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Report of Quinquennial Review Team

(01.04.2012 To 31.03.2017)

भाकृअनुप
ICAR

ICAR-Directorate of Onion and Garlic Research

Rajgurunagar–410 505, Pune, Maharashtra, India

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(Indian Council of Agricultural Research)

Rajgurunagar–410 505, Pune, Maharashtra, India

Acknowledgement

The Quinquennial Review Team (QRT) is grateful to the Director General and Deputy Director General (Hort.), Indian Council of Agricultural Research (ICAR), New Delhi for providing opportunity to review the progress of work under the ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune and Network Project for the period from 1 April, 2012 to 31 March, 2017.

The team acknowledges the assistance, co-operation and help received from the Director, Scientists and Administrative staff of ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. The team also puts on record its appreciation to MPKV, Rahuri, TNAU, Coimbatore, JAU, Junagadh, IGKV, Raipur, RARI, Durgapura, CSAUAT, Kanpur, PAU, Ludhiana, UAS, Dharwad, RARI, Jaipur and CITH, Srinagar for technical and logistics support extended during the visits of QRT . The review team acknowledges the Division of Horticulture, ICAR for the necessary help extended. QRT has great pleasure in completing the task assigned to it and submitting the report for the consideration and further necessary action.

(D.P. Ray)
Member

(K.E. Lawande)
Member

(T. Marimuthu)
Member

(R.D. Gautam)
Member

(Kirti Singh)
Chairman

(Vijay Mahajan)
Member-Secretary

Pune
01-08-2018

Preface

The ICAR-Directorate of Onion & garlic (ICAR-DOGR) is the research institute under ICAR with a national mandate on onion and garlic and its main focus is to strengthen research on all aspects of onion and garlic under irrigated conditions.

The Indian Council of Agricultural Research constituted by ICAR, vide ICAR Office Order No. F.No.HS/1-7/2016-IA.V dated 27 September, 2017, to review the progress of research work done by ICAR-DOGR and AINRPOG for the period from 2012 to 2017 and to suggest area of strengthening the research programme with Chairman QRT, Dr. Kirti Singh, Former Vice Chancellor & Chairman, ASRB, members were: Dr. D.P. Ray, Former Vice Chancellor, OUAT, Dr. K.E. Lawande, Former Vice Chancellor, DBSKKV, Dapoli & Director, ICAR-DOGR, Prof. T. Marimuthu, Former Dean, School of Post-Graduate Studies and Director, Centre for Plant Protection Studies, TNAU and Additional Director, World Noni Research Foundation, Dr. R.D. Gautam, Former Professor & Head, Entomology, ICAR-IARI and Dr. Vijay Mahajan, Pricipal Scientist, ICAR-DOGR as Member Secretary. This is the fourth QRT constituted by Council for ICAR-DOGR and the earlier three reviews were conducted during 2002, 2006, and 2012. The Team visited ICAR-DOGR Laboratories, experimental plots, onion and garlic farmers' fields, AINRP Centre on Onion and Garlic and held discussions with stakeholders of these crops.

The QRT is grateful to Dr. T. Mohapatra, Secretary DARE and Director General, ICAR, New, Delhi for providing an opportunity to review the work carried out at ICAR-DOGR, Rajgurunagar, Pune during 2012 to 2017. The Team is thankful to Dr. A. K. Shingh, Deputy Director General (Hort.Sc.), ICAR and Dr. T. Janakiram, Asst. Director General (Hort. Sc.-II) ICAR for arranging a Preliminary Meeting at ICAR, New Delhi and Guiding the Team in conducting the review in the right direction.

The help rendered by Dr. Major Singh, Director, ICAR-DOGR, Rajgurunagar, Pune in making arrangements for smooth conduct of review is duly acknowledged. Thanks to scientists of ICAR-DOGR and AINRPOG centres and other staff for their coordination during the review. Mr. Dilip Mundharikar, Private Secretary and Mr. H. S. C. Shaikh, AAO and administrative staff for providing secretarial assistance.

The Team could gain knowledge about the research activities of the Institute, study the crop well, as well as understand the onion and garlic sector in the country. Accordingly, in this report, we are putting forth our observations, suggestions and priorities for research and development of onion and garlic in the country.

(D.P. Ray)
Member

(K.E. Lawande)
Member

(T. Marimuthu)
Member

(R.D. Gautam)
Member

(Kirti Singh)
Chairman

(Vijay Mahajan)
Member-Secretary

Pune
01-08-2018

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Executive Summary

A Quinquennial Review Team (QRT) was constituted by ICAR (vide ICAR Office Order No. F.No.HS/1-7/2016-IA.V dated 27 September, 2017) to review the progress of research work done by ICAR-DOGR and AINRPOG for the period from 2012 to 2017 and to suggest area of strengthening the research programme. The Committee was chaired by Dr. Kirti Singh, Former Vice Chancellor & Chairman, ASRB, members were: Dr. D.P. Ray, Former Vice Chancellor, OUAT, Dr. K.E. Lawande, Former Vice Chancellor, DBSKKV, Dapoli & Director, ICAR-DOGR, Prof. T. Marimuthu, Former Dean, School of Post-Graduate Studies and Director, Centre for Plant Protection Studies, TNAU and Additional Director, World Noni Research Foundation, Dr. R.D. Gautam, Former Professor & Head, Entomology, ICAR-IARI and Dr. Vijay Mahajan, Pricipal Scientist, ICAR-DOGR as Member Secretary. The QRT, at the outset, observed that realizing the importance of these commodities in the country, Indian Council of Agricultural Research established National Research Centre (NRC) for Onion and Garlic in VIII Plan with its headquarters at Nasik. However, due to technical and working constraints, the Centre could not be established well at Nasik and was shifted to Rajgurunagar in June 1998. It is located at 553.8 m above MSL with temperature ranging from 5.5 °C to 42.0 °C and an annual mean rainfall of 669 mm. Considering the achievements of the centre, importance of the commodities in trade and intricate future challenges, the NRC was further strengthened and upgraded as Directorate of Onion and Garlic Research (ICAR-DOGR) in 2009 along with All India Network Research Project on Onion & Garlic (AINRPOG) having 13 centres including coordinating unit at ICAR-DOGR and 16 voluntary centres in XI Plan and at present have 12 main and 14 voluntary centres. Over a decade, the centre has created infrastructure facilities of high level and has contributed significantly in increasing the production and productivity of onion and garlic in the country by developing improved varieties, new agricultural practices and by imparting training to the stakeholders. The centre has identified sustainable and eco-friendly practices for production as well as post-harvest management of onion and garlic to enhance profitability and welfare of the farming community. In XII plan, the project was continued with addition of some new centres with special attention to North Eastern Region to increase onion and garlic production in non- traditional areas.

Onion and garlic are the most important vegetable crops used as an ingredient in various dishes. India is the second largest producer of Onion and Garlic after China with the production of 22.43 million tonnes of onion and 1.70 million tonnes of garlic during 2016-17. The major onion growing states are Maharashtra (6.7 mt), Madhya Pradesh (3.72 mt), Karnataka (3.04 mt), Gujarat (1.29 mt) and Bihar (1.25 mt). The major garlic growing states are Rajasthan (0.73 mt), Madhya Pradesh (0.41 mt) and Uttar Pradesh (0.20 mt). India is projected to have a population of 1.7 billion by 2050 and there is no possibility to increase the cultivable land. In order to catch the requirement of our increasing population, India needs to produce 24.62 million tonnes by 2050. Apart from domestic requirement, there is large demand for export. The country earned 4,651 crores through export of onion during 2017-18. On account of being second largest producer and exporter, we cannot be self-complacent, as there are many challenges associated with production and trade of these commodities. Inherent low yield, susceptibility to biotic and abiotic stress, high storage losses, are some of the factors that fluctuates its production.

ICAR-Directorate of Onion and Garlic Research (ICAR-DOGR) has developed ten onion varieties (Bhima Light Red, Bhima Dark Red, Bhima Raj, Bhima Red, Bhima Super, Bhima Kiran, Bhima Shakti, Bhima Shweta, Bhima Shubhra and Bhima Safed) and two garlic varieties (Bhima Omkar and Bhima Purple) based on genetic improvement during the period of review. All these varieties have been released at National level. ICAR-DOGR has identified five novel genetic stocks with different characteristics, developed eight hybrids which are being evaluated under AINRPOG multi-location trials and identified the genotypes resistant to biotic and abiotic stresses. ICAR-DOGR has succeeded in developing different technologies such as *kharif* onion production technology, integrated nutrient management technology for *rabi* onion, integrated nutrient management technology for garlic, micronutrient management for *rabi* onion, micro irrigation and fertigation for onion and garlic, integrated weed management technology for onion, integrated pest and disease management, haploid induction in onion and sensitive diagnostics against viruses.

The Directorate has licensed Bhima Super variety to M/S Jindal Crop Sciences Pvt. Ltd and Bhima Red to M/S Safalmantra Agro Farms Pvt. Ltd for seed production and marketing through non-exclusive license. Motorised Onion grader has been licensed to M/S R.K. Engineering Works for manufacturing and marketing through non-exclusive agreement. ICAR-DOGR has distributed 9482 kg onion seed and 23656 kg planting material (onion bulb) to farmers during 2012-17. ICAR-DOGR has also got ISO certificate, registered ICAR-DOGR logo as trademark and also developed MobileApp during last five years.

The first meeting was held at New Delhi on 6 October, 2017 with DDG (Hort.) and ADG (Hort.) to have the first hand information and planning of the review. QRT visited ICAR-DOGR units located at Rajgurunagar and reviewed the progress made during the period of review. Subsequently, the QRT visited most of centres located in various states and interacted with Vice-Chancellors, Directors, Directors of Research, Directors of Extension Education, Deans, Head of the Departments, Principal Investigators, Scientists and Farmers of nearby areas in the vicinity of centres.

After thorough review of the ICAR-DOGR and AINRPOG, QRT has made 27 recommendations (Page 46-48) to enhance the quality of research on onion and garlic. Only few major recommendations are mentioned here: (i) Upgrading ICAR-DOGR to the Institute level with more scientific, technical, administrative and supporting staff for intensifying the research (ii) Establishment of Regional Centre at Leh in Ladakh for long day onion and garlic research (iii) Strengthening the infrastructure facilities such as expansion of present building, storage structures, auditorium and guest house (iv) Strengthening of research on processing and value addition in onion and garlic (v) Production of virus free seed in garlic, introgression breeding are the priority areas identified for the next decade (vi) Conversion of IGKV, Raipur and MPKV, Rahuri voluntary centres in main regular centres (vii) Increase in budget in view of rising input and labour costs.

1 Introduction

The Indian Council of Agricultural Research (ICAR), New Delhi, vide Office Order F.No.HS/1-7/2016-IA.V dated 27th September, 2017 constituted the Quinquennial Review Team (QRT) to review the work done during the period 01.04.2012 to 31.03.2017 by the Directorate of Onion and Garlic Research (DOGR) and All India Coordinated Research Project on Onion and Garlic [AINRPOG]. The composition of the team is as follows (Annexure-I):

1.	**Dr. Kirti Singh** Former Vice Chancellor & Chairman, ASRB, 38-G, Maruti Nagar, T.D. College Main Gate, Husenabad, Jaunpur – 222 002, (U.P.)	Chairman
2.	**Dr. D.P. Ray** Former Vice Chancellor, OUAT, HIG-105, K-5, Kalinga ViharBhubneswar – 751 019 (Odisha)	Member
3.	**Dr. K.E. Lawande** Former Vice Chancellor, DBSKKV, Dapoli & Director, ICAR-DOGR, Rajgurumagar, Pune	Member
4.	**Prof. T. Marimuthu** Former Dean, School of Post-Graduate Studies& Director, Centre for Plant Protection Studies, TNAU &Additional Director,World Noni Research Foundation, 12, Rajiv Gandhi Road, Sreenivasa Nagar, Chennai – 600 096	Member
5.	**Dr. R.D. Gautam** Former Professor & Head, Entomology, ICAR-IARI,New Delhi	Member
6.	**Dr. Vijay Mahajan** Pr. Scientist, ICAR-DOGR, Rajgurunagar, Pune	Member-Secretary

Terms of Reference

(i) Research relevance and budget allocation
(ii) Policies priorities and strategies
(iii) Relationship/collaboration with SAUs and other stakeholders
(iv) Linkages with clients/end-users
(v) Proposed changes in organization programmes and budget
(vi) Organization and management
(vii) Constraints
(viii) Looking forward
(ix) Research relevance and budget allocation

2 Action Taken Report on Previous QRT

The composition of III QRT for the period 1.4.2006 to 31.3.2012 of ICAR-DOGR has been communicated vide office order F.No.1(11)/2011-IA.V dated 14th October, 2011 to review the work done at Directorate of Onion and Garlic Research, Rajgurunagar and AINRPOG during the period 1.4.2006 to 31.3.2012. The DOGR and AINRPOG have implemented recommendations of previous QRT in letter and spirit.

The action taken report on the recommendations of previous QRT along with Councils comments is given below:

CROP IMPROVEMENT

1. Recommendations: Continuous efforts should be made to strengthen the germplasm of cultivated, semi cultivated and wild species of genus Allium both from indigenous and exotic sources. Entire germplasm (exotic/ indigenous) should be screened for desirable horticultural traits and also for major viral and fungal diseases for breeding programme. All the members of QRT appreciated the efforts of the Chairman, Dr. Brahma Singh for collecting onion germplasm from a remote area Araku Hills of Vizag (A.P.) and handing over to the Director, DOGR for research work

Councils Comments: Agreed. The work is already in progress. It will be done more systematically.

Action Taken: Extensive survey for collection of Allium germplasm from Sikkim, West Bengal, Arunachal Pradesh, Assam, Kashmir, Leh and Ladakh were done and collected 153 accessions including cultivated as well as 28 wild/ semi wild types. 564 onion and 625 garlic germplasm were screened for desirable horticultural traits and catalogue were developed in form of Technical Bulletin. These germplasm are being maintained at ICAR-DOGR and at NBPGR Regional Centre Bhowali. 139 lines consisting of 17 wild/semi cultivated Allium species were collected from within the country as well as 13 species imported from USA, Netherlands and Germany are being maintained under field conditions. 27 lines of eight species are flowering under short day plants. These are being evaluated for diseases and pest resistance and for foliage consumption. 2 lines of *A. tuberosum* and one line of *A. angulosum* were promising. 1000 germplasm were received from NBPGR during 2016 & 2017 and are being evaluated for various desirable traits. Long day onion & garlic germplasm including exotic lines are being evaluated and maintainesd at CITH, Srinagar. 9 lines for *Stemphylium* blight and anthracnose under field conditions were moderately resistant. Out of 32 wild accessions screened under poly house conditions, 3 were moderately resistant for anthracnose. 25 lines identified for earliness, less bolting and double bulbs. Besides DOGR, 713 onion and 631 garlic germplasm were evaluated at 11 different centres. Out of these 72 germplasm of onion, 35 multiplier onion and 73 of garlic were identified superior for different characters. In garlic core group has been formulated which includes 46 genotypes comprising 95% genetic diversity of entire germplasm further corset subjected to biochemical characterization. Two lines identified for high allicin.

2. Recommendations: Emphasis should be given to develop resistant varieties of onion and garlic for abiotic (high and low temperature, high humidity, bad soils etc) and biotic stresses like important insect pests (thrips, aphids) and diseases (purple blotch, stemphyllium blight, anthracnose, etc).

Councils Comments: Agreed. Plant pathologist's post will be filled shortly to initiate work on abiotic stress tolerance.

Action Taken: Onion lines were screened for bolting tolerance during late *kharif* with five dates of planting. Two lines *viz.*; DOGR-1168 and DOGR-595 were recommended for bolting tolerant along with Bhima Kiran & Bhima Shakti and found highly suitable for late *kharif* and *rabi* season. In white onion lines White Genepool LG-107-4, W-448 LG-107-4 and Bhima Shweta LG-107-4 were bolting free during late *kharif*. Two advance lines KHM-2 and RGP-5 and white onion entry W 208 were found tolerant to excess water and will be evaluated at through multilocation trial. Two onion entries W 397 and Acc. 1656 were found to be tolerant to water stress and being further evaluated for release as a drought tolerant onion variety under field conditions, 5 entries were moderately resistant to *Stemphylium* blight and 4 entries were moderately resistant against anthracnose. Out of 32 wild accessions screened under poly house conditions, 3 were moderately resistant for anthracnose.

3. Recommendations: The seasonal barrier has been broken in several vegetable crops and now varieties are available in these crops for growing almost round the year. As such efforts should be made for evolving varieties/germplasm for climatic change, in addition to taking high temperature and high CO_2 into account, the problem of excess water through rains during the harvest especially during fag end of *Kharif* season should also be considered. Similarly there is a strong need to develop varieties of onion and garlic for growing them in different seasons so that year round production is possible both in traditional and non-traditional areas of the country.

Councils Comments : Agreed. Genotypes will be tested under varying agro-climatic conditions in different locations and seasons.

Action Taken: Eight white onion lines were found suitable for all the three seasons. Bhima Red and Bhima Raj can be grown in all the three seasons; i.e. *kharif*, late *kharif* & *rabi* season, Bhima Shweta is recommended for *kharif* & *rabi* season. Bhima Shubhra is suitable for *kharif* as well as late *kharif* season and seeds can be produced annually. However, season-wise varieties have been recommended for year-round growing of onion in the country. Under screening of onion lines against water logging, red lines KH-M-1, KH-M-2, RGP-2, RGP-5, DOGR Hy-7, DOGR Hy-50, Acc. 1623, Acc. 1624 and Acc. 1626 and white lines W396, W306AD3, W174GP, MS100 X Phule Safed, Palampur, Bhima Shweta, MS100 X W172WL1, MS100 X Bhima Shweta WL1, W361, w-208 were tolerant under excess water condition. In case of garlic efforts were made to evaluate the germplasm in *kharif*. Out of 625 lines evaluated during *kharif* season for three years, 20 elite lines were identified besides 761,30,478,751,72,18 acessions.

4. Recommendations: Onion genotypes performing well in storage should be selected for further evaluation and development of promising lines for long storage. The Directorate should try to develop superior varieties both in onion and garlic having minimum storage losses.

Councils Comments : Agreed. Genotypes will be tested for storability.

Action Taken: Evaluation of onion lines for long storability is in progress. However, Bhima Light Red an onion

variety is recommended for high yield along with long storability (5-6 months) in addition to earlier released Bhima Kiran and Bhima Shakti. In *rabi* white germplasms accessions *viz*., W-416, W-088, W-078, W-174, W-398, W-444 W-344, W-114, W-125, W-507, W-514, W-498 and W-443 were reported to have less than 30% weight loss in storage after 3 months. In garlic accessions 19, 16, 24, 17 and 46 had 10-15% storage losses.

5. Recommendations: In garlic, efforts should be made to induce flowering by using vernalization, application of growth regulators and other means so that fertile genotypes are achieved to go for sexual propagation leading to development of improved varieties and hybrids. Besides, regular varieties induced mutant if any identified should also be subjected to such treatments to induce sexual propagation. This will help to create more variability in garlic for its fast improvement in its yield and other desirable traits.

Councils Comments: Agreed. The post of Plant Physiologist will be filled by ASRB shortly.

