of new varieties/ hybrids with resistance to biotic and abiotic stresses using Marker Assisted Selection, Marker Assisted Back Cross, Marker Assisted Recurrent Selection, gene pyramiding, Genome wide selection for interested traits for crop improvement; Gene silencing technique to address the problem of bacterial blight, fruit borer, *etc.*; Development of complete linkage map for chromosomes of pomegranate; Understanding the population structure and evolutionary relationship of accessions;

Use of genomics (structural, functional & comparative) for basic, applied & strategic research;

- Development of Doubled Haploidy (DH) lines in pomegranate for reduction of breeding cycle and release of varieties as per the need
- Improving water use efficiency (WUE) of pomegranate during different phonological stages and seasons
- Enhancing nutrient use efficiency (NUE) of pomegranate for sustainable production
- Enhanced production strategy based on INM and increased NUE, WUE for sustainable production
- Establishing mother nurseries for production and supply of quality planting material
- Expansion of pomegranate to potential non-traditional areas: Kullu and other apple growing areas in HP, other areas of western Himalaya would be covered with pomegranate due to climate change.
- Use of renewable energy sources for production and processing of pomegranate
- Mechanized farm operations for pesticides spray, pruning and harvesting of pomegranate
- Community farming in pomegranate: Due to high cost, pomegranates are affordable only to high class people; by 2050, the fruits would be affordable and consumed by all (including below poverty line people) due to reduction in cost/ price; thus, domestic consumption will be more; Integrated farming system approach including animal husbandry, poultry, fisheries and pomegranate
- It will be a regular fruit in breakfast plate by 2050 (similar to mango, banana, guava)
- Intensification of organic production thereby soil organic carbon will increase upto a level in equilibrium with the existing environmental condition.
- The large scale pomegranate processing industry will come up in the country along with fragmented small scale processing units in production catchment areas
- Potential of pomegranate will be utilized to the fullest extent for nutraceutical purpose and medicines from pomegranate for heart diseases, cancer, oral health, skin health, reproductive health will be commonly available and become multi billion industry.
- All the processing units will utilize pomegranate completely making it highly profitable venture and thereby reducing the cost of processed products.

Way forward:

- Bridging scientific and technology gap
- Strategic partnership and alliances – PPP & international institutions
- Problem solving, demand driven and futuristic research
- Expansion of pomegranate cultivation in non-traditional areas
- Establishment of model nurseries
- Pomegranate based industry for high value products

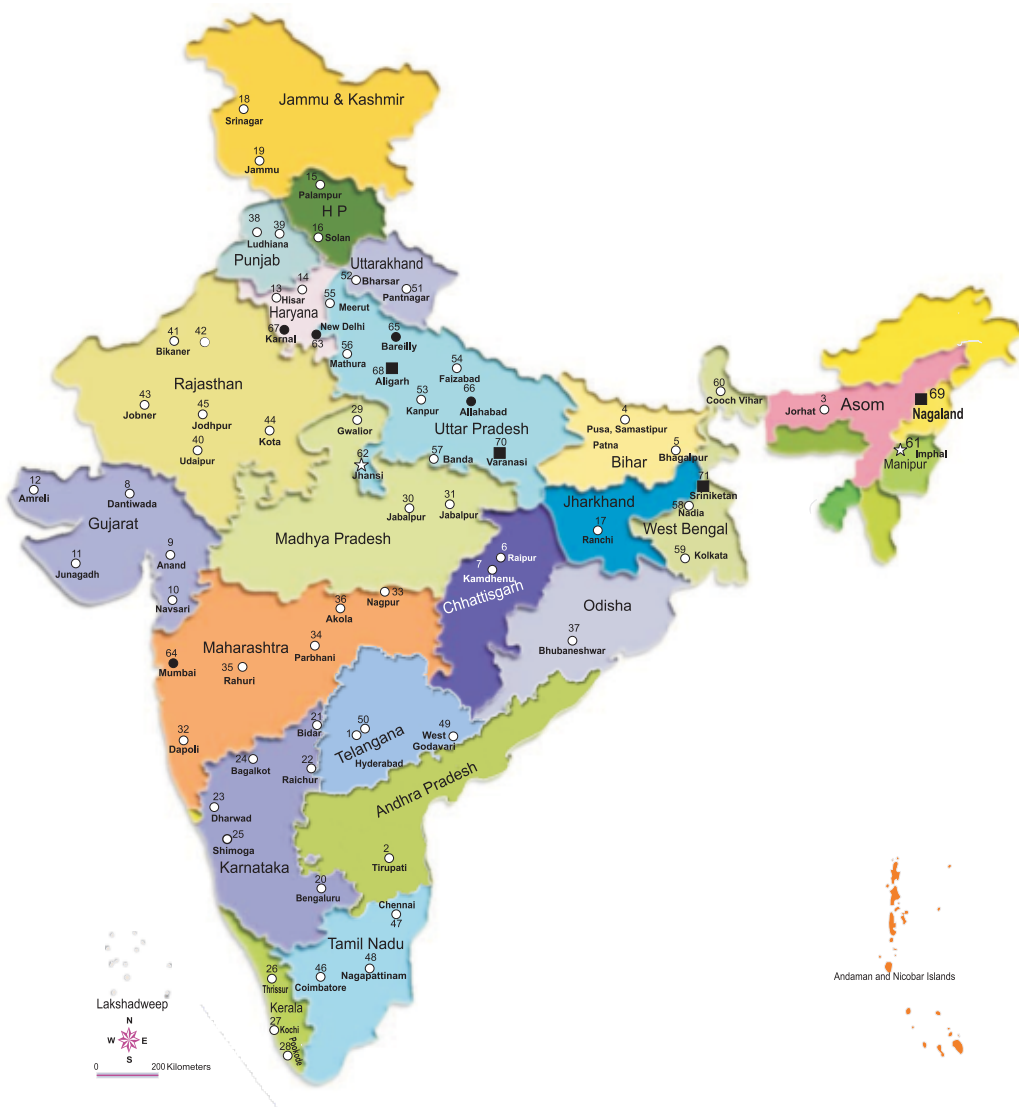
Imagine pomegranate fruits with good size (500 g), bright crimson red colour, soft seed, easy to peel and separate arils, resistant to blight with enhanced bio-active components.





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