Action Taken: Trail was conducted with two short day garlic cultivars, Bhima Purple and Gadag Local and one long day type, CITH-5. Different concentrations of foliar spray of GA3 with inductive photoperiod induced floral stem like structure in Gadag Local cultivar but failed to produce the complete flower. Further plants were subjected to 6-Benzyl amino purine but failed to induce the flowering. 30 lines were sent to VPKAS, Almora and 22 lines to CITH, Srinagar for evaluation of flowering ability under temperate conditions but could not flower. Work is now initiated in collaboration with Dr. C. K. John, Scientist, NCL, Pune for flower induction in garlic. For creation of variability a total of 110 plants were regenerated through callus in four different garlic varieties using root tip as explants. 25 putative somaclones were developed using three different chemical mutagens.

6. Recommendations: Heterosis breeding should be given priority in onion to develop high yielding F_1 hybrid for increasing its production and productivity. There is a strong need to develop varieties and F_1 hybrids of onion having desirable traits including more than 15% TSS for processing, long storage and export purpose. Onion germplasm at the directorate has high TSS entries.

Councils Comments: Agreed. Work on heterosis breeding will be strengthened by starting a separate project in which conventional and biotechnological approaches will be used.

Action Taken: Out of 110 red and 30 white F_1 hybrids, some were superior over best check in respective of uniformity, earliness and high yield and 11 F_1 hybrids have been introduced in AINRPOG trails for multi-location evaluation. Development of *in vitro* lines are also in progress under field condition. Under *in-vitro* condition haploid induction in Indian short day onion was achieved through gynogenesis in 14 varieties. Total of 25 lines had significantly higher TSS than the check variety Bhima Shweta (11.76 ^{0}brix) with maximum TSS of 18.24 ^{0}brix recorded in line HT-GR-2C M-5-1 (yield 8.52 t/ha) followed by line WHT-5B (yield 16.33 t/ha) with 17.92 ^{0}brix. Bhima Shweta, the check variety reported marketable yield of 27.11 t/ha and further purified and multiplied for selecting bigger size high TSS bulbs.

7. Recommendations: There is a demand of big-sized cloves garlic for export and as such efforts should be made to develop the said kind of varieties in short day type of garlic besides laying emphasis on production of garlic in long day conditions of hill states.

Councils Comments: Agreed. More emphasis will be given to develop big-sized cloves varieties both for short and long day conditions.

Action Taken: The available 765 accessions/lines screened for clove size and out of these 69 accessions had big cloves. Further five big sized cloves garlic line viz. 18,40,152,527,489 were identified on basis of three years data in rabi season.

8. Recommendations: Tissue culture protocols should be developed/ standardized for mass multiplication of virus free planting material in garlic for increasing yield per unit area.

Councils Comments: Agreed. It will be one of the flagship programme of XII plan.

Action Taken: Tissue culture protocols were standardized for mass multiplication of garlic. A protocol for 'plantlet regeneration through callus induction from root meristem' has also been standardized. *In vitro* slow growth conservation medium (3% sucrose + 2% sorbitol) for garlic at ambient temperature has been standardized. Further standardization of protocol for development of virus free planting material through meristem tip culture along with thermo and chemo therapy is in progress. Collaborative project with Devlila Biotech under PPP mode is also submitted.

9. Recommendations: Research in the area of bio-technology should be strengthened by providing adequate human resource. In this context, work on marker assisted selections should be initiated to develop varieties resistant to biotic and abiotic stresses, with lesser post-harvest losses and superior in nutritional qualities.

Councils Comments: Agreed. With available resources, work on biotechnological are being carried out. Efforts will be made to provide one more biotechnologist in near future.

Action Taken: For marker assisted selection for storage trait like sprouting, 40 genotypes for sprouting and 12 for bolting were screened and the early and late sprouting genotypes were crossed to develop F_1 which is confirmed by SSR markers. Population survival was very low in F_2 generation. Efforts are underway to develop DH based mapping population for sprouting trait. A total of 50 SSR primer sets were screened for estimating their ability to reveal polymorphism in onion accessions and able to distinguish all seven varieties based on polymorphism and presence of unique alleles using these primer sets. Evaluated different *Allium* species using SRAP marker and also developed A retro-transposon based TRAP marker for evaluation at molecular level. Further in *Allium cepa*, *Allium sativum* and *Wild Allium*, 26, 10, 26 respectively polymorphic SSR & ILP markers were identified. Among 116 ILP & SSR markers 27 were cross-transferable among *Allium* species and these markers may be utilized in molecular breeding. Core set of garlic has been characterized using SRAP and SSR markers.

10. Recommendations: Directorate may establish strong linkage with national and international institutions/ organizations working on research and development on onion and garlic for further strengthening of research programme of the Directorate.

Councils Comments: Agreed.

Action Taken: Had collaborations with ICAR-CITH for introgression breeding between long and short day onion besides maintenance of long day germplasm; NIASM, Baramati and IIHR (NICRA) for abiotic stress; CIAE, Bhopal and MPAU, Rahuri for mechanization, Bejo-Sheetal for development of hybrids in onion; Jindal Crop

Science, Safal Mantra, KVK's and VSI for seed production; NHRDF, Nasik and NRC Grapes for biochemical analysis; M/S Jain Ltd for dehydration; University of Wisconsin, Madison, CGN Netherlands, USDA, USA and Japan for *Allium* germplasm; Cornel University, besides 27 network centres located at different parts of the country. NCL, Pune for flower induction in garlic.

CROP PRODUCTION

11. Recommendations: A comprehensive package should be developed including judicial adjustment of planting date for onion so as to make onion bulb available throughout the year.

Councils Comments: Onion bulbs are available throughout the year because of production of onion in *kharif*, late *kharif* and *rabi* seasons. Work on refinement of package of practices will be accelerated.

Action Taken: Comprehensive good package of practices for onion and garlic has been developed by ICAR-DOGR and recommended to the farmers. Work in progress to refine drip fertigation in onion and garlic as per nutrient requirement and weed management.

12. Recommendations: In the standardization of agro-techniques for climatic change, in addition to taking high temperature and high CO_2 into account, the problem of excess water through rains during the harvest especially during fag end of *kharif* season should also be considered.

Councils Comments: Agreed. The problem of excess water at the time of harvest will be taken into consideration in the ongoing experiments.

Action Taken: Developed agro-techniques like BBF planting, selecting suitable varieties, seedling treatments, and timely plant protection measures to adopt excess water red lines KH-M-1, KH-M-2, RGP-2, RGP-5, DOGR Hy-7, DOGR Hy-50, Acc. 1623, Acc. 1624 and Acc. 1626 and white lines W396, W306AD3, W174GP, MS100 X Phule Safed, Palampur, Bhima Shweta, MS100 X W172WL1, MS100 X Bhima Shweta WL1, W361, w-208 were tolerant under excess water condition and elite lines will be evaluated through multi-location trial for confirmation before release as a variety.

13. Recommendations: Multiplication of DOGR varieties adapted to specific zone can be taken up at the Network Centre in that location. This will facilitate spread of that variety. Besides, there is a need of multiplication of quality seed of DOGR varieties of onion and planting material of garlic in large quantities. For this DOGR should contact National and State Seeds Corporations for fast multiplication of seed and planting material of varieties developed by the directorate for their spread in larger areas of the country.

Councils Comments: Agreed. Efforts will be made in this direction through network project and national and state seed corporations.

Action Taken: Seeds of developed varieties were already sent to different centres for bulb production which are being utilized for seed production. Besides, in coordination with KVKs are being produced. ICAR-DOGR produced 10185 kg of seeds for onion varieties which were distributed 18392 kg onion bulbs and 4546 kg garlic bulbs for seed production was drawn with the help of KVKs at Jalna, Nandurbar, Pal, Tuljapur, Latur, Osmanabad,

Narayangaon besides at DOGR farm in Maharashtra. Palampur, Chitradurga are also producing seed through KVK,s. NHRDF, IIHR, Ludhiyana, Durgapura, Dharwad, Junagadh, Rahuri, Tamil Nadu, CITH, Almora, Kanpur, Akola centres are producing seeds at their institute level. Similarly, seeds were supplied to NSC as well as MAHABEEJ for multiplication as well as for evaluation. Further, seeds were also given to more than 60 different seed producing companies to bring seeds under seed chain. MOU were signed with Jindal Crop Science and Safal Mantra private companies. Further letter to Zonal Coordinator was written to produce onion seeds through KVK. Seeds/bulbs have been provided to 38 KVK's (i.e. in Maharashtra 9, Karnataka 5, Gujarat 2, Rajasthan 3, MP 6, Odisha 10, Manipur 1, Chhattisgarh 1, and Mizoram 1 besides in universities/ Institutes at Dharwad, Bagalkot, NIASM Baramati, NSC and Mahabeej).

14. Recommendations: Initiate research and development on mechanization of onion and garlic cultivation by providing required resources making onion and garlic cultivation fully mechanized as a great decline in availability of labour is expected in the near future.

Councils Comments: Agreed. Requirement for Agriculture Engineer will be included in 12th plan. Work will be initiated taking help from Central Institute of Agril. Eng., Bhopal.

Action Taken: ICAR-DOGR conducted direct seeding experiment by using pneumatic seed drill (imported from Italy) and other locally made seed drills. Among the various direct sowing methods, bigger bulbs, more percent of 'A' grade bulbs and less number of double bulbs were observed. Further there is need for modifications in various seed drills suitable for our conditions which is taken up in collaboration with CIAE, Bhopal. Further research on mechanization for seedling transplanting, bulb harvesting, development of roller for neck fall, modification in onion grader are in progress in collaboration with CIAE and MPKV. Collaboration with CIPHET for project on “Design, development and evaluation of different machines/Instruments and storage structures and transportation system for onion processing to complete value chain” is submitted which was approved in IRC, CIPHET. Project on “Automation of planting/transplanting and weeding operations in onion cultivation” submitted to National Agricultural Science Fund (NASF) by CIAE with DOGR as collaborating institute. At present scientist is on maternity leave. Will start the work after joining the office from Dec 1st, 2017.

15. Recommendations: In case of organic production trials, a systematic study on role of post- harvest pathogens and pests in onion and garlic involving pathologist and entomologist need to be taken up.

Councils Comments: Agreed

Action Taken: Observations were recorded for various diseases and pests in storage. Application of neem cake/ poultry manure significantly reduced thrips population compared FYM and vermi-compost treatments.

16. Recommendations: Effect of sulfur on storability on onion and garlic should be confirmed by conducting controlled studies.

Councils Comments: Agreed. Results will be confirmed.

Action Taken: Pot experiment was conducted to study the effect of K & S on keeping quality of onion bulbs with 10 treatment combinations. Results indicated that soil application of S did not improve storage quality of onion bulbs, but, improved storage quality of garlic bulbs.

CROP PROTECTION

17. Recommendations: Production of healthy planting material should receive utmost priority. Disease free area and/off season area should be identified for multiplication of virus free planting material as in the case of potato seed certification programme.

Councils Comments: Agreed. This work has been initiated under network programme.

Action Taken: Production of disease-free garlic planting material program was given utmost priority. A flagship program on this aspect was initiated by ICAR-DOGR. A protocol of virus free planting material through meristem tip culture and its mass multiplication has been standardized. Further, a collaborative proposal with private firm Devleela Biotech is proposed for mass multiplication of garlic planting material at field level.

18. Recommendations: There is a need to develop systematic disease distribution map both for viral and fungal diseases in both the crops.

Councils Comments: Agreed. This work has been initiated under network programme.

Action Taken: In this direction a trial on survey of pests and diseases has been initiated under network mode. The data of pests and diseases have been compiled based on 5 years data and disease map of major diseases has been prepared.

19. Recommendations: Diagnostic reagents/ protocols and clones developed against viruses at IARI need to be shared with DOGR for fast improvement in the programme and avoid duplication of efforts.

Councils Comments: Agreed

Action Taken: Diagnostics protocols and reagents, expertise were shared with IARI regularly.

20. Recommendations: Insect (thrips & aphids) population dynamics studies should be continued at the Directorate as well as network centres in light of climate change and virus vector relationship studies should receive attention.

Councils Comments: Agreed. The work on population dynamics is in progress and will be continued.

Action Taken: In this direction the studies on population dynamics of thrips, aphids and mites was started during 2013. The substantial data have been generated. The data are presently being used to identify the vector free area for mass multiplication of garlic planting material. Further, this data will also be used for developing forecasting models for these insects. The work on virus vector relationship was initiated at ICAR-DOGR; transmission protocol for major viruses have been developed. DNA Barcodes for major vectors such as aphids, thrips and mites were developed. Vector population genetics using nuclear and mitochondrial markers is being studied. The work on impact of the vector population genetics on disease epidemiology is in progress.

21. Recommendations: Competence available at IARI Regional Research Station, Pune could be utilized in addressing the viral problems in onion and garlic.

Councils Comments: Agreed. Collaboration with IARI regional station will be developed.

Action Taken: Competence available at IARI is being utilized. In this connection, a collaborative project with IARI- RS Pune on virus vector relationship was submitted to NASF.

POST HARVEST TECHNOLOGY

22. Recommendations: Studies on post-harvest management practices should be continued including evolving superior genotypes with better shelf life in storage. Studies on cold storage should also be taken up in both the crops to reduce storage losses.

Councils Comments: Agreed. The work on breeding for storability is in progress. Cold storage facilities will be created subject to approval in 12th plan.

Action Taken: Different varieties of DOGR were evaluated for storage losses to identify best variety. Bhima Kiran and Bhima Shakti were found good for long term storage. Pre-harvest application of CIPC was found to reduce sprouting in onion in *kharif* season. Residues were also under permitted limits. Surveyed cold storage and modified atmosphere storage where onion was stored without irradiation. Based on preliminary studies a project in PPP ((with Fresh-O Veg and S&T Council, Govt. of MP) mode was submitted to DST. At present scientist is on maternity leave. Will start the work after joining the office from Dec 1st, 2017.

23. Recommendations: Superior types of zero-energy onion and garlic storage structures for different production areas need to be developed.

Councils Comments: Agreed. The zero-energy storage structures will be created subject to approval in 12th plan.

Action Taken: Storage structures were constructed at ten different network centres. Low cost storage structures were also constructed under Tribal Sub Plan at Nadurbar. At present scientist is on maternity leave; will start the work after joining the office from Dec 1st, 2017.

SOCIAL SCIENCES

24. Recommendations: Resource conservation technologies developed by the DOGR like raised bed cultivation, drip irrigation, fertigation, chemical weed control, barrier cropping using maize and wheat against thrips should be demonstrated at several farmers' fields for effective transfer of technologies to the growers. For taking up FLD on proven technologies, ICAR may allot separate funds and man power. This will facilitate farmers to see and believe the technologies evolved by DOGR including new varieties. Social scientists should be involved along with Breeders and Horticulturists in such programmes.

Councils Comments: Agreed. Work will be undertaken depending upon the availability of man power and budget.

Action Taken: Total of 31 frontline demonstrations were conducted in major onion growing states *viz*.,

Maharashtra, Madhya Pradesh, Rajasthan, Karnataka, Gujarat, Bihar, Andhra Pradesh and Punjab to demonstrate ICAR-DOGR varieties and technologies in farmers' fields. Farmers were convinced and learnt the improved onion cultivation practices through these demonstrations. After seeing the results of demonstration trials, other farmers are also adopting the improved onion production practices developed by ICAR-DOGR.

25. Recommendations: Progressive growers of onion crop and seed of DOGR varieties should be contacted by social scientists to study the socio-economic impact of developed technologies.

Councils Comments: Agreed.

Action Taken: Progressive farmers of Maharashtra from Pune, Ahmadnagar, Nasik, Akola and Wardha districts were contacted to study the socio-economic impact of ICAR-DOGR developed technologies. ICAR-DOGR developed varieties, package of practices, broad bed furrow with micro irrigation and modified storage structures were adopted by 90.84%, 70%, 62.5% and 44.17% farmers, respectively. Adoption of technologies had positive effect on socio-economic condition of the farmers in terms of increased annual income, loan repayment capacity, improvement in farm and home condition, increase in domestic spending and participation in social events. In Vidharbh area of Maharashtra the variety Bhima Shubhra had highest adoption (52.5%), followed by Bhima Super (21%) and Akola Safed (6.5%). Otur village is almost 100% converted under drip irrigation in onion & garlic. Further micro irrigation and storage structures are being adopted by the farmers at faster rate and more than 50% area is under drip cultivation.

26. Recommendations: DOGR and NHRDF should work in close collaboration in research, seed production and transfer of technology.

Councils Comments: Matter will be discussed with NHRDF.

Action Taken: The meeting was held on 13 February, 2013 and areas of duplication have been identified. Further ICAR-DOGR and NHRDF is working in collaboration in research, seed production and transfer of technology. DOGR and NHRDF worked in collaboration for programmes such as Brain storming, National symposium, etc. Monitoring of seed production has been done in collaboration.

27. Recommendations: Public-private partnership should be given priority to bring about synergy in research, seed production and transfer of technology on both the crops.

Councils Comments: Agreed.

Action Taken: Variety “Bhima Super” has been commercialized through public-private partnership, by signing a non-exclusive licence with Jindal Crop Sciences Pvt. Ltd. (an ISO 9001:2008 certified company) for its seed production and marketing. Onion variety Bhima Red was licensed to M/S. Safalmantra Agro Farms Private Limited (SAFPL), Navi Mumbai. ICAR-DOGR Signed MoU with R. K. Engineering Works, Rajgurunagar to promote the mechanization in agriculture for manufacturing and sale of motorized onion grader developed by ICAR-DOGR. A collaborative proposal with private firm Devleela Biotech is proposed for mass multiplication of garlic planting material at field level. A collaborative project is in progress with Beej Sheetal, Jalna to develop hybrids in onion.

ADMINISTRATIVE/OTHERS

28. Recommendations: Keeping in view the charter of the directorate as well as the importance of both onion and garlic, the QRT recommends to ICAR to upgrade the Directorate to a full-fledged "Institute on *Alliums*" along with the provision of staff as per ICAR norms along with adequate budget. Besides, to fulfill the national mandate, there is an urgent requirement of starting regional stations in different major onion and garlic growing areas of the country including a centre at temperate region.

Councils Comments: Efforts will be made during XIIth plan for its upgradation with necessary budget and man power as per norms.

Action Taken: There is a need to upgrade the Directorate to a full-fledged "Institute on *Alliums*" along with the provision of staff as per ICAR norms with adequate budget along with regional stations in different major onion and garlic growing areas of the country, including a centre at temperate region to fulfill the national mandate. But yet not materialized.

29. Recommendations: Of 83 posts approved by EFC to the Directorate, 34 posts are still awaiting sanction. QRT recommends an early sanction of these posts by the council.

Councils Comments: It will be discussed during EFC discussion of XIIth plan.

Action Taken: Posts were proposed in EFC for creation in XIIth plan, but not materialized.

30. Recommendations: QRT felt the shortage of man power and recommends to provide additional scientific post proposed in 12th plan EFC *viz*. 2 post of Principal Scientist (1 Horticulture and 1 Plant Pathology), 5 of Senior Scientists (One each of Plant Pathology, Agricultural Economics, Physiology, Seed Technology and Agri. Entomology) and 6 of Scientists (One each of Horticulture, Food Technology, Plant Pathology, Statistics/Agril. Engineering, Plant Breeding and Agricultural Extension) may be provided to fulfill the mandate of the Directorate. Commensurate with the scientists and the programme, adequate number of technical and supporting staff may also be provided to run the programmes of the Directorate smoothly.

Councils Comments: Agreed. Council is requested to sanction proposed posts of scientific and technical staff.

Action Taken: As suggested, efforts were made but posts were not sanctioned, hence, could not be filled.

31. Recommendations: QRT recommends provisioning of dedicated power supply line to the Directorate.

Councils Comments: Not Agreed. However, efforts will be made in near future.

Action Taken: It could not be materialized, hence proposed in EFC for 2017-20.

3 Mode of Review and Visits

The visits of QRT were made to ICAR-Directorate of Onion and Garlic Research, Rajgurunagar and Coordinating centres of AINRPOG spread over different states between 6-7 Oct., 2017 to 29 July- 1August, 2018. The schedule of visits of the QRT to the institute and AINRPOG centres are given in **Annexure-II**.

The mode of review of the QRT included initial discussion with the Deputy Director General (Horticulture) followed by critical examination of the documents provided by the DOGR, AINRPOG and its centres, interaction with scientists and visits to laboratories, experimental fields and farmers.

A. ICAR-DOGR, Rajgurunagar

The QRT observed that Directorate of Onion and Garlic Research has made significant contribution during the period of review not only in research achievements and technology development in onion and garlic but also in research farms development and equipping the laboratories. The QRT members were very much satisfied with the progress made at ICAR-DOGR.The Directorate has also established strong linkages with several relevant national and international institutions and organizations. The seed production plots of onion and garlic are maintained well. The Directorate has also showed progress in technology transfer to the farmers/seeds men and nurserymen involved with the said vegetable crops. Seed production of released varieties has been commercialized through public and private partnership approach. The Directorate has also been involved in training programmes for farmers, stake holders, extension workers, *etc*. With regard to future perspective, the Directorate has already prepared a Perspective Plan 2030 and Vision 2050. The clear-cut foresight, untiring efforts of the Director and staff needs appreciation along with the efforts made by RAC members who helped in framing and monitoring the research programmes. The QRT has reviewed Directorate's programme on both onion and garlic and made recommendations in broad areas of research, seed production, extension and policy issues (Information about ICAR-DOGR is given in Annexure VII). Keeping in view, the constraints in terms of location, manpower, availability of power, budget, infrastructure, the QRT made the following recommendations after finalizing in IMC and review team.

3.1 Crop Improvement

(i) As there is a huge demand for high TSS onion variety in processing sector, high TSS lines (>15%) should be evaluated through All India Network Research Project on Onion and Garlic by including existing high TSS varieties as a check for direct release as a variety. Biochemical quality (TSS and Sugar) of all high TSS lines needs to be assessed for quality check. Large scale demonstrations of high TSS lines at Bhavnagar, Gujarat and Jalgaon, Maharashtra needs to be conducted to create awareness.

(ii) Entire germplasm (exotic/indigenous) should be screened for major biotic and abiotic stresses and documented in phases. Emphasis should be given to develop resistant varieties of onion and garlic for abiotic (drought, floods) and biotic stresses like important insect pests (thrips) and diseases (purple blotch, stemphyllium blight, anthracnose, *etc*).

(iii) There is need to develop varieties suitable for export. Variety specific protocol for export is the need of the date. It should be done in collaboration with APEDA and Farmer Produce companies.

(iv) Hybrid onion is a grey area more focus should be given for developing hybrids for different seasons and purposes.

(v) Creating variability in garlic, garlic flowering and fertility restoration is essential. ICAR-DOGR should take up project in this regard on priority basis.

(vi) Mechanization in production of onion and garlic is need of the day. A complete protocol should be developed for both the communities.

(vii) Work should be initiated on organic production of onion and garlic for niche area markets.

(viii) There is need for standardization of protocol for cool chain management in onion and garlic. Parallarly, there is a need for updating presently recommended, "on farm" storage structures.

(ix) Tissue culture protocols should be developed/ standardized for mass multiplication of virus free planting material in garlic for increasing yield per unit area. For mass multiplication of virus free planting material in garlic, use of diverse genetic base for getting promising meristems should be done. Effort should be made to get garlic seeding genotypes from available sources abroad. Garlic flowering experiment should be given more emphasis.

3.2 Crop Production

(i) Focus should be on mechanisation of onion and garlic cultivation to cut down budget on labour which is to the tune of 60% of total cost of production.

3.3 Crop Protection

(i) Forewarning model for various pest and diseases in onion and garlic should be developed.

(ii) Insect pest and natural enemy population dynamics with special reference to thrips, and virus-vector relationship should be continued at the Directorate.

(iii) Newer chemicals should be studied to revise the existing Biointensive IPM packages. The compatibility of various agrochemicals that are being used is to be checked.

(iv) Management of biotic stresses causing losses during storage need to be strengthened.

3.4 Post-Harvest Technology

(i) Protocol for cool chain management of onion and garlic should be standardised.

(ii) Existing storage structures needs to be modified keeping the onion and garlic storage environment in view. Superior types of zero-energy onion and garlic storage structures for different production areas need to be developed.

(iii) Studies on seed storage especially regarding packaging materials needs to be initiated.

(iv) Varity specific protocol for export of onion should be developed in collaboration with APEDA and farmers.

3.5 Extension

(i) Varieties and technologies developed by ICAR-DOGR needs to demonstrated in large scale all over the country wherever it is grown. Impact analysis of ICAR-DOGR varieties and technologies needs to be conducted across the country. Research proposal in this aspect may be submitted to NHM.

(ii) On farm - farmers participatory research for socio-economic appraisal and market research needs to be conducted.

3.6 General comments

Directorate may establish strong linkage with national and international institutions/ organizations working on research and development on onion and garlic for further strengthening the research programme of the Directorate.

B. AINRPOG Centres

1. MPKV, Rahuri, Voluntary Centre on 23 November, 2017

Dr. K.P. Vishwanatha, Vice-Chancellor, Dr. M.N Bhalekar, Principal Investigator, Dr. S.A. Ranpise, Head, Dept. of Hort have mentioned regarding that of good work done in the area of onion and garlic. They have developed onion varieties B-780, Phule Samarth, Phule Swarna and in garlic, Phule Baswant are popular among the farmers. The centre conducted all experiments allotted. QRT team visited experimental farm and was satisfied with the work being carried out under the project.

- The centre demanded elevation of the centre as a main centre considering the importance of these crops under University jurisdiction.
- MPKV should join with ICAR-DOGR to popularize and disseminate micro-irrigation technology at a faster rate.
- There is a need to develop variety specific GAP, considering the future export potential in collaboration with ICAR-DOGR, MPKV Rahuri, NHRDF, APEDA, Marketing Board, Exporters and farmer producer company.
- Separate Commodity board for Onion and Garlic for the benefit of the farmers should be created.

2. TNAU, Coimbatore, Main Centre on 22 January, 2018

QRT visited TNAU, Coimbatore on 22 January, 2018. Dr. Arumugam, Head and PI, TNAU, Dr. S. Thanburaj, Ex-Dean, Dr. I. Irulappan, Dr. D. Veeragavathatham, Ex-Dean, Horticulture, TNAU participated in the meeting. Production technologies for onion are recommended to farmers at Coimbatore and in garlic at Ooty. Team visited the experimental plots which were well maintained and research was properly conducted.

- It was suggested to popularize micro irrigation and gather information about expansion of onion cultivation under micro-irrigation.
- Plant Protection scientists were requested to confirm the pathogen under artificial inoculation and identify the disease causing agents. Garlic extract may also be tried for management of thrips.
- Economics of the technology developed and its adoption by the farmers need to be studied.
- As there were constraints regarding inconsistency of SRF continuing in projects resulting in discontinuity of project, there was a demand of permanent positions of scientists for smooth functioning of the project.
- Looking to the increase in labour and input cost, there is a need to increase the budget along with provision of non-recurring contingency for maintenance and development of infrastructure under the project.
- TNAU having well established bio-control laboratory, this centre should develop disease management strategies using most efficient bioagents- bacteria/ fungi.

3. JAU, Junagadh, Main Centre on 25 January, 2018

The QRT team visited JAU on 25 January, 2018. Dr. A. R. Pathak, Vice-Chancellor, was also present. Dr. J.H. Vaccani, Research Scientist (Garlic & Onion) introduced the staff working under the project and briefed about

the research work conducted on onion and garlic in the University. Dr. I. U. Dhruj, Associate Director of Research and Dr. M. A. Vaddoria, Professor, Genetics & Plant Breeding, College of Agri. and former PI AINRPOG also attended the meeting. The ICAR has sanctioned AINRPOG from February, 2009 which gave boost in onion and garlic research in the area of crop improvement, production, protection and post-harvest technology. He also mentioned about the conduct of third AINRPOG group meeting at JAU, Junagadh during 22-23 June, 2012. JAU also developed garlic varieties *viz*., Gujarat Garlic-2, Gujarat Garlic-3, Gujarat Garlic-4 and Gujarat Junagadh Garlic-5. Similarly, Gujarat White Onion-1, Junagadh Junagadh Red Onion -11 and Gujarat Junagadh White Onion-3 were developed in onion. Seeds are being produced and distributed to multiplying agency as well as farmers. Thirteen production and protection technologies were also recommended to farmers. Team visited the experimental site as well as to farmers field and noted good impact of the technology adopted by the farmers.

- There was a demand to increase the budget allocation in view of increased cost of inputs.
- It was recommended to provide help of an entomologist to carry out research work in plant protection which was agreed upon by the University authority.




4. IGKV, Raipur, Voluntary Centre on 9 February, 2018

Raipur centre is working as voluntary centre since 2009 in Chhattisgarh state under AINR on Onion & Garlic in prersence of Dr. Jitendra Singh, Head, Dept. of Vegetable Science. Dr. Praveen Sharma, PI of the project gave brief presentation regarding progress of research under AINRPOG. QRT also had interactions with Vice Chancellor Dr. S.K. Patil and Director Research Dr. S. Rao.

- QRT suggested to focuse on research for popularizing *kharif* onion production in Chhattisgarh.
- It was suggested to demonstrate and popularize micro-irrigation in onion and garlic.

- Losses due to pest and diseases need to be assessed.
- University may undertake demonstration trials utilizing funds from RKVY from state government.
- University requested to elevate this centre as main centre considering the importance of the crop and popularity among tribals of Surguja and Jagadalpur.
- As increase in labour cost was also one of the constraints, request was made to increase the contingent grant.
- The VNR seeds were advised to join with ICAR-DOGR for commercial seed production of onion varieties for Chhattisgarh region.

5. RARI, Durgapura, Jaipur, Main Centre on 10 February, 2018

RARI, Durgapura is one of the main centres working under AINROG since 2009. QRT team visited the centre on 10 February, 2018. Vice-Chancellor Dr. P. S. Rathore, SKNAU, Jobner, Dr. V. K. Yadav, Director Research, SKNAU, Jobner, Dr. S. J. Singh, Director, RARI, Durgapura, Dr. V. S. Yadav, Head, Division of vegetable Science, RARI, Durgapura, PI AINRPOG Dr. S. K. Khandelwal and other scientists of RARI, Durgapura were also present during the meeting. The presentation was made on AINRPOG project work by Dr S.K. Khandelwal, PI. Three varieties of onion namely RO-1, RO-59 and RO-252 were released from this centre and are popular among the farmers. The centre has recommended six production and three protection technologies. QRT visited the field experiments which were laid out systematically and also visited storage structures.

- It was suggested to monitor thrips population using yellow sticky traps besides the natural enemies.
- Storage structures need to be modified looking in to the extreme weather conditions of Rajasthan so as to increase shelf life of onion.
- Set technology to popularize *kharif* onion production may be standardized as there is difficulty in raising seedlings in *kharif* season.
- It was suggested to scientist to make a visit to “Katputali” to explore onion seed production and see onion storage by the farmers in Barmer region of Rajasthan.
- Acute shortage of water was also noticed at this centre. Though the centre is doing good work it was advised to shift the location to major onion and garlic growing areas of University. It was also suggested to conduct all trials on micro-irrigation.
- Therewas a request to increase the budget and provision of permanent position of supporting technical staff/SRF for smooth functioning of the project due to increased labor cost.

6. CSAUAT, Kanpur, Main Centre on 11 February, 2018

CSAUAT, Kanpur is working as main centre under AINRPOG since 2009 on onion and garlic. With the intervention of AINRPOG the kharif onion production has been initiated in districts like Fatehpur, Aurraya, Kannauj and Farrukhabad. One variety of onion, Kalyanpur Red Round,was developed by this University and onion processing for flakes and powder and garlic for powder has been initiated in small scale in Mainpuri, Agra and Etawah. Principal Investigator (PI) of the project, Dr. A.K. Dubey gave a brief presentation about the progress of research, which was followed by visit to experimental plots.

- The Committee expressed dis-satisfaction about the conduct of trials. It appeared that PI did not focus

on the principle of network programme. Kanpur location plays very strategic role in enhancing production of onion and garlic in central UP. Therefore, the centre should play very important role.

- It was suggested not to evaluate multiplier onion as almost all the entries are bolting which is not a desirable trait.
- The PI was advised to revive the drip irrigation system immediately. The PI assured to take up the matter and solve the problem.
- It was suggested to multiply seeds of recommended varieties in large scale and popularize set technology for kharif onion production through demonstrations with the help KVK.
- The package of practices for onion and garlic should be demonstrated at KVK as well as at farmers filed to popularize the technologies.
- CSAUAT scientists, KVK staff and Director Research were advised to visit the trials at ICAR-DOGR and also visit the progressive farmers at Otur and nearby areas in Maharashtra.
- Shortage of budget due to increase in labour wages and inputs are major constraints represented.

7. PAU, Ludhiana, Main Centre on 13 February, 2018

PAU, Ludhiana centre was initiated as voluntary centre in 2010 and later upgraded as main centre in 2015. Till date PAU has developed nine improved varieties of onion and three of garlic. Production, protection and storage management practices for cultivation of onion and garlic were standardized besides micro-irrigation and fertigation which helped to increase yield. PAU has focused on development of machinery for mechanized cultivation. The centre is working on biotechnological aspects of onion. Dr N.S. Bains, Director Research, Dr. A.S. Dhatt, Head, Dept. of Vegetables and PI, AINRPOG, presented the research work being carried out at PAU, Ludhiana in onion and garlic. QRT also met Dr. Baldev Singh Dhillon, Vice- Chancellor, PAU.

- QRT was of the view that PAU should focus on mechanization of onion & garlic at Ludhiana to increase area in Punjab. PAU may also collaborate with ICAR-DOGR, MPKV, Rahuri and CIAE, Bhopal for mechanization.
- Punjab can be identified as seed zone for garlic multiplication.
- Separate fund should be provided for construction of storage structure as PAU is being main centre and suitable design should be worked out according to PAU conditions.
- PAU has good potential and can be developed as hub to supply onion and garlic to J&K, Himachal Pradesh, Delhi and Northern plains. Hence, production strategies can be developed accordingly.

- There should be close collaboration between PAU, ICAR-DOGR and NHRDF particularly for seed production and its marketing.
- QRT recommended the 'Best Centre Award' to PAU for their good work in all aspects of onion and garlic. This centre is also facing shortage of budget for smooth functioning of the project.

8. UAS, Dharwad, Main Centre on 26-27 March, 2018

UAS, Dharwad is working under AINRPOG as main centre since 2009. Kharif onion is more popular in Karnataka and farmers have adopted Bhima Super variety in large scale. Last year, Dharwad itself produced about 25 quintals of seed which was insufficient. Similarly Bhima Shakti is also in great demand during *rabi* season. QRT met Dr. V I Benagi (Director of Research, UAS, Dharwad). Dr. Benagi introduced the staff and briefed about research activities of the University. Dr. Dharmatti, Head, Dept. of Hort. & PI AINRPOG, gave brief presentation about the progress under the project. Raised bed technology with ICAR-DOGR varieties are performing well and accordingly seeds are being multiplied in large quantities. Bhima Super is cultivated in about 2500 acres and Bhima Shakti in about 750 acres and area is further increasing. It is suggested to introduce Bhima Dark Red.Seed production programme may also be initiated.

- Micro-irrigation technology for raised bed cultivation should be demonstrated to the farmers through State Agriculture Department and KVKs.
- White onion is preferred in North Karnataka to some extent therefore ICAR-DOGR varieties should be demonstrated and popularized in these areas.
- There wasrequest to increase the budget as the cost of inputs and labour is increased.

9. CITH, Srinagar, Main Centre on 30-31 May, 2018

CITH, Srinagar is only main centre under long day onion & garlic and is part of ICAR-DOGR in maintenance of long day onion and garlic germplasm and its evaluation. Introgression breeding work is in progress at CITH where crosses were made during 2007 & 2008 between exotic long day and Indian short day onion. Subsequently seeds are being produced at this centre in further generation after selection of bulbs and are being evaluated in long day as well as short day conditions. Dr. O.C. Sharma, Director briefed about the Institute. Dr. Geetika Malik, PI, AINRPOG gave overall progress of the research work related to onion and garlic. CITH has developed two garlic varieties notified by AINRPOG (CITH-G-1 and CITH-G-3) for hill zone-I. CITH-G-1 also notified by CVRC at national level and two garlic entries are in pipeline under AINRPOG. Two onion entries are proposed for AINRPOG testing at IET level (2018-19). Under long day type, 107 genotypes of onion and 78 of garlic from J&K and HP are being conserved in field gene bank. Team visited SKUAST at Shalimar, Dr. Nazeer Ahmad, VC explained the work done on onion and garlic.

- Srinagar is identified a centre for introgression breed for long day as well as short day onion varieties and garlic flowering. This should be the flagship programme of this centre.
- It was suggested to conduct field demonstration in farmers filed with the help of KVK's.
- There is a need to modify onion and garlic storage structures as per long day climatic conditions. These should be designed in consultation with ICAR-DOGR and engineers.
- ICAR-CITH should have strong collaboration with SKUAST, Srinagar.

- There is a need to standardize seed production, particularly for long day locations.
- It was suggested to invite all PIs dealing with long day onion to ICAR-DOGR for finalization of technical programme.

4 Research Achievements and its Impact

A. ICAR-DOGR

1. Crop Improvement

I. Onion and Garlic varieties developed and impact

ICAR-Directorate of Onion and Garlic Research (ICAR-DOGR) has developed ten onion and two garlic varieties based on genetic improvement and selection. All these varieties have been released at national level.

Onion varieties

1. Bhima Super

Bhima Super, is onion variety recommended for *kharif* and late kharif season. It produces more than 90% single centreed bulbs. Bulbs mature in 100-105 DAT in *kharif* and 110-120 DAT in late *kharif*. It has a yield potential of 20-22 t/ha during *kharif* and 40-45 t/ha during late *kharif.* This variety has been identified for release in Chhattisgarh, Delhi, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan and Tamil Nadu. Several demonstrations have been conducted in different parts of the country to promote cultivation of bulb and seed production of Bhima Super including more than 35 demonstrations under tribal belts of Nandurbar.

Mr. Mangdya Dhendya Kokani, a group leader of tribal farmers of Sai Krupa Shetkari Gat, Shravani, Navapur, Nandurbar, Maharashtra cultivated Bhima Supar by following ICAR-DOGR recommended cultivation practices. He produced 9.8 t/acre marketable bulb yield during *kharif* 2015and earned net profit of Rs. 1,44,770/acre. During *kharif* 2016, he produced 11.0 t/acre marketable bulb yield and earned net income of Rs.82,850/acre.

Bhima Super promising kharif variety

Prograssive farmer with Bima Super kharif variety at Nandurbar

Mr. Ishra Fatya Gavit, a group leader of tribal farmers of Nachiketa Sheti Utpadak Gat, Ucchi Shevdi, Navapur, Nandurbar, Maharashtra raised onion seed crop cv. Bhima Super by following ICAR-DOGR recommended technology and produced 397.9 kg/acre onion seed and earned net income of Rs. 1,65,000/acre with seed price of Rs. 500/kg.

Farmers are often earning a net profit of more than Rs. 1.0 lakh/acre by cultivating Bhima Super. ICAR-DOGR has produced and sold 82.5 quintal seed of Bhima Super. This variety is now grown over1.31 lakh acres in different states.

Kharif onion production is not a tradition in Vidarbha region of Maharashtra. The farmers of Vidarbha generally cultivate *rabi* onion. The farmers have slowly shifted from onion to other crops due to shortage of water, irregular electric supply, high temperature during *rabi* season. Owing these constraints, ICAR-DOGR has demonstrated Bhima Super by adopting *kharif* onion production technology at Vidarbha region. After visualizing the impact, Shri Namdeorao Adhau, a progressive farmer of Patur, Akola district of Vidarbha region (Maharashtra) decided to cultivate *kharif* onion in his field. First he planned for 4 acre useing Bhima Super developed by ICAR-DOGR and raised his nursery on raised beds with sprinkler irrigation and transplanted seedlings on BBF with sprinkler irrigation in the first week of August. He harvested onions after 95 days and harvested 10 t/acre onion bulbs and sold right at the field @ Rs.30 per kg which gave him total income of Rs. 3 lakh/acre. His cost of cultivation for onion was Rs.40,000 per acre. He promoted kharif onion production technology by cultivating ICAR-DOGR varieties in Vidarbha region.

2. Bhima Shakti

Bhima Shakti is a red onion variety recommended for late *kharif* and *rabi* season. It produces less than 10% bolters and highly suitable for late *kharif* season. Bulbs mature in 120-130 DAT during late *kharif* and *rabi* season. Marketable yield during late *kharif* is 45-50 t/ha and during *rabi* 40-45 t/ha. The variety has better storage for 5-6 months. This variety is recommended for Maharashtra, Karnataka, Andhra Pradesh, Delhi, UP, Haryana, Bihar, Punjab, Rajasthan, Gujarat, MP, Chhattisgarh and Orissa.

Several demonstrations have been conducted in different parts of the country on onion bulb and seed production of Bhima Shakti including thirty-four demonstrations under tribal belts of Nandurbar with the help of KVKs and All India Network Research Project on Onion and Garlic. Farmers have preferred this variety because of its attractive red colour and good storability.

Mr. Sandip Chandrasingh Kokani, a group leader of tribal farmers of SaiShetkari Mandal, Shravani, Navapur, Nandurbar, Maharashtra had grown onion bulb crop cv. Bhima Shakti by following ICAR-DOGR package of practices during *rabi* 2014-15. He produced 13.5 t/acre marketable bulb yield and earned net income of Rs.

Bhima Shakti

Bhima Shakti on raised bed with drip irrigation

1,25,000/-. He produced 13.4 t/acre marketable bulb yield during *rabi* 2016-17 and earned net income of Rs. 65,000/- per acre. Mr. Harish Nurjee Valvi, a group leader of tribal farmers of Merali Yaha Shetkari Bachat Gat, Palipada, Navapur, Nandurbar, Maharashtra raised onion bulb crop cv. Bhima Shakti by following recommended cultivation practices of ICAR-DOGR. He produced 13.0 t/acre marketable bulb yield and earned net income of Rs. 1,15,000/- per acre.

Bhima Shakti variety with farmers storage at village Gosasi

ICAR-DOGR has also demonstrated its varieties through '*Mera Gaon Mera Gaurav*' scheme to the farmers of adopted villages. Shri Ravindra Namdeo Gorde, a farmer from Gosasi village, Pune district had grown Bhima Shakti variety by following ICAR-DOGR production technologies and produced 145% higher yield compared to previous year. Shri Gorde harvested 9.8 t/acre onion bulbs compared to his previous year yield of 4.0 t/acre. Due to its attractive colour and good quality bulbs, he received market rate of Rs. 21 per kg. Previously he was getting only Rs. 10 per kg. Shri Gorde said that he has been benefitted through '*Mera Gaon Mera Gaurav*' scheme.

Bhima Farmers have shown interest in Bhima Shakti for its quality. ICAR-DOGR had already sold more than 43 quintal seed of Bhima Shakti. This variety is grown in over 70,000 ha in different states including Maharashtra, Karnataka, Gujarat, Madhya Pradesh, Uttar Pradesh, Punjab, Chhattisgarh, Odisha and Mizoram. If the price of onion bulbs are low, bulbs of Bhima Shakti can be stored for 6-7 months and sale in the market after getting suitable price in the market. Most of the farmers are often earning a net profit of more than Rs. 70,000-80,000 per acre by cultivating Bhima Shakti.

3. Bhima Kiran

Bhima Kiran, a light red onion variety with good bulb storability matures in 115-120 days after transplanting. This variety is field tolerant to thrips and foliar diseases. Bhima Kiran has been recommended at national level in 1st Annual Group Meeting of AINPORG held at CITH, Srinagar (J&K) during 10-11 May, 2010 for *rabi* season for cultivation in Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Maharashtra, Punjab and Uttar Pradesh. Bulb storability 5-6 months. Uniform neck-fall, good in storage, bulb attains immediate light red colour after harvest. It is field tolerant to thrips and foliar diseases. Notification number of this variety is S.O. 2227 (E), 17th August 2015.

Several demonstrations have been conducted in different parts of the country on onion bulb and seed production of Bhima Kiran including thirty-seven demonstrations under tribal belts of Nandurbar with the help of KVKs and AINRPOG. Farmers preferred this variety mainly for bulb storability. ICAR-DOGR produced and sold about 4.8 t seed of Bhima Kiran to the farmers of different states. This variety has covered about 76000 acres in different states. Most of the farmers are often earning a net profit of more than Rs. 1.0 lakh per acre by cultivating Bhima Kiran.

Mr. Harish Nurjee Valvi, a group leader of tribal farmers of Merali Yaha Shetkari Bachat Gat, Palipada, Navapur, Nandurbar, Maharashtra raised onion bulb crop cv. Bhima Kiran by following ICAR-DOGR recommended

Bhima Kiran

Demonstration of Bhima Kiran at farmers field at Nandurbar

cultivation practices. He produced marketable bulb yield of 20.0 t/acre and earned net income of Rs. 80,000/acre with onion bulbs rate of Rs. 6/kg. Mrs. Archana Surupsingh Valvi, a group leader of tribal farmers of Saraswati Mahila Bachat Gat of the same village cultivated onion seed crop cv. Bhima Kiran by following ICAR-DOGR recommended technology. She produced 279 kg/acre onion seed and earned net income of Rs. 1,04,000/acre. Mr. Harish Nurjee Valvi and Mrs. Archana Surupsingh Valvi were felicitated on the occasion of 19thFoundation Day of ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune held on 16thJune, 2016 for their contribution to onion cultivation.

4. Bhima Shubhra

Bhima Shubra, a white onion variety has recommended for *Kharif* and late *Kharif*. It matures in 110-115 DAT during *kharif* and 120-130 DAT in late *kharif*. This variety has TSS of 10-12^{0}B. Bhima Shubra is tolerant to water logging. Average marketable yield is 18-20 t/ha during *kharif* and 36-42 t/ha during late *kharif*. This variety has been recommended for cultivation in Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Tamil Nadu for *kharif* season and Maharashtra for late *kharif* season.

Several demonstrations and trainings were conducted in Akola and Wardha districts of Vidarbha region to promote Bhima Shubhra variety in 2013. Farmers have shown interest in this variety due to its suitability. Consumer preference in Vidarbha region is more for white onion compared red onion. Successful implementation of demonstrations significantly increased area in Vidharbha region. Mr. Namdeorao Adhau, a farmer from Patur village Akola district (Maharashtra) had purchased 5 kg seed of Bhima Shubhra from ICAR-DOGR and raised on 1.25 acre area on raised bed by following recommended technology of ICAR-DOGR. He

Bhima Shubhra

Bhima Shubhra with Mr. Namdeorao Adhau at Patur

obtained a record marketable yield of 21 tons/acre of good quality bulbs with uniform size without doubles, bolters. He earned a net profit of Rs 2.5 lakhs by marketing the produce. Impressed by the performance of this variety, Mr. Adhau decided to disseminate the technology to the farmers in his vicinity. He formed a group of about 300 farmers from twelve villages and now promoting the cultivation of Bhima Shubhra. Mr. Adhau also displayed the bulbs of Bhima Shubhra in various agriculture exhibitions including at 'Krishi Vasant' a National Agriculture Exhibition held at Nagpur during 9-13 February, 2014. Shri Pranab Mukherjee, Hon'ble President of India who was the Chief Guest of the occasion was very much impressed by the quality of bulbs of onion variety Bhima Shubhra displayed by Mr. Adhau. Hon'ble President remarked "Bhima Shubhra is the King of Onion". Mr. Adhau, the recipient of Late Vasantrao Naik Krishi Gaurav Award, has been recently bestowed by Innovative Farmer Award by IARI, New Delhi. The award was presented during Pusa Krishi Vigyan Mela at IARI during March 10-12, 2015. Mr. Adhau gives due credit to ICAR-DOGR for his pragmatic achievements in onion cultivation.

Bhima Shbhra is grown in an area of more than 750 acres in Akola and Wardha District. Most of the members of this group are often earning a net profit of more than Rs. 1.0 lakh/acre.

5. Bhima Red

Bhima Red was initially recommended for *rabi* season in Maharashtra and Madhya Pradesh. This variety has a yield potential of 30-32 t/ha in *Rabi* season with medium storability of 3-4 months. This variety found suitable for *Kharif* and late *Kharif* season as well with the maturity of 105-110 DAT during *kharif* and 110-120 DAT during late *kharif*. The average marketable yield is 19-21 t/ha during *kharif* season and 48-52 t/ha during late *kharif* season. Bhima Red is suitable for cultivation in Delhi, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Rajasthan and Tamil Nadu during *Kharif* season.

Bhima Red

6. Bhima Dark Red

Bhima Dark Red is a *kharif* onion variety moderately tolerant to water logging. Average marketable yield of this variety is 20-22 t/ha. This variety has attractive dark red flat globe bulbs. It attains maturity in 95-100 DAT. This variety has been identified for release in Chhattisgarh, Delhi, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan and Tamil Nadu.

Bhima Dark Red

7. Bhima Light Red

It is a *rabi* variety having light red globe bulbs with average bulb weight of 70-80 g. It has thin neck and total soluble solids of 13%. This variety matures in 110-115 days after transplanting (DAT). Total weight losses after four months of storage was less than 25%. It is almost free from doubles and bolters. This variety is recommended through All India Network Research Project on Onion and Garlic (AINRPOG) for cultivation in Karnataka and Tamil Nadu. Its average yield in multi-location trials in the recommended zone was 38.5 t/ha.

Bhima Light Red

8. Bhima Shweta

Bhima Shweta

Bhima Shweta is white onion variety recommended for *kharif* and *rabi* seasons. This variety has TSS of 11-12^{0}B and matures in 110-120 DAT. It has medium storability of 3 months. Average marketable yield is 18-20 t/ha during *kharif* season and 26-30 t/ha during *rabi* season. This variety is recommended for Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Tamil Nadu.

10. Bhima Safed

Bhima Safed

Bhima Safed, a new white variety having round to oval bulbs with average bulb weight of 70-80 g. This is a medium maturing (110-120 days) variety. It has 11-12% TSS and is thus suitable both for table purpose and processing. Its average yield in multi locational trials in the recommended zones was 185 q/ha. It has less than 5% doubles and bolters. This variety is suitable for cultivation Chhatisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, and Tamil Nadu.

Garlic varieties

1. Bhima Purple

Bhima Purple has attractive purple skin colour. This variety matures in 120-135 days with the average yield of 6-7 t/ha. Bhima Purple has been recommended for cultivation in the states of Delhi, UP, Haryana, Bihar, Punjab, Maharashtra, Karnataka and Andhra Pradesh.

ICAR-DOGR organized trainings and frontline demonstrations of Bhima purple variety of Garlic for farmers primarily from Maharashtra and later expanded to Madhya Pradesh, Gujarat, Rajasthan, etc. states. Improved garlic cultivation practices along with basic information of garlic varity Bhima Purple disseminated through frontline demonstrations and distribution of technical bulletins and flyers to the farmers. Our one trainee Mr. Vishnu Ramchandra Jare, a farmer from Bahirwadi, Ahmednagar (Maharashtra) where no garlic has been grown before 2007 for commercial purpose, purchased 1 kg seed of garlic bulbs from ICAR-DOGR and raised garlic crop along with other garlic variety by following ICAR-DOGR recommended practices. After harvesting, he

Bhima Purple

Bhima Purple on farmer field at Ahmadnagar

found Bhima Purple as a high yielding variety compare to others. Further he multiplied Bhima Purple and grown on his whole land holding i.e. one hectare. He obtained a record net yield of 4.0 t/acre of uniform bulb size, shape and colour and earned a net profit of Rs 2.0 lakh/acre by selling garlic bulbs @ Rs. 80-100/kg as seed to other farmers. He is continuously multiplying Bhima Purple along with other farmers of his village. In 2014-15, Mr. Jare along with other farmers planted Bhima Purple in about 40 acres and sold harvested bulbs as seed directly to different farmers from Maharashtra, Karnataka, Gujarat and Madhya Pradesh. The area under this variety has been expanded up to 600 acres covering different states. Through cultivation of this variety, most of the farmers are often earning a net profit of more than Rs. 1.0 lakh/acre. Mr. Jare received Late Vasantrao Naik Krushi Bhushan Award (2012) and Mahindra Samriddhi India Agri Award (2013) for promoting garlic cultivation consequently improving livelihood of villagers and standing tall among garlic growers.

In addition to this, recently under Tribal Sub Plan (TSP), garlic variety Bhima Purple has been introduced and expanded up to 250 ha area at Nandurbar where initial cultivation of garlic is negligible. Eventually, socio-economic status of tribal farmers improved due to interventions of ICAR-DOGR technologies.

2. Bhima Omkar

Bhima Omkar produces medium size compact white bulbs. This variety matures in 120-135 days and has potential yield of 8-14 t/ha. Bhima Omkar is susceptible to thrips. This variety has been recommended for cultivation in the states of Gujarat, Haryana, Rajasthan and Delhi.

Bhima Omkar

II. Novel Genetic Stock

A. Registered with NBPGR

ICAR-DOGR has identified five novel genetic stocks and the details are given below

1. DOGR-1203-DR is unique onion genetic stock for early maturity and uniform neck fall. This has been registered with NBPGR as **IC0598327** with registration number **INGR14057.** This is the first common onion genotype matures in 90 days after transplanting suitable for *rabi* season. This genotype is useful in transferring early maturity trait into improved common onion varieties. This has been registered with NBPGR, New Delhi.

DOGR -1203-DR

2. DOGR-1549-Agg' is a unique early and high yielding pink multiplier onion. This has been registered with NBPGR as **IC-0616539 with** registration number **INGR16006.** It is the first multiplier onion genotype registered with ICAR-NBPGR as a unique genetic stock. It is about one week earlier than popular multiplier onion variety CO-5 and suitable for both *rabi* and *kharif* seasons. It has six to eight uniform pink bulblets per bulb.

DOGR-1549-Agg

B. Under registration with NBPGR

BDOGR-1523-Agg

1. DOGR- 1523-Agg, a clonal selection from a sample collected from Irur, Perambalur dist, Tamil Nadu. It is a unique dark red early maturing multiplier onion suitable both for *kharif* and *rabi* seasons. It matures in 85 days after planting during *rabi* and 75 days after planting during *kharif*, *i.e.* more than one week earlier than popular variety CO-5. It has 5 to 6 bulblets/bulb.

WM-514

2. WM-514, a white multiplier onion genotype collected from Karimnagar district of Andhra Pradesh. It has average bulb yield of about 20 t/ha. The numbers of bulblets are 4 to 6 in a cluster with cluster diameter of 3.5 to 4.0 cm and length up to 3.0 cm. Percentage total soluble solids ranges between 13 and 14%. Bulblets are ovate and mature 90-100 days after transplanting in *rabi* and late *kharif*, respectively.

DOGR -1168

3. DOGR-1168 is a bolting tolerant onion line by screening the germplasm available at the institute. The highest marketable yield was 38.8 t/ha with bolting percentage of less than 5%. It is a unique bolting tolerant onion variety suitable both for late *kharif* and *rabi* seasons. This line matures in 125-130 days after planting. It has attractive medium red globe bulbs.

III. Hybrids

DOGR has developed eight promising F1 hybrids and they are being evaluated under AINRPOG multi location trials. These include DOGR Hy-1 (F_1), DOGR Hy-2 (F_1),DOGR Hy-3 (F_1), DOGR Hy-4 (F_1), DOGR Hy-5 (F_1), DOGR Hy-7 (F_1), DOGR Hy-8 (F_1).

IV. Sources of resistance for biotic and abiotic stresses

DOGR has identified some of the genotypes resistant to biotic and abiotic stresses and the details are given below.

S.No.	Type of stress	Sources of genotypes
1.	Thrips	Onion wild germplasm, *A. ampeloprasum*was identified as resistance to thrips.
2.	Anthracnose (*Colletotrichum gloeosporioides*)	ICAR-DOGR Hy-50 and wild accessions *A. tuberosum* (CGN-16418), *A. fragrance* and *A. tuberosum* (CGN-16418) were identified as moderately resistant to anthracnose.
3.	*Stemphylium* blight	Three genotypes B. Shakti, MS100 X B. Shubhra and W-419, were moderately resistant during kharif.

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S.No.	Type of stress	Sources of genotypes
4.	*Fusarium* basal rot during *rabi*	Accession-56 was identified as resistant to Fusarium. Accession. 48, 52, 100, 119, 123, 141, 166, 211, 228, 271, 389, 458, 500, 513, 519, 573 were identified as moderately resistant.
5.	*Fusarium* basal rot /plate rot during *kharif*	Accession-360 was identified as resistant to basal rot.
6.	Viruses	Total of 60 accessions of garlic were tested for resistance to the allexivirus group, LYSV and GarCLV and 20 accessions were found to be resistant to these viruses.
7.	Water logging	White onion entries W 208, W 453 and red onion entries namely, DOGR Hybrid 50, DOGR Hybrid 4, DOGR Hybrid 5, KH-M-2, RGP-5, RGP-2 and Acc.1626 are tolerant to water logged stress.
8.	Drought	Red entries namely; Acc. 1630, Acc. 1656 and Red genepool-2 whereas, white entries namely; W 448, W 419, W 043, W 397 were identified as tolerant to drought.

6. Production technologies

I. *Kharif* onion production technology

Kharif season is characterized by heavy rain fall which leads to poor drainage and incidence of diseases like anthracnose, purple blotch and *Stemphylium* blight. These factors affect *kharif* onion production. *Kharif* onion yield is very poor with 4.0 t/ha. Keeping this in view, ICAR-DOGR developed *kharif* onion production technology to increase *kharif* onion yield. The technologies include:

- Selection of varieties recommended for *kharif* season (Bhima Super, Bhima Darkred, Bhima Red, Bhima Raj, Agrifound Darkred, Arka Kalyan, Baswant 780, Phule Samarth *etc*.)
- Raising nursery during second fortnight of June on broad bed furrow with drip or sprinkler irrigation under shade nets and keeping the seedlings ready for transplanting in the first fortnight of August.
- Raising seedling under shade net
- Transplanting of seedlings on broad bed furrow with drip irrigation. The raised bed in broad bed furrow facilitates quick and efficient drainage of rainwater, which minimizes the incidence of soil borne and foliar diseases.
- Combined application of 75:40:40:20 kg NPKS/ha, organic manure equivalent to 75kg N/ha is recommended for *kharif and Azospirillum* and phosphorus solubilising bacteria at 5kg each per ha is recommended.
- Application of FYM or Vermicompost pre-mixed with *Trichoderma viride* before bed preparation which helps in reducing the incidence of soil borne diseases.
- Fertigation through drip avoids leaching losses of nutrients, which is common in high rainfall conditions: 2/3 of top dressing N needs to be applied in seven splits at weekly interval from transplanting to 60 DAT.
- Application of pre-emergence herbicide pendimethalin @0.2%.
- Developed Spray schedule for effective management of pest and diseases

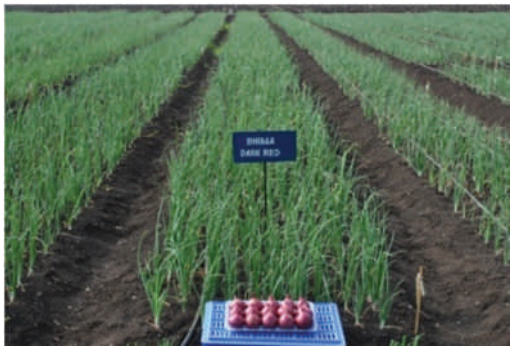
    1. Mancozeb @ 0.25% with Methomyl @ 0.08 g/l at 30 days after transplanting (DAT),

2. Tricyclazole @ 0.1% with Carbosulphan @ 0.2% at 45 DAT,
3. Hexaconazole @ 0.1% with profenofos @ 0.1% at 60 DAT.
4. Propiconazole @ 0.1% with fipronil @0.1% at 75 DAT if required

This *technology* ensures 20-25 tons of yields per hectare without compromise on quality of bulbs.

Kharif onion production technology: For improving livelihood of onion farmers– a success story

Kharif onion production has been affected severely due to excess rainfall and higher incidence of Anthracnose disease. Farmers were getting 4.0 tonnes of onion bulbs per hectare. ICAR-DOGR has developed *Kharif* onion production technology to overcome this issue. This technology ensures 20-25 tons of yields per hectare without compromise in quality of bulbs. It has also been demonstrated to the farmers of different states and non-traditional areas such as Vidharba regions and Nandurbar districts of Maharashtra and across the country for promoting *kharif* onion production with the help of KVKs and AINRPOG.



Kharif onion on raised bed with drip irrigation

Demonstration of kharif production technology at village Patur

Shri Namdeorao Adhau, from Patur, Akola (Maharashtra), purchased seeds of 'Bhima Shubhra' and Bhima Kiran from DOGR and raised onion on raised bed following *kharif* production technology of ICAR-DOGR. He obtained a record marketable yield of 21 tonnes/acre of Bhima Shubhra (white onion) and 10 t/acre of Bhima Super (red onion). He earned a net profit of ₹6.0 lakhs during *kharif* season. Shri Adhau formed a group of about 300 farmers from twelve villages of the region. He is promoting *kharif* production technology in Vidharba region. Area under *kharif* onion production in 2014-15 has increased by 100-150% in Vidarbha region compared to 2011-12. *Kharif* onion production was also demonstrated in Navapur Taluka of Nandurbar in 2013. With this demonstration, area under *kharif* onion production has increased to about 3000 ha in Nandurbar district with the production of 0.5 lakh tones. The *kharif* production technology has also been successfully demonstrated to the farmers of Karnataka, Madhya Pradesh, Uttar Pradesh, Rajasthan, Andhra Pradesh, Bihar, Gujarat and West Bengal with help of All India Network Project on Onion and Garlic and local Krishi Vigyan Kendra's. The area under *kharif* production has been increased

With *kharif* onion production technology of ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune, the farmers are continued to grow onion with higher productivity with increased profit. The farmers are producing higher (20-25 t/ha) bulb yield and profit. Overall *kharif* onion growing areas in Maharashtra during 2014-15 has increased by 1.4 times (1.54 lakh ha area) compared to 2004-05 with production of about 23.5 lakh tones of onion with economic benefit of about Rs.1156.0 Crores. With this intervention, the livelihood of onion farmers is improved.

considerably in these states as well. Government of West Bengal has approved a pilot project for increasing area under *kharif* onion production through field demonstration.

II. Micro Irrigation for Onion and Garlic

For drip irrigation, seedlings need to be planted at a spacing of 10 x 15 cm in a broad bed furrow (BBF) of 15 cm height and 120 cm top width with 45 cm furrow. Each BBF should have two drip laterals at (16 mm size) 60 cm distance with inbuilt emitters. The distance between two inbuilt emitters should be around 30-50 cm and the discharge flow rate is 4 l/hr. For sprinkler, the distance between two laterals (20 mm) of micro sprinkler should be 6 m and with a discharge rate of 135 l/hr. Drip irrigation at 100% Pan Evaporation (PE) significantly improved the marketable bulb yield (15-25%) with higher per cent 'A' grade bulbs. Water saving of 35-40% and labour saving of 25-30%.

Drip irrigation: Changing the fortune of onion growers– a success story

Looking into the need of saving irrigation water for future and for increasing area under onion crop, ICAR–Directorate of Onion and Garlic Research (ICAR–DOGR), Rajgurunagar, Pune conducted field experiment to study the effect of drip irrigation on onion yield, quality and water use efficiency in comparison to surface irrigation method during 2000-2003.

Drip irrigation technology was demonstrated to farmers of different places in Maharashtra. A farmer Mr. Vikram Avchat of Chaitanya farmers club from Othur village adopted this technology and observed higher bulb yield, good quality bulbs and higher net planted area with less input cost. After visualizing the benefits, about 90% of onion growers from the village have adopted this technology. At same time, this technology has been demonstrated to Mr. Padekar, Mr. Adau, Mr. Zare Patil and at Nandurbar district. With continuous effort from ICAR-DOGR, this technology has been adopted by about 60% of onion growers in Maharashtra.

Mr. Vikram Avchat farm with drip irrigation

With drip irrigation technology, the farmers could get additional benefit of Rs.50000-55000 perhectare compared to flood irrigation system. The farmer obtained benefit of about Rs.39500/ha from increased yield and about Rs. 15000/ha by saving labour charges. Area under onion and its production is increased continuously over the years. Area under onion cultivation in 2000-01 was 1.08 lakh tones with the production of 13.0 lakh tones. It increased to 5.22 lakh ha with the production of 65.4 lakh tones in 2014-15. Drip irrigation technology contributed much in increasing area under onion and its production. In Maharashtra, farmers are growing onion under drip system in about 3.13 lakh hectares with additional bulb yield of 24.0 lakh tones and profit of Rs.1250.0 crores. This technology also demonstrated and spread to other major onion growing states like Gujarat and Madhya Pradesh as well. Area under drip irrigation

In Overall since adoption of this technology, farmers have received an additional profit of about Rs 5600 crore. Besides this, drip irrigation, helped in saving of about 35-40% of irrigation water which can be used for cultivation of additional crop. This technology is truly fulfilling the dream (Per Drop More Crop) of our Honourable Prime Minister.

technology in remaining states are about 0.44 lakh hectares with additional production of 3.5 lakh tones and profit of Rs.180.0 crores.

III. Fertigation

Fertigation is an effective and efficient method of applying fertilizers through drip irrigation system along with irrigation water. Drip irrigation system is used as the carrier and distributor of irrigation water and crop nutrients. Application of fertilizers @ NPK 40:40:60 kg /ha as basal and the remaining 70 kg N in seven splits through drip irrigation is recommended for achieving higher marketable bulb yield and cost benefit ratio. Split doses should be applied at weekly interval from transplanting to 60 DAT. Drip irrigation system not only helps in water saving but also reduces nitrogen losses by leaching into ground water as fertilizer nutrients are applied in root zone only.

IV. Integrated nutrient management technology for *rabi* onion

ICAR-DOGR developed INM technology, combined application of 110:40:60:20 kg NPKS along with organic manures equivalent to 15t FYM and *Azospirillum* and Phosphorus solubilizing bacteria @ 5 kg each/ha for *rabi* onion. Combined application of 110:40:60:20 kg NPKS along with organic manures equivalent to 15t FYM and *Azospirillum* and Phosphorus solubilizing bacteria @ 5 kg each/ha increased onion bulb yield by 10-15% compared to previous recommendation of DOGR (150:50:80:50 kg NPKS + 20 t FYM ha^{-1}). Besides the yield and cost benefit ratio, available soil nutrient status after harvest was also increased compared to the initial values. By adopting this recommendation, the use of costly inorganic fertilizers can be reduced by 25%.

V. Integrated nutrient management technology for garlic

Combined application of 75:40:40:20 kg NPKS along with organic manures equivalent to 15 t FYM and *Azospirillum* and Phosphorus solubilizing bacteria @ 5 kg each/ha is recommended for garlic. Application of 75:40:40:20 kg NPKS inorganic fertilizers along with organic manures equivalent to 15 t FYM and *Azospirillum* and Phosphorus solubilizing bacteria @ 5 kg each/ha was found better over previous recommendation of DOGR (100:50:50:50 kg NPKS + 20 t FYM ha^{-1}). Besides the yield and cost benefit ratio, available soil nutrient status after harvest was also increased over the initial values. By adopting this recommendation, the use of costly inorganic fertilizers can be reduced by 25%.

VI. Micronutrient management for *rabi* onion

ICAR-DOGR in collaboration with AINRPOG analyzed soil micronutrient status and conducted field experiments. Based on the results, $ZnSO_4$ @ 10 kg/ha as basal is recommended in areas having Zn deficiency (Nashik, Chiplima and Jabalpur). Borax @ 10 kg/ha is recommended for areas having boron deficiency (Dharwad and Shrinagar). FYM @ 15 t/ha is recommended in areas having multi-micronutrient deficiency (Junagadh, Pune, Samastipur, Durgapura, Hissar and Kanpur) along with foliar application of micronutrient mixture (Fe: 2.5%, Zn: 0.3%, Mn: 1%, Cu: 1.0%, B: 0.2%) at 45 and 60 days after transplanting for increasing onion productivity. Application of micronutrient increased bulb yield by 7-15% compared to control.

VII. Integrated weed management technology for onion

Application of Oxyflurofen 23.5 % EC @ 1.5ml/L before planting and one hand weeding at 40-60 days after onion seedlings transplanting recorded the higher marketable bulb yield (43.5t/ha) with maximum weed control efficiency of 78.4%. The same treatment was also recorded higher cost benefit ratio of 1:3.1.

3. Protection technologies

Spray schedule for the management of fungal foliar diseases of onion

In order to stop the possible development of resistance in foliar fungal onion and garlic pathogens, an experiment was designed by using spray schedule involving broad spectrum systemic and contact fungicides spray in alternate fashion during peak disease period i.e. 30-60DAT. Among different treatments, spray schedule involving first spray of mancozeb (0.25%) + methomyl (0.8g/L) at 30 DAT, tricyclazole (0.1%) + carbosulphan (2ml/L) at 45 DAT and hexaconazole (0.1%) + profenophos (1ml/L) at 60 DAT found effective for the management of *Stemphylium* blight and Purple blotch.

Farmers' driven approach of IPM interventions yielded healthy and profitable onion farming – a success story

Demostration of onion IPM at Farmer's field

The adaptable integrated pest management (IPM) technology developed by ICAR- Directorate of Onion and Garlic Research, Pune was validated and promoted among onion growers at village Wadgaon Sahani, of Pune District of Maharashtra. The comprehensive package of IPM interventions included (i) onion seed treatment with bio control agent, *Trichoderma* sp @ 4-6 g/kg seed (ii) field application of *Trichoderma* sp @ 2 kg which was multiplied in a quintal of farm yard manure (FYM) for a hectare (iii) seedling root dipping (bottom 1/3rd of onion seedling) with fungicide and insecticide combination (0.25% carbosulfan 25 EC + 0.1 % carbendazim 50 WP) solution for 2 hours before transplanting, (iv) planting two rows of maize 7-10 days prior to onion transplanting, across the field border as barrier to break adult thrips movement (v) field scouting or monitoring of onion thrips and other diseases twice a week and (vi) need based application of DOGR recommended pesticides (vi) balanced application of recommended fertilizers (110: 40: 60:30 Kg of NPKS per hectare) and avoid of excessive nitrogen fertilizer application.

The interventions recommended by experts of ICAR-DOGR and ICAR-NCIPM convinced the onion growers about the utility of onion IPM module. As a result of adoption of IPM strategies, onion growers of this village were able to substantially reduce the number of sprays in a season, maximum up to three sprays instead of eight to ten sprays that were usually followed for a crop. The total plant protection cost under IPM adopted field was Rs. 7000 per hectare against Rs.15000 per hectare under Non-IPM (Farmer Practice) that reflected a decrease in cost of IPM inputs to the tune of 53.33%. The total cost of cultivation under IPM situation was Rs.165000 per hectare whereas it was ` 175000/- under farmer' practice (Non-IPM). Ultimately, growers were able to cut down the cost of production up to 5%. The total bulb yield achieved under IPM was 45 ton/ha against 47 t/ha in Non-IPM. However, marketable bulb weight after storage under IPM and Non-IPM regimes was 35 t/ha and 30 ton/ha, respectively. Moreover, losses incurred due to bulb weight reduction after physiological and storage loss were much higher in bulbs produced with Non-IPM practices. The excessive application of synthetic insecticides, growth enhancer and nitrogenous fertilizers probably contributed to much storage losses in non-IPM regime. The IPM practices resulted higher monetary gains of Rs.185000 as compared to Rs.125000/ in non-IPM with IPM gains to the tune of 32.43% per hectare. The benefit cost ratio (B: C) under IPM and Non-IPM (Farmer Practice) was 2.1:1 and 1.71:1, respectively.

4. Post-harvest

Onion grader

ICAR-DOGR developed hand operated and motorized onion graders. These graders have increased efficiency by 5 and 20 times, respectively, compared to manual grading. The precision of grading achieved by graders is 98% as against 50% in manual grading. Both the graders have become popular with the onion growers as well as traders. ICAR-DOGR has signed MoU with M/S R.K. Engineering Works for manufacturing and sale of motorized onion grader.

1. Hand operated onion grader

Manual operated grader is a double roller type grader, which grades onion on the basis of equatorial diameter. The grader has provision for grading onion in five grades (<35mm, 35–50 mm, 50–60mm, 60–80mm and >80 mm) according to the size of onions. Output capacity is 1.0 tone per hour.

2. Motorized onion grader

Motorized grader has two sets of counter rotating double rollers, which grades onion on the basis of equatorial diameter. The grader has one HP motor for rotating the rollers. It has provision of grading onion in five grades i.e. <35 mm, 35–50 mm, 50– 60mm, 60–80 mm and >80mm. Output capacity 1.5 to 2.0 tons per hour.

Both the graders have become popular with the onion growers as well as traders. MoU has been signed with M/S R.K. Engineering Works for manufacturing and sale of motorized onion grader. **A total of nine graders have been sold by the M/S R.K. Engineering Works.**

Driving positive change through new generation onion storage structures – a success story

ICAR-DOGR developed new generation storage structures. These new generations storage structures are commissioned within the premises of ICAR-DOGR at Rajgurunagar, Pune. As part of this several types of storage structures such as Traditional double row storage structure with asbestos roof (Capacity: 38 T), Modified bottom ventilated double row storage structure with asbestos roof (Capacity: 42 T), Modified bottom cum top ventilated double row storage structure with asbestos roof (Capacity: 30 T), bottom ventilated double row

In Several progressive farmers have reported a jump in their annual profits upon successful adoption of these new generation storage structures. Shri Dattatre Sahadev Vaane, a progressive farmer from Ahamadnagar, is witnessing the true benefits of this lab-to-land technology transfer initiative.

"*We used to store onions in a traditional way. Because of that, the onion was soaked. With information from the scientists of the Directorate of Onion And Garlic Research, we have built a new storage of onions. It has 1 to 1-1 / 2 feet airy floor. Onions keep the height of 4 to 5 feet. Due to this the loss of onion started decreasing*"

storage structure with asbestos roof and chain links on sides (Capacity: 32 T), Low cost bottom ventilated single row onion storage structure with thatched roof (Capacity: 5 T), Traditional single row storage structure with Mangalore tiles roof (Capacity: 5 T), Bottom ventilated single row storage structure with Mangalore tiles roof (Capacity: 5 T) were constructed. These structures vary in their capacity and cost to fulfill the requirement of all income group of farmer's viz., small, marginal and big farmers/traders.

The Government of Maharashtra upon realizing the performance of these new generation storage structures, has granted subsidies to those enterprising and progressive farmers who are willing to adopt these well engineered storage structures. As per the data reported by the Government of Maharashtra, so far a storage capacity of 10-12 lakh tonnes is created adopting the new generation storage structures.

2 Entrepreneurship developed

ICAR-DOGR has taken initiative along with KVK Nandurbar to establish *NESU Parisar Farmers Producer Company of* the tribal farmersat Nimboni, Nandurbar and registered it with Ministry of Corporate Affairs, GOI with the support of ICAR-DOGR through Tribal Sub-Plan. Socio-economic status of tribal farmers has been significantly improved due to the intervention of ICAR-DOGR through TSP scheme. It involves 500 farmers and each farmer receives 1-2 lakh income per year by producing onion seed.

Farmer Producer Organization 'Shramik Bharti Agro Producer Company' at Patur of Akola district (Maharashtra) has been formed and registered in the year 2014. It involves 200 farmers and each farmer gets 2-3 lakh per annum from their onion seed production.

8 Breeder Seed produced (year-wise, Kg)

Sr. No.	Onion Variety	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Total
1	Bhima Super	152.4	0	0	0	0	100	**252.4**
2	Bhima Raj	31.4	0	57	107	92	30	**317.4**
3	Bhima Red	168	0	0	0	148	100	**416**
4	Bhima Dark Red	0	0	0	0	633	100	**733**
5	Bhima Shubhra	0	0	0	0	641	0	**641**
6	Bhima Shakti	1007	0	0	0	0	100	**1107**
7	Bhima Kiran	357	0	0	0	570	100	**1027**
8	Bhima Shweta	7.9	0	0	0	246	100	**353.9**
	Total (kg)	**1723.7**	**0**	**57**	**107**	**2330**	**630**	**4847.7**

9. Truthful Seed produced (year wise, Kg)

Sr. No.	Variety	2012-13	2013-14	2014-15	2015-16	2016-17	Total
	Onion						
1	Bhima Super	597.3	790.8	536	1080.1	1274.1	**4278.3**
2	Bhima Raj	-	-	-	-	13.2	**13.2**

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Sr. No.	Variety	2012-13	2013-14	2014-15	2015-16	2016-17	Total
	Onion						
3	Bhima Red	-	23.9	13	-	415.24	**452.14**
4	Bhima Dark Red	-	-	45	-	182	**227**
5	Bhima Shubhra	33.5	125.7	76	-	-	**235.2**
6	Bhima Shakti	-	200	597	578	1869.31	**3244.31**
7	Bhima Kiran	17	293.3	1684.4	320	964	**3278.7**
8	Bhima Shweta	44.7	2.9	87	-	116	**250.6**
9	Bhima Safed	-	-	-	-	208	**208**
	Total (kg)	**692.5**	**1437**	**3038.4**	**1978.1**	**5041.85**	**12187.85**
	Garlic						
1	Bhima Omkar	1104	2068	1545	225	137	**5079**
2	Bhima Purple	351	675	2386	797	359	**4568**
	Total (kg)	**1455**	**2743**	**3931**	**1022**	**496**	**9647**

10. Area covered by varieties of Directorate

Directorate has produced and sold seeds as well as bulbs based on this the estimated area covered by the varieties developed by the institute is 3.47 lakh ha which covers about 27 percent of the area of the onion cultivation in the country.

Sr. No.	Onion Variety	Seeds (kg)	Area covered (ha.)
1	Bhima Super	8272	131296.19
2	Bhima Raj	891	14147.14
3	Bhima Red	904	14341.75
4	Bhima Dark Red	960	15238.10
5	Bhima Shubhra	876	13907.94
6	Bhima Shakti	4351	69068.41
7	Bhima Kiran	4819	76490.48
8	Bhima Shweta	605	9595.24
9	Bhima Safed	208	3301.59
	Total (kg)	**21886**	**347392.06**

11. Technologies commercialized and income generated

The centre has sold 17 Tonnes of onion seed and 9.6 tonnes of garlic of released varieties worth Rs. 196 Lakhs during the period under report. Besides, through MOU for onion varities and grader Rs. 3.6 Lakhs have been earned.

12. Consultancy money earned

Contract research trials

A total of **Rs. 44,73,150/-** was generated through contract research trials during the reporting period. Year wise details are given below.

Contracting Party	*Project Title*	*Project Cost*
Syngenta Pvt. Ltd	Evaluation of Bio-efficacy of Thiamthoxam14.1 + Lambda cyhalothrim 10.6% w/w (Alika) against thrips	Rs. 2,02,250/-
Syngenta Pvt. Ltd	Evaluation of Bio-efficacy of Azoxystrobin 18.2% + dienoconazole 11.4% SC w/w (AmistaeTop) against onion disease complex	Rs. 2,25,000/-
Agrinos India Pvt Ltd	Evaluation of high yielding technology products of onion	Rs. 1,70,000/-
BASF India Ltd., Mumbai	Evaluation of Bio-efficacy and phytotoxicity of Pyraclostrobin 12.8% + Boscalid 25.2% WG (Pristine 38% WG) against Purple blotch and Stemphylium blight of Onion	Rs. 3,35,000/-
BASF India Ltd., Mumbai	Evaluation of Cycloxydim 20% EC (BAS 51725H) with and without MSO adjuvants	Rs. 3,35,000/-
Sulphur Mills Ltd., Mumbai	Evaluation of Turbo ZS on quality and yield of onion crop	Rs. 4,60,000/-
Embio Ltd., Mumbai	Evaluation of Biomanure (BIOFIX) for onion production	Rs. 4,60,000/-
United Phosporous Ltd. Mumbai	Evaluation of Water absorbent for onion production	Rs. 5,00,000/-
Coromandel International Ltd., Secuderabad	Sulphur fortified NPKS 24:24:0:8 fertilizer in onion	Rs. 4,03,000/-
Sea6 Energy Pvt. Ltd., Bangalore	Evaluating the effect of Sea6 Biostimulants formulations on the yield of onion	Rs. 2,70,000/-
UPL Pvt. Ltd. Valsad, Gujarat	Evaluation of bio-efficacy of UPH 716 herbicide on weeds of onion	Rs. 4,44,000/-
BASF	Evaluation of BAS 703 01 F for onion	Rs. 2,88,350 /-
Syngenta	Evaluation of Virtako 1.5 GR on onion crop	Rs. 3,80,550 /-
	Total	**Rs. 44,73,150/-**

Other Consultancy Income Rs.720649/- year 2014-15

13. Resources generated through sale of produce

A total of **Rs. 2,89,16,760/-** generated during the reporting period. Year wise details are given below

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Year	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Sale of Farm Produce	440695	1332374	994457	2922538	1663477	7353541
Sale of Seed	2008952	4449105	2876643	3988523	6304194	19627417
Sale of publication	58270	120230	120998	109525	82390	491413
License Fee	175610	231855	107272	114490	100673	729900
Sale of Technology	-	-	125000	-	476862	601862
Royalty	-	-	42240	39337	31050	112627
Total						**28916760**

14. Publications

During the period 2012-2017, the Institute brought out 317 publications with an average of 4.40 publications per scientist per year. Average number of research papers per scientist per year was 0.97. Seventy research papers were published in National/ International research journals. The list of publications are mentioned below (Details in Annexure III and IV).

	012-13	013-14	2014-15	2015-16	2016-17	Total
Research Papers	15	11	16	15	13	**70**
Books				1		**1**
Reviews / Book chapters	3	1	-	14	8	**26**
Papers/ Abstracts in proceeding	3	7	9	6	39	**64**
Technical Bulletin/ News Letter	5	5	5	10	7	**32**
Popular articles	5	26	12	33	48	**124**
Total	**31**	**50**	**42**	**79**	**115**	**317**

B. All India Network Research Project on Onion and Garlic

Considering the achievements of the centre, importance of the commodities in trade and intricate future challenges, the NRC was strengthened and upgraded as Directorate of Onion and Garlic Research (ICAR-DOGR) in 2009 along with All India Network Research Project on Onion & Garlic (AINRPOG) with 13 centres including coordinating unit at ICAR-DOGR and 16 voluntary centres in XIth plan and at present have 12 main & 14 voluntary centres. Over a decade, the centre has created infrastructure facilities of high rank and has contributed significantly in increasing the production and productivity of onion and garlic in the country by breeding improved varieties, developing new agricultural practices and by imparting training to stakeholders. The centre has identified sustainable and eco-friendly practices for production as well as post-harvest management of onion and garlic to enhance profitability and welfare of the farming community. In XIIth plan the project was continued with addition of some new centres and special attention to north eastern region as given below:

Centres of AINRPOG in XIIth Plan

Main Centres (12)	Voluntary Centres (14)
• **Coordinating Centre;**	✓ BCKV, Kalyani
✓ ICAR-DOGR, Rajgurunagar	✓ IGKVV, Raipur
• **Networking Centres;**	✓ IIHR, Bangalore
✓ ICAR-CITH, Srinagar	✓ MPKV, Rahuri
✓ PAU, Ludhiana	✓ NHRDF, Nasik
✓ CSAUAT, Kanpur	✓ ICAR-VPKAS, Almora
✓ JAU, Junagadh	✓ Dr. PDKV, Akola
✓ SKRAU, Durgapura, Jaipur	✓ ICAR-CITH, Mukteshwar
✓ JNKVV, Jabalpur	✓ NHRDF, Karnal
✓ RAU, Samastipur, Bihar	✓ AUK, Jhalawar
✓ OUAT, Chiplima, Bhubaneshwar	✓ SKUAST, Jammu
✓ UAS, Dharwad	✓ UHS, Bagalkot
✓ TNAU, Coimbatore	✓ CSSHPKV, Palampur
• **Network Centre under NEH Regions;**	✓ RVSKVV, Mandsaur
✓ ICAR-Research Complex, Barapani/Gangtok	
✓ (Tripura, Meghalaya, Sikkim, Nagaland)	

Year Wise Recommendations of AINRPOG

2009-10

- Onion variety RO-597 from DOGR, Pune was identified for release in Zone III and VI and Line 355 from NHRDF, Nasik for release in Zone III, IV and VI during 2009-10.
- Based on two years results, it was observed that pre emergence application of Oxyflurophen @ 0.15 kg ai/ ha at ten days after transplanting recorded the highest marketable yield combined with higher cost benefit ratio of 2.23 and maximum weed control efficiency. This may be recommended for western Maharashtra conditions.
- Based on three years results of seed pelleting experiment, seed pelleting with DAP 30g + ZnSO4 0.10g + Bavistin 3g/ Kg of seeds recorded significantly higher yield combined with higher cost benefit ratio of 4.3 and 4 on raised bed and flat beds, respectively at JNKVV, Jabalpur. This may be recommended for Kymore Plateau and Satpura hills of Madhya Pradesh.
- To control thrips in onion during *rabi* season, give three sprays of Fipronil @ 1.5ml/l at 15 days interval from 30 days after transplanting.

2010-11

- Three varieties of onion viz. NRCRO-2 (1156) from DOGR is identified for release in Zone III, IV, V and VI; Sel-126 from IARI is identified for released in Zone III, IV and V; and NRCWO-2 (White Elite Composite) from DOGR is identified for release in Zone III, V and VI. Three varieties of garlic viz. VGP-5 from VPKAS, Almora is identified for release in Zone I; NRCRG-1 (316) from DOGR was identified for release in Zone III and VI, and G-189 from NHRDF for release in Zone III, IV and VI during 2010-11.
- Foliar application of water soluble NPK fertilizers (20:20:20) in onion @ 5g/litre at 30, 45 & 60 days after transplanting during rabi season recorded the highest yield and cost benefit ratio of 392 q/ha and 1:4.95 at Rahuri, 365 q/ha and 1:5 at Nashik, 450 q/ha and 1:2.5 at Rajgurunagar and 298 q/ha and 1:2.52 at Coimbatore, respectively Hence foliar application of water soluble NPK fertilizers (20:20:20) in onion @ 5g/litre at 30, 45 & 60 days after transplanting during rabi season is recommended for Maharashtra (Rahuri, Rajgurunagar and Nasik) & Tamil Nadu (Coimbatore).
- Foliar application of water soluble NPK fertilizers (19:19:19) recorded the highest yield of 327 q/ha with higher cost benefit ratio of 1:5.17 in addition to recommended dose of NPK. Hence it is recommended for Junagadh conditions of Gujarat.
- Drip irrigation in onion seed crop at 75% PE – daily interval is recommended for Junagadh conditions of Gujarat with the highest seed yield of 6.21 q/ha and higher cost benefit ratio of 1:3.24.
- Drip irrigation at 100% PE daily interval gave the highest seed yield (5.21q/ha), maximum water saving (49.3%) combined with higher cost benefit ratio of 1:2.23 at Rahuri. Whereas, under Rajgurunagar conditions, the highest seed yield of 6.16 q/ha with higher cost benefit ratio of 1:3.81 and maximum water saving (48.3%) was recorded in the same treatment. Hence it is recommended for Rahuri and Rajgurunagar conditions of Maharashtra.

2011-12

- Based on conclusion of three year trial on botanicals and bio-pesticides, spray of bio-pesticide Spinosad @56 g. ai./ha at 10-15 days interval is recommended for effective management of thrips on onion.

2012-13

- In onion for *kharif*, five onion varieties were recommended for different colour and zones and also suitable for different seasons. Bhima Super a medium red, single centred onion variety from DOGR has been identified for release in Zone II, IV, V& VI. NRCRO-3 (RGO-53) a dark red onion variety from DOGR has been identified for Zone II, IV, V& VI. Bhima Red already recommended for *rabi*, has also been recommended for cultivation in *kharif* in Zone II, V & VI. NRCWO-4 (W-009) (Bhima Shubhra) a white variety has been identified for zone IV, V & VI and NRCWO-3 (White Elite Composite) (Bhima Shweta) already recommended for *rabi* has also been recommended for cultivation in *kharif* in Zone IV, V & VI. In case of garlic, G-408 variety from NHRDF has been recommended for Zone I for long day *rabi* season.
- The results of weed management study carried out at 14 networking centres in zones I to VI, showed that application of Oxyflurofen 23.5 % EC before planting + one hand weeding at 40-60 days after transplanting (DOGR recommended practices) was found superior in terms marketable bulb yield, WCE

and B:C ratio at 12 networking centres. Adoption of this practice increased the weed control efficiency by 75-90 % over control.

- Field experiment was carried out to evaluate integrated nutrient management for *rabi* onion at 14 networking centres in zones I to VI, for three years from 2008-09 to 2011-12 and the results showed that combined application of 110:40:60:40 kg NPKS along with organic manures equivalent to 15 t FYM and Azospirillum and Phosphorus solubilizing bacteria @ 5 kg each/ha found better with respect to marketable bulb yield and cost benefit ratio over previous recommendation of DOGR (150:50:80:50 kg NPKS + 20 t FYM ha-1) and local recommendations of networking centres. Besides the yield and cost benefit ratio, soil available nutrient status after harvest was also increased over the initial values. By adopting this recommendation, the use of costly inorganic fertilizers can be reduced by 25 %.

2013-14

Garlic varieties for *rabi* season

a) Mukteshwar Selection-2 from CITH, for Zone I consisting of Srinagar, Almora, Mukteshwar, Palampur and Ooty centres.

b) CITH-1 from CITH, Srinagar for Zone I consisting of Srinagar, Almora, Mukteshwar, Palampur and Ooty centres.

c) G-313 from NHRDF for Zone I consisting of Srinagar, Almora, Mukteshwar, Palampur, and Ooty centres.

d) G-384 from NHRDF for Zone II consisting of Jammu, Ludhiana, Delhi, Karnal, Hissar, and Durgapura centres.

- **Sulphur recommendation for onion:** Based on three years trial, application of S @ 30 kg/ha is recommended for onion crop where soils sulphur level is more than 15 kg/ha. Application of S @ 45 kg/ha recommended for onion crop where soils sulphur level is less than 15 kg/ha. Gypsum is recommended as a source of sulphur for J & K (Srinagar), UP and Gujarat and elemental sulphur is recommended for Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh, Odessa, West Bengal, Haryana and Bihar.

- **Integrated Nutrient Management for garlic:** Application of 75:40:40:40 kg NPKS/ha along with combination of two or three organic manures (FYM, Poultry manure and Vermicompost) equivalent to 15 t FYM/ha is recommended for Tamil Nadu (Ooty), Rajasthan, Bihar, Orissa, Madhya Pradesh, Maharashtra and Gujarat. Application of 100:50:50:50 kg NPKS + 20t FYM/ha is recommended for Haryana and Uttar Pradesh.

- **Management of foliar disease:** Two sequential spray schedules of fungicide in combination with insecticide found to be effective for the management of foliar diseases of onion as follows:

a. Mancozeb 0.25% +Methomyl 0.8g/L at 30 DAT, Tricyclazole 0.1% + Carbosulfan 2ml/L at 45DAT and Hexaconazole 0.1% +Profenofos 1ml/L at 60DAT.

b. Mancozeb 0.25% + Methomyl 0.8g/L at 30 DAT, Propiconazole 0.1%+ Carbosulfan 2ml/L at 45 DAT and Copper oxychloride 0.25% + Profenofos 1ml/L at 60DAT

- **IPM for onion thrips**

For management of thrips, following IPM module was recommended in all the zones (tested at Srinagar, Hissar, Karnal, Durgapura, Kanpur, Kalyani, Samastipur, Imphal, Jabalpur, Chiplima, Junagadh, Nashik, Rajgurunagar, Coimbtore and Dharwad centres).

a) Planting barrier crops – outer row of maize + inner row of wheat on all 4 sides of the plot at least 7-10 days before onion seedling transplanting. Wheat was sown closely and maize at 25cm interval. Avoid tall maize variety. No gaps should be there between maize plants.

b) Seedling root dip: dip the seedlings (bottom 1/3rd) in carbosulfan (2ml/L) solution for 2h before transplanting.

c) Monitor thrips population twice a week regularly. Whenever thrips population (nymphs) crosses 30/plant, spray – Profenophos 1ml/L (Ist spray), carbosulfan 2ml/L (II nd spray).

2014-15

- **Varieties:** Garlic for *rabi* season: G-386 recommended for zone –II, onion - red for *rabi* season: Col. 744 recommended for zone – III and onion - white for *kharif* season: NRCWO-3 recommended for zone - IV, V and VI.
- **Varieties for sets:** On the basis of three years data for sets production of onion varieties at six locations, Bhima Super, RGO-53 (Bhima Dark Red) and Bhima Shweta were found to produce more desirable sets in comparison with check variety ADR. Hence, above mentioned varieties have been recommended for cultivation of early *kharif* crop through sets technology in central and northern part of India where raising of seedlings is difficult during *kharif*.

2015-16

Varieties:

- Onion variety DOGR-571-LR from ICAR-DOGR, red onion for *rabi* season for release in South Zone VI.
- Garlic variety CITH-G-3 from CITH for release in Hill Zone-I.
- ZnSO4 @ 10 kg/ha as basal is recommended in areas having Zn deficiency (Nasik, Chiplima and Jabalpur). Borax @ 10 kg/ha is recommended for areas having boron deficiency (Dharwad and Srinagar). FYM @ 15 t/ha is recommended in areas having multi-micronutrient deficiency (Junagadh, Pune, Samastipur, Durgapura, Hissar, Kanpur) along with foliar application of micronutrient mixture (Fe: 2.5%, Zn: 0.3%, Mn: 1%, Cu: 1.0%, B: 0.2%) at 45 and 60 days after transplanting for increasing onion productivity.
- Foliar application of salicylic acid @ 250 mg/liter at 30 days after sowing in nursery and in the main field either at 30 or 45 or 60 days after transplanting is recommended for Durgapura, Hisar, Samastipur, Chiplima, Jabalpur, Junagadh, Coimbatore, Kanpur, Kalyani and Srinagar for increasing onion productivity.

2016-17

- Sel. 153-1 (OSR-1347) red onion variety from IARI is identified for release in Zone II (Delhi, Rajasthan, Haryana, J&K Jammu and Punjab) for *rabi* season.

- Col. 819 (OSR-1344) red onion variety from NHRDF is identified for release in Zone II (Delhi, Rajasthan, Haryana, J&K Jammu and Punjab) and Zone V (Gujarat & Maharashtra) for *rabi* season.

Overall Impact

Because of Network programme awareness of varieties, production technology and storage has increased among the farmers. This has resulted in enhancing production per unit area. Further, production and productivity has been increased in non-traditional area *viz*., Chhattisgarh, Madhya Pradesh, Kalahandi and Bolangir in Odisha, and North East. This would reduce expenditure on logistic for transporting onion and garlic from traditional areas. This would also help balancing demand supply mechanism which is major concern of central government.

5 Linkages

As a leading research organization in the country for Onion and Garlic, the Directorate has close linkages with the institute and universities in NARS. Collaboration also exists with selected conventional universities, Institute of CSIR, Department of Biotechnology, Molecular Biology etc.

During the period, Directorate has established linkages with NIASM, Baramati (for research on abiotic stresses in onion and garlic), NRC on Grapes, Pune (for chemical profiling of garlic germplasm), CIAE, Bhopal (for development of onion planters), IIHR, Bangaluru (for development of onion harvester and grader), IARI, New Delhi (for chemical profiling of garlic), ICAR-CITH, Srinagar; PAU, Ludhiana; CSAUAT, Kanpur; JAU, Junagadh; SKRAU, Durgapura, Jaipur; JNKVV, Jabalpur; RAU, Samastipur, Bihar; OUAT, Chiplima, Bhubaneshwar; UAS, Dharwad; TNAU, Coimbatore; ICAR-Research Complex, Barapani/Gangtok (Tripura, Meghalaya, Sikkim, Nagaland);BCKV, Kalyani; IGKVV, Raipur; IIHR, Bangalore; MPKV, Rahuri; NHRDF, Nasik & Karnal; ICAR-VPKAS, Almora; Dr. PDKV, Akola; ICAR-CITH, Mukteshwar; AUK, Jhalawar; SKUAST, Jammu; UHS, Bagalkot; CSSHPKV, Palampur and RVSKVV, Mandsaur (for evaluation of varieties of onion and garlic and validation of production, protection and post harvest technologies).University of Wisconsin, USA (for research on male sterility and colour genes), Washington State University (for biosecurity).

The Directorate has signed MoU with Jaipur National University, Jaipur, IGKV, Raipur, MPKV, Rahuri for extending the research facilities to the students of M.Sc. and Ph.D. programme. Under the MoU students can complete the research activities in laboratories of ICAR-DOGR under the supervision of scientists of this Directorate.

Directorate has strong collaboration with various KVK's and private companies for seed production and marketing, evaluation for bioefficacy of new chemicals as listed below:

Programme	Name of Organization
Bhima Super onion variety seed production and marketing	Jindal Crop Sciences Pvt. Ltd
Bhima Red onion variety seed production and marketing	Safalmantra Agrofarms Pvt. Ltd
Motorized onion grader manufacturing and marketing	R.K.Engineering works
Evaluation of Bio-efficacy of Thiamthoxam14.1 + Lambda cyhalothrim 10.6% w/w (Alika) against thrips	Syngenta Pvt. Ltd
Evaluation of Bio-efficacy of Azoxystrobin 18.2% + dienoconazole 11.4% SC w/w (AmistaeTop) against onion disease complex	Syngenta Pvt. Ltd
Evaluation of high yielding technology products of onion	Agrinos India Pvt Ltd

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Programme	Name of Organization
Evaluation of Bio-efficacy and phytotoxicity of Pyraclostrobin 12.8% + Boscalid 25.2% WG (Pristine 38% WG) against Purple blotch and Stemphylium blight of onion	BASF India Ltd., Mumbai
Evaluation of Cycloxydim 20% EC (BAS 51725H) with and without MSO adjuvants	BASF India Ltd., Mumbai
Evaluation of Turbo ZS on quality and yield of onion crop	Sulphur Mills Ltd., Mumbai
Evaluation of Biomanure (BIOFIX) for onion production	Embio Ltd., Mumbai
Evaluation of Water absorbent for onion production	United Phosporous Ltd. Mumbai
Sulphur fortified NPKS 24:24:0:8 fertilizer in onion	Coromandel International Ltd., Secuderabad
Evaluating the effect of Sea6 Biostimulants formulations on the yield of onion	Sea6 Energy Pvt. Ltd., Bangalore
Evaluation of bio-efficacy of UPH 716 herbicide on weeds of onion	UPL Pvt. Ltd. Valsad, Gujarat
Evaluation of BAS 703 01 F for onion	BASF
Evaluation of Virtako 1.5 GR on onion crop	Syngenta
Demonstration and seed production in collaboration with different KVK's	Narayangaon, Nandurbar, Baramati, Jalna, Pal, Osmanabad, Aurangabad, Babhaleshwar,

6 Recommendations

A. ICAR-DOGR, Rajgurunagar

Researchable Issues

1. Processing of onion and garlic industry is prospering in India. The industry demands trait specific varieties with high total soluble solids and white colour. Although, the Directorate is addressing on this issue, the process should be accelerated with greater zeal and priority.
2. India used to be number one in export of onion. However it has gone to No.2 position. The export is done through aggregate of all genotypes in the market. The Directorate should develop variety specific protocol for export in onion and garlic in collaboration with APEDA and farmer producer companies.
3. Garlic productivity in India is very low due to latent viruses which degenerate planting material. The project on virus free garlic production, though started much early, has not given tangible results. There should be time bound focused programme for production of virus free planting material in garlic.
4. Hybrid onion has been discussed a lot, yet remained a grey area in India. Concerted efforts should be made for developing F_1 hybrids suitable for different seasons and different purposes in short day sector.
5. Indian genotypes of onion have got inherent low yield potential. This yield barrier should be broken down with introgression breeding with long day genotypes. Efforts are being made through Srinagar centre. However, more focus should be given for this project. New centres like Almora and Mukteshwar should also be clubbed under this programme.
6. Garlic flowering and fertility restoration has been a challenge world-wide. Yet this programme is most needed for enhancing diversity in garlic for harnessing more genetic potential.
7. ICAR-DOGR has made a dent in micro-irrigation in the country for onion and garlic. However, nutrient uptake based fertigation is the need of the day to cut down budget on fertilizers vis-a-vis enhancing productivity. This will again help in developing customized grades of fertilizers exclusively for onion and garlic.
8. Onion and garlic are highly labour oriented proposition. About 60% budget goes for labour charges. Mechanization in various operation is possible. The centre has initiated work in this regard. However, there is an urgent need for accelerating this programme.
9. Organic production of onion and garlic is again a most needed technique. Holistic programme should be started in this regard.

10. Good work on ”On Farm” storage of onion and garlic has been done by the centre which has helped enhancing storage capacity to the tune of 40 lakh tons countrywide. Yet storage losses are up to 30%. There is need to develop protocol for total cold chain management for long day duration storage. This will also help enhancing export of both the commodities. Further, there is also a need for updating“On Farm” storage structures designed and recommended by ICAR-DOGR.
11. ICAR-DOGR has made visible impact all over the country over last 20 years of research. As a result, the production, productivity and availability of onion and garlic are enhanced. This has helped farmers and other stakeholders to elevate their economic status. However, quantifiable impact analysis has not been done so far. ICAR-DOGR should address this issue through third party intervention.
12. Refinement of bio-intensive IPM for onion and garlic should be made.
13. Continuation of population dynamic studies along with potential parasitoids and predators using proper monitoring techniques like sticky yellow traps are required and conservation and enhancement of natural enemies of thrips with special reference to Eulopid parasitoids are to be carried out.
14. While searching for favorable agrochemical traits in germplasm collections presence of resistance to biotic stresses must also be recorded and validated.
15. There is need to develop protocol for production of residue free onion and garlic through Good Agricultural Practices (GAP).

Administrative and Financial Issues

1. The Directorate has got only 16 scientific cadre strength with minimal support of technical and administrative staff. Considering the proposed programme there is need for Plant Pathologist, Agricultural Engineer, Processing Engineer, Biotechnologist, Vegetable Breeder, Agricultural Economist, Statistician and Librarian. One scientific post as Network Programme Coordinator is also necessary. Commensurate to that of scientific positions, support of administrative and technical staff is also necessary.
2. For proposed manpower, infrastructural facilities and equipments, there is a need for enhanced in budget allocation in EFC.

Infrastructure

With limited resources, the Directorate has made good progress in terms of varietal development, production technology, storage technology, water conservation technology, etc. But looking to challenges ahead narrated in researchable issues, there is need to strengthen the infrastructure. This committee strongly recommends for the following facilities and equipments:

1. Building expansion to accommodate biotech and processing lab.
2. Pre-cooling and cold storage unit for standardizing protocol for cold chain management.
3. Auditorium for seminars, conferences of state, national and international levels.
4. Expansion of existing guest house.
5. Equipments like LCMS and pilot processing plant.

Policy Issues

1. Introgression breeding programme in long and short day onion and garlic following and restoration of fertility is only possible in high altitude areas like Srinagar, Leh, Almora, etc. Some work has been initiated with the help of CITH, Srinagar. However, there is need to have exclusive Regional centre of ICAR-DOGR in these areas. The QRT strongly recommends as Regional Centre in Leh as this would be the most suitable area for envisaged programme.
2. It has been observed that the scientists are transferred before completion of projects at hand. Unfortunately, the scientists who have been doing the work get transferred in the middle of the execution of the project leading to the restart of the work causing huge loss of time and money. Council may ensure that scientists are transferred only when they complete the project in hand and Director may take steps to continue the project with all pertinent record and documents including properhanding over of materials and records to the next incumbent by the scientist who is leaving.
3. ICAR-Directorate of Onion and Garlic Research should be upgraded to the level of a Institute with more scientific, technical, administrative and supporting staff along with regional centre.

B. Network Research Programme on Onion and Garlic

ICAR-DOGR has developed unique network programme with minimum administrative and financial liability on ICAR. There are 10 main and 14 voluntary centres in strategic production as well as potential areas in the country. Through network system over nine years, 14 varieties of onion and 10 varieties of garlic are identified for different zones. Further, 13 technologies are recommended after verification. The QRT has taken first time review of the programme by visiting network centres at MPKV, Rahuri; TNAU, Coimbatore; JAU, Junagadh; IGKV, Raipur; RARI, Durgapura (Jaipur); CSAUT, Kanpur; PAU, Ludhiana; UAS, Dharwad and CITH, Srinagar. Some of the centres especially Ludhiana, Junagadh, Dharwad, Rahuri and Raipur are doing good work. They are studying adaptability of varieties developed by ICAR-DOGR as well as developing their own genotypes. The technologies such as micro-irrigation, storage, fertigation and plant protection are being verified across the regions. This has resulted in enhancing production in non-traditional areas like Madhya Pradesh, Chhattisgarh, Odisha and North East. As a result, there has been regional balance of production and price control. The committee realized the importance and necessity of networking centres. There is need for enhancing support in terms of manpower and finance to these centres. These centres will popularize onion and garlic in strategic production areas. This will reduce un-necessary expenditure on logistic for transporting onion and garlic from Maharashtra and Gujarat. Instead these states can focus for export and processing.

1. In this context, QRT strongly recommends strengthening of network programme which is giving tangible results.
2. Further, for strengthening of network programme, there is a need for enhancing contingencies for contractual help, equipment, inputs and labour wages. QRT strongly recommends for enhancing manpower and budget accordingly.
3. Conversion of IGKV, Raipur and MPKV, Rahuri voluntary centres in main regular centres.

Annexure-I

Constitution of DOGR QRT by ICAR office order

भारतीय कृषि अनुसंधान परिषद
कृषि अनुसंधान भवन-II
पूसा, नई दिल्ली 110 012
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAVAN-II
PUSA, NEW DELHI 110 012

F. No. HS/1-7/2016-IA.V Dated 27th September, 2017

OFFICE ORDER

The Director General, ICAR has been pleased to constitute the Quinquennial Review Team to review the work done during 01.04.2012 to 31.03.2017 at ICAR-Directorate on Onion & Garlic Research, Pune.

COMPOSITION:

1. Dr Kirti Singh, — Chairman
   Former VC and Former Chairman, ASRB
   38-G, Maruti Nagar, T.D. College Main Gate,
   Husenabad, JAUNPUR-222 002(U.P.),
2. Dr D.P. Ray, — Member
   HIG-105,
   K-5, Kalinga Vihar,
   Bhubneswar-751 019(Odisha)
3. Prof. T. Manimutthu, — Member
   Additional Director,
   World Noni Research Foundation,
   12, Rajiv Gandhi Road, Sreenivasa Nagar,
   Chennai-600 096
4. Dr. Lawande, — Member
   Ex.-Vice Chancellor,
   The Mahatma Phule Krishi Vidyapeeth (MPKV),
   Rahuri, Maharashtra 413722
5. Dr. R.D. Gautam, — Member
   Prof. of Entomology (Retd.)
   Block ED.
   T6 B, Pitampura (near Madhuban Chowk)
   New Delhi-110 034

contd ..

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6. Dr. Vijay Mahajan, Secretary
Principal Scientist,
ICAR- DOGR, Pune.

The team shall conduct the review of the work of ICAR- Directorate on Onion & Garlic Research, Pune keeping in view the guidelines and submit its report to the Council within six months for submission to the Governing Body of the ICAR.

PROCEDURE`

The Chairman of the Review Team will initiate action to convene the meeting of the team as early as possible. The Chairman will also inform the Director, ICAR-DOGR, Pune to furnish the information required by the team in regard to the work done or proposed to be done etc. by the Institute as may be required for conducting the review of the ICAR-DOGR, Pune.

The T.A. of the non-official members of the QRT will be borne by the Institute and will be met out of the sanctioned budget of the Institute.

Honorarium will be paid to the Chairman and Members of QRT in addition to TA/DA admissible to them as per ICAR norms.

P.K. Srivastava

(P.K. Srivastava)
Under Secretary (HS)

1. The Director, ICAR- Directorate on Onion & Garlic Research, Pune with a request to inform all the members of the QRT.
2. PS to DDG(Hort.), ICAR
3. Director (Fin.), ICAR.
4. ADG (HS-I), ICAR.
5. F&AO, ICAR-DOGR, Pune.
6. Section Officer Hort.-II Section for further action regarding meeting of QRT with DDG (HS) may please be arranged.
7. Spare copies

Annexure-II

Schedule of QRT Visits

Sr. No.	Date of meeting	Place of Visit	Meeting	Meeting attended by QRT members
1.	6-7 Oct., 2017	ICAR-Horticulture, New Delhi	Pre-QRT meeting with DDG, Horticulture	QRT Chairman: Dr. Kirti Singh, DDG Horticulture: Dr. A.K. Singh, ADG Hort.: Dr. T. Janakiram, QRT Members: Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh
2.	22 Nov., 2018	ICAR-DOGR, Pune	First QRT Meeting	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. D.P. Ray, Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Special Invitee: Dr. R.P. Gupta, Ex-Director, NHRDF, Dr. Umesh Srivastava, Ex-ADG (Horticulture), Shri C. B. Singh, **AGM, APEDA**
3.	23 Nov., 2018	MPKV, Rahuri	Meeting with AINRPOG Voluntary Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. K.P. Vishwanatha, Vice-Chancellor,Dr. S.R. Gadakh, Director Research, Dr. S.A. Ranpise, Head, Dept. of Hort. Special Invitee: Dr. Umesh Srivastava, Ex-ADG (Horticulture), Shri C. B. Singh, **AGM, APEDA**
4.	22 Jan., 2018	TNAU, Coimbatore	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. M. Jawahar, Dean, Dr. S. Thanburaj, Ex-Dean, Dr. I. Irulappan, Dr. D. Veeragavathatham, Ex-Dean, Horticulture, Dr. Arumugam, Head
5.	25 Jan., 2018	JAU, Junagadh	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. A. R. Pathak, Vice-Chancellor, Dr. I. U. Dhruj, Associate Director of Research.
6.	9 Feb., 2018	IGKV, Raipur	Meeting with AINRPOG Voluntary Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh,Dr S.K. Patil, Vice Chancellor and Dr. S.S. Rao, Director Research, Dr. Jitendra Singh, Head, Dept. of Vegetable Science.

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Sr. No.	Date of meeting	Place of Visit	Meeting	Meeting attended by QRT members
7.	10 Feb., 2018	RARI, Durgapura	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh,Dr. P. S. Rathore, Vice Chancellor, Dr. V. K. Yadav, Director Research, Dr. S. J. Singh, Director, Dr. V. S. Yadav, Head, Division of Horticulture.
8.	11 Feb., 2018	CSAUAT, Kanpur	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. Sushil Soloman, Vice-Chancellor, Dr. H.G. Prakash, Director Research, Dr. D.P. Singh, Joint Director Research, Dr. A.K. Dubey, Head,
9.	13 Feb., 2018	PAU, Ludhiana	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. Baldev Singh Dhillon, Vice Chancellor, Dr N.S. Bains, Director Research, Dr. A.S. Dhatt, Head, Dept. of Vegetables
10.	22-24 Mar., 2018	ICAR-DOGR, Pune	QRT-RAC Interface meeting	Dr. Kirti Singh, Chairman, QRT and Ex-Chairman, ASRB, New Delhi, Dr. V.A. Parthasarathy, Chairman, RAC and Members Dr. K.E. Lawande, Prof. Marimuthu, Dr. Umesh Srivastava, Ex-ADG, ICAR, Dr. T. Janakiram, ADG (HS-II), ICAR, KAB-II, Dr. Major Singh, Director, Dr. R.D. Gautam, Dr. V. Mahajan, Member Secretary of QRT, and Dr. A.J. Gupta, Member Secretary of RAC, ICAR-DOGR, Pune
11.	26-27 Mar., 2018	UAS, Dharwad	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. V I Benagi, Director of Research, UAS, Dharwad, Dr. Dharmatti, Head, Dept. of Horticulture.
12.	30-31 May, 2018	CITH, Srinagar	Meeting with AINRPOG main Centre	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. D.P. Ray, Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Dr. Geetika Malik & staff of CITH, Dr. Nazeer Ahmed, VC, DR, DEE, Dean & faculty of SKUAST, Srinagar.
13.	30 July, 2018	ICAR-DOGR, Pune	Finalization of technical programme for Long day Centres	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. D.P. Ray, Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh, Scientists from Long day centres (ICAR-CITH (Srinagar & Mukreshwar, VPKAS (Almora), ICAR-Reg. Complex RS (Sikkim) & Scientists ICAR-DOGR
14	31 July – 1 Aug., 2018	ICAR-DOGR, Pune	Finalization of QRT report and recommendations	QRT Chairman: Dr. Kirti Singh, QRT Members: Dr. D.P. Ray, Dr. K. E. Lawande, Dr. T. Marimuthu, Dr. R.D. Gautam, Dr. Vijay Mahajan, Director ICAR-DOGR: Dr. Major Singh,

Annexure-III

List of Research Paper Published by ICAR-DOGR

Year 2012-2013

1. Aslam M, Grover A, Sinha VB, Fakher B, Pande V, Yadav PV, Gupta SM, Anandhan S, Ahmed Z. 2012. Isolation and characterization of cold responsive NAC gene from *Lepidium latifolium*. Mol Biol Rep. (in press).
2. Bhoyar MS, Mishra GP, Naik PK, Murkute AA, Srivastava RB. 2012. Genetic variability studies among natural populations of *Capparis spinosa* from cold arid desert of trans-Himalayas using DNA markers. National Acad. Sci. Lett., 35: 505-515.
3. Gopal J, Kumar V, Kumar R, Mathur P. 2013. Comparison of different approaches to establish a core collection of andigena (Solanum tuberosum Group andigena) potatoes. Potato Research (in press).
4. Gupta AJ, Verma TS, Bhat R, Mufti S. 2012. Studies on genetic variability and character association in temperate carrot. Indian J. Hort., 69: 75-78.
5. Gupta N, Rathore M, Goyary D, Khare N, Anandhan S, Pande V, Ahmed Z. 2012. Marker-free transgenic cucumber expressing Arabidopsis CBF1 gene confers chilling stress tolerance. Biologia Plantarum 56: 57-63.
6. Kadian MS, Luthra SK, Patel NH, Bonierbale M, Singh SV, Sharma N, Kumar V, Gopal J, Singh BP. 2012. Identification of short cycle, heat-tolerant potato *(Solanum tuberosum*) clones for the semi-arid agro-ecology. Indian J. Agr. Sci., 82: 814-818.
7. Khar A. 2012. Cross amplification of onion derived microsatellites and mining of garlic ESTdatabase for assessment of genetic diversity in garlic. Acta Hort., 969: 289-295.
8. Kumar J, Mishra GP, Murkute AA, Phanikumar G, Naik PK, Srivastava RB. 2012. Exploring genetic relationships in *Artemisia* species growing in trans - Himalayan cold arid desert using RAPD markers. Indian J. Hort., 69: 239-245.
9. Kumar R, Gopal J, Pandey SK. 2012. Genetic improvement for yield and tuber size in andigena potatoes (*Solanum tuberosum* subsp. *andigena*) after one cycle of recurrent selection. Indian J. Agri. Sci., 82: 885-888.
10. Kumar SR, Anandhan S, Dhivya S, Zakwan A, Sathishkumar R. 2013. Isolation and characterization of cold inducible genes in carrot by suppression subtractive hybridization. Biologia Plantarum 57: 97- 104.
11. Patil VU, Gopal J. Singh BP. 2012. Improvement for bacterial wilt resistance in potato by conventional and biotechnological approaches. Agricultural Res., 1: 299-316.
12. Singh RK, Singh S, Pandey P, Anandhan S, Goyary D, Pande V, Ahmed Z. 2012. Construction of cold induced subtracted cDNA library from *Cicer microphyllum* and transcript characterization of identified novel wound induced gene. Protoplasma. (in press)

13. Tiwari J, Gopal J, Singh BP. 2012. Marker-assisted selection for virus resistance in potato: options and challenges. Potato J., 39: 101-117.

14. Uchinoa H, Iwamaa K, Jitsuyamaa Y, Ichiyamma K, Sugiuraa E, Yodatea T, Nakamuraa S, Gopal J. 2012. Effect of interseeding cover crops and fertilization on weed suppression under an organic and rotational cropping system 1. Stability of weed suppression over years and main crops of potato, maize and soybean. Field Crop Res., 127: 9-16.

15. Warghat AR, Bajpai PK, Murkute AA, Sood H, Chaurasia OP, Srivastava RB. 2012. Genetic diversity and population structure of *Dactylorhiza hatagirea* (Orchidaceae) in cold desert Ladakh region of India. J. Medicinal Plants Res., 6: 2388-2395.

Year 2013-2014

16. Dash SK, Kar A and Gorrepati K. 2013. Modified atmosphere packaging of minimally processed fruits and vegetables. Trends in Post Harvest Technol. 1: 1-19.

17. Gawande SJ, Chimote KP, Gurav VS and Gopal J. 2013. Distribution and natural incidence of onion yellow dwarf virus (OYDV) on garlic and its related *Allium* species in India. Indian J. Hort. 70: 544-548.

18. Gawande SJ, Gurav VS, Ingle AA and Gopal J. 2014. First report of leek yellow stripe virus on garlic in India. Plant Disease DOI/abs/10.1094/PDIS-11-13-1163-PDN.

19. Gopal J, Kumar V, Kumar R and Mathur P. 2013. Comparison of different approaches to establish a core collection of Andigena (*Solanum tuberosum* Group Andigena) potatoes. Potato Res. 56: 85-98.

20. Gupta AJ and Yasmin S. 2013. Effect of drip irrigation and fertigation on yield, quality and input use efficiency in cucumber. Indian J. of Ecology. 4: 252-257.

21. Murkute AA, Singh B and Gopal J. 2013. Residues analysis and bulb sprouting in CIPC treated onion. Indian J. Hort., 70: 575-579.

22. Thangasamy A, Sankar V and Lawande KE. 2013. Effect of sulphur nutrition on pungency and storage life of short day onion (*Allium cepa*). Indian J Agri. Sci., 83: 1086-1089.

23. Tiwari JK, Chandel P, Gupta S, Gopal J, Singh BP and Bhardwaj V. 2013. Analysis of genetic stability of in-vitro propagated potato microtubers using DNA markers. Physiol Molecular Biol. Plants. DOI 10.1007/s12298-013-0191-6.

24. Tiwari JK, Pandey SK, Poonam, Chakrabarty SK, Gopal J and Kumar V. 2013. Molecular markers of Ryadg gene and serological assay reveal potato virus Y (PVY) resistance in the tetraploid Indian potato (*Solanum tuberosum*) germplasm. Indian J Agri. Sci., 83: 397-401.

25. Tiwari JK, Poonam, Chakrabarti SK, Kumar V, Gopal J, Singh BP, Pandey SK and Pattanayak D. 2013. Identification of host gene conferring resistance to potato virus Y using Ry gene-based molecular markers. Indian J. Hort. 70: 373-377.

26. Tiwari JK, Singh BP, Gopal J, Poonam and Patil VU. 2013. Molecular characterization of the Indian Andigena potato core collection using microsatellite markers. Afric. J. Biotech. 12: 1025-1033.

Year 2014-2015

27. Anandhan S., Mote S. R., Gopal J. 2014. Evaluation of onion varietal identity using SSR markers. Seed Sci. & Technol., 42: 279-285.

28. Anandhan S., Chavan A. A., Gopal J., Mote S. R., Shelke P. V. and Lawande K. E. 2014. Variation in gynogenic potential for haploid induction in Indian short day onions. Indian J. Genet., 74(4): 526-528.

29. Gawande S. J., Gurav V.S., Ingle A. A. and Gopal J. 2014. First Report of Iris yellow spot virus infecting *Allium tuberosum* in India. Plant Disease 98: 1161.

30. Gawande S. J., Gurav V.S., Ingle A.A. D.P. Martin, Asokan, R. and Gopal J. 2015. Sequence analysis of Indian Iris yellow spot virus ambisense genome segments: evidence of interspecies RNA recombination. Archives of Virology, DOI:10.1007/s00705-015-2354-x

31. Gopal, J. 2014. Challenges and prospects of endosperm balance number in potato (*Solanum tuberosum*) improvement. Indian J. Agric. Sci. 84: 1027-1037

32. Gopal, J. 2014. Heterosis breeding in potato. Agricultural Research. 3: 2011-2017

33. Gopal, J. 2014. A step towards prevention of onion shortage (a report). Current Science: 106: 1176-1177

34. Gupta A. J. and Chattoo M. A. 2014. Response of Knolkhol cv. Early White Vienna to Drip Irrigation and Fertigation in Kashmir Region. Indian Journal of Ecology 41(1):152-157.

35. Gupta A. J., Chattoo M. A. and Bhat F. N. 2014. Standardization of drip irrigation and fertigation practices for commercial cultivation of hybrid cucumber under Kashmir conditions. Progressive Horticulture 46(2): 343-348.

36. Gupta A. J., Dolma T., and Khan A. A. 2014. Component analysis of lettuce (*Lactuca sativa* L.) for horticultural traits and yield. Progressive Horticulture 46(1): 85-88.

37. Jayanthi Mala B. R., Sreenivas P.S., Thangasamy A. and Nighot P. 2014. Role of different nutrients on attack of thrips (Thrips tabaci Lindeman) in onion. Current Biotica. 8(1):72-75.

38. Kalyani Gorrepati, Balasubramanian S., Chandra P. 2014. Plant based butters: review, Journal of Food Science and Technology, ISSN 0022-1155, DOI 10.1007/s13197-014-1572-7.

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42. Singh V., Chavan A. A., Burungale S.V., Deshpande M.B., Nimbkar N. 2014. Heterosis for yield and its components in thermosensitive genetic male sterility based hybrids in safflower. J. Agric Res. Technology., 39(2):320-323

Year 2015-2016

43. Anandhan S., Nair A., Kumkar D.S., Gopal J. 2015. Retrotransposon based TRAP marker displays diversity among onion (*Allium cepa* L.) genotypes. Sci Hort., 190: 123-127.

44. Gawande S.J., Gurav V.S., Ingle A.A. and Gopal J. 2015. First report of Garlic virus A in garlic from India. Plant Dis., 99(9), (http://dx.doi.org/10.1094/PDIS-11-14-1210-PDN).

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47. Gupta A.J., Chattoo M.A. and Singh L. 2015. Drip irrigation and fertigation technology for improved yield, quality, water and fertilizer use efficiency in hybrid tomato. Indian J. of Agri Search, 2(2): 94-99.

48. Karuppaiah V., Saroj P.L. and Krishna H. 2015. Impact of intercrop on incidence of ber fruit fly Carpomyia vesuviana Costa (*Tephritidae: Diptera*) under hot-arid ecosystem. Indian J. Arid Horti.., 9(1-2): 112-114.

49. Mahajan V., Devi A., Khar A. and Lawande K.E. 2015. Studies on mutagenesis in garlic using chemical mutagens to determine lethal dose (LD50) and create variability. Indian J Hort., 72(2): 289-292.

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55. Thangasamy A. 2016. Quantification of dry-matter accumulation and nutrient uptake pattern of short day onion (*Allium cepa* L.). Commun. Soil Sci. Plant Anal., 46 (2): 246–254.

56. Tiwari J.K., Gupta S., Gopal J., Kumar V., Bhardwaj V. and Singh B.P. 2015. Molecular analysis of genetic stability of *in-vitro* conserved potato microplants. Potato J., 42: 137-145.

57. Uchima H., Iwama K., Jitsuyama Y., Yudate T., Nakamura S. and Gopal J. 2015. Interseeding a cover crop as a weed management tool is more compatible with soyabean than with maize in organic farming systems. Plant Prod. Sci., 18: 187-196.

Year 2016-2017

58. Gopal J. and Gadge S.S. 2016. Onion and garlic adding wealthy flavour. Indian Hort., 61(6): 52-56.

59. Mahajan V. and Gupta A.J. 2016. Development of photo and thermo- insensitive cultivars of short day onion in India. Acta Hort., 1143: 61-68.

60. Mahajan V. and Gupta A.J. 2016. Breeding white onion varieties for processing under short day conditions of India. Acta Hort., 1143: 303-310.

61. Murkute A.A. and Anandhan S. 2016. Onion quality affected by ethanol and ethephon during storage. Natl. Acad. Sci. Lett., 39:163–169.

62. Thangasamy A. 2016. 4R stewardship approach for nutrient management in onion and garlic. Better crops-South Asia, X (10). No. 1: 8-12.

63. Thangasamy A. and Chavan K.M. 2017. Assessment of dry matter accumulation and nutrient uptake pattern of garlic crop during crop growth period. Indian J. Hort., 74(1):80-84.

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66. Sujayanand G.K. and Karuppaiah V. 2016. Aftermath of climate change on insect migration: a review. Agri Rev., 37(3): 221-227.

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68. Gorrepati K., Thangasamy A., Bhagat Y. and Murkute A.A. 2017. Curing of onion: a review. Indian Hort. J., 7(1): 08-14.

69. Kuldip J., Mahajan P., Singh G., Parmar R., Seth R., Raina A., Swarnkar M.K., Singh A.K., Sankar R., Sharma R.K. 2016. Transcriptome analysis reveals candidate genes involved in blister blight defense in tea (Camellia sinensis (L) Kuntze). Nat. Sci. Rep., 6, 30412; doi: 10.1038/srep30412.

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73. Sabina Islam, Neelam Patel, Anil Khar, Arpita Srivastava, Pritam Kalia and Yogesh Khade (2017). Variation in various antioxidant biochemical and morphological traits in *kharif* onion. Indian Journal of Horticulture. 74(1): 67-70.

Annexure-IV

List of other Publications by ICAR-DOGR

a. ICAR-DOGR Publications (2012-2017)

Vision 2050	:	ICAR-DOGR Perspective Plan
ICAR-DOGR Annual Reports	:	4
AINRPOG Annual Report	:	5
Newsletters	:	10
CD's	:	2

b. Technical/Extension Bulletins (Marathi & Hindi From 2012-2017)

Technical/Extension Bulletins (2012-2017): 50

Year 2012-2013

1. Mahajan V, Khar A, Gupta AJ, Gopal J. 2012. Onion and Garlic Varieties of DOGR, Technical Bulletin No. 20, Directorate of Onion and Garlic Research, Rajgurunagar, Pune, 9p.
2. Gupta AJ, Negi KS. 2012. Exploration and collection of *Allium* germplasm from Sikkim and West Bengal. DOGR News., 16: 2-3.
3. Murkute AA. 2012. Evaluation of onion varieties in ambient storage. DOGR News., 16: 2-3.
4. Anandhan S. 2012. Prospects in inbred development in onion (*A. cepa*) through induction of haploids.DOGR News., 16: 2.
5. Jayantimala BR. 2012. Ceranisus sp. – A new parasitoid of onion thrips (*T. tabaci* L.). DOGR News., 16: 2.

Year 2013-2014

6. Anandhan S. 2014. Role of Biotechnology in onion and garlic. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 42-48.
7. Gadge SS. 2014. Group dynamics in onion and garlic growers. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 116-121.
8. Gawande SJ. 2014. Management of onion diseases and insect pests. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 87-101.

9. Gopal J. 2013. Onion Crisis: Remedial measures for price stabilization. NAAS News 13: 3-6.

10. Gopal J. 2014. Status of onion and garlic in India and World. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 1-9.

11. Gorrepati K. 2014. Value addition of onion and garlic. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 80-86.

12. Gupta AJ. 2014. Development of hybrids in onion. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 27-41.

13. Gupta AJ. 2014. DUS characterization of onion and garlic varieties. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 107-115.

14. Mahajan V, Gupta AJ and Gopal J. 2013. White multiplier onion 'WM-514'. DOGR News 17 (2): 2

15. Mahajan V. 2014. Varieties of garlic in India. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 22-26.

16. Mahajan V. 2014. Varieties of onion in India. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 10-21.

17. Murkute AA and Gopal J. 2013. Taming the glut. Agriculture Today August, 16: 28-30.

18. Murkute AA. 2014. Postharvest management of onion and garlic. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 122-129.

19. Thangasamy A. 2014. Improved INM module for rabi onion. DOGR News. 17(2): 2.

20. Thangasamy A. 2014. Integrated nutrient and water management in onion and garlic. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 49-60.

21. Thangasamy A. 2014. Weed management in onion and garlic. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 61-79.

22. Yalamalle VR. 2013. Seed Production Technology of Garlic. In: Training manual of National training on 'Quality Seed production of Vegetable Crops' organized by National Seed Research and Training Centre, Varanasi, UP from 16-20 December, 2013, pp. 31-34.

23. Yalamalle VR. 2013. Seed Production Technology of Onion. In: Training manual of National training on 'Quality Seed production of Vegetable Crops' organized by National Seed Research and Training Centre, Varanasi, UP from 16-20 December, 2013, pp. 98-101.

24. Yalamalle VR. 2014. Onion seed production. 2014. In: Compendium of model training course on 'Production technology in onion and garlic' Edited by Gopal J and Gadge SS. DOGR, Rajgurunagar, pp. 102-106.

25. Gopal J and Gadge SS. 2014. Compendium of model training course on “Production technology in onion and garlic”. DOGR, Pune. 159p.

26. Gopal J, Mahajan V, Gawande SJ, Sankar V and Khar A. 2012. DOGR Vision -2050. 43p.

27. Gopal J, Mahajan V, Gupta AJ and Gadge S. 2013. "Nideshalaya dwara viksit pyaj avum lahsoon ki kismet". Extension Bulletin No. 2 (in Hindi): 6p.

28. Gopal J, Mahajan V, Gupta AJ and Gadge S. 2013. Onion and garlic varieties of DOGR, Extension Bulletin No. 2 (in Marathi), Directorate of Onion and Garlic Research, Rajgurunagar, Pune, 6p.

29. Sankar V, Thangasamy A and Gopal J. 2014. Improved cultivation practices for onion. Technical bulletin No. 21. Directorate of Onion and Garlic Research. Rajgurunagar - 410 505, Dist. Pune, Maharashtra.

Year 2014-2015

30. Gupta, A.J., Mahajan, V., Singh, R.K. and Gopal, J. 2015. Bolting in Onion, Technical Bulletin No. 22, ICAR-DOGR, Rajgurunagar, Pune. p.16.

31. Kalyani Gorrepati, Murkute A. A., Gopal J. 2014. Value added products from onion. Processed Food Industry. 17(6): 16-18.

32. Tailor A. K., Sharma H. P. and Gadge S. S. 2014. Impact analysis of technologies developed by NHRDF. Bulletin. NHRDF, Nashik. p. 60.

Year 2015-2016

33. Gopal J. and Gorrepati K. 2015. DOGR profile. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 12.

34. Gupta A.J., Mahajan V. and Gopal J. 2015. Onion and garlic varieties of DOGR. Technical Bulletin No. 20 (Revised). ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 12.

35. Gupta A.J., Singh P., Neeraj S. and Gopal J. 2015. Kandika-Rajbhasha Hindi Patrika. No. 2, ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 52.

36. Gupta A.J., Singh P. and Gopal J. 2015. Pyaj and Lahsun ke Aushdhye Gun. Extension Bulletin No. 5. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p.6.

37. Mahajan V., Gupta A.J., Gadge S.S. and Gopal J. 2015. Sanchalanalaya dware vikasit kanda va lasnachya jati (Revised). Extension Bulletin No. 2. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 6.

38. Sankar V., Thangasamy A., Gadge S.S., Singh P. and Gopal J. 2015. Unnat vidhiyon dwara pyaj ki kheti. Technical Bulletin No. 21. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p .23.

39. Singh P. and Gopal J. 2015. Pyaj Shrenikaran Yantra. Extension Bulletin No. 3. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 4.

40. Singh P. and Gopal J. 2015. Kanda Pratwari Yantra. Extension Bulletin No. 4. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 4.

41. Thangasamy A., Gadge S.S. and Gopal J. 2015. Improved Cultivation Practices for Garlic. Technical Bulletin No. 23. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 20.

42. Thangasamy A., Gadge S.S. and Gopal J. 2015. Lahsun ki unnat kheti. Technical Bulletin No. 24. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. p. 20.

Year 2016-2017

43. Gopal, J., Mahajan, V. and Gupta, A.J. 2016. Catalogue of onion germplasm, Technical Bulletin No. 25, ICAR-DOGR, Rajgurunagar, Pune. 34 p.
44. Gopal J., Mahajan V. and Gupta A.J. 2016. Catalogue of garlic germplasm (Allium sativum L.). Technical Bulletin No. 26. ICAR-DOGR, Rajgurunagar, Pune. 23p.
45. Lawande K.E. and Mahajan V. 2017. Summary Proceedings and Recommendations of 2nd National Symposium on Edible Alliums: Challenges and Future Strategies for Sustainable Production. ICAR-DOGR, Rajgurunagar, Pune. 12p.
46. Mahajan V., Tripathi P.C., Srinivas P.S., Gawande S.J., Anandhan S., Thangasamy A., Gadge S.S. and Singh R.P. 2016. Lead papers & abstracts: 2nd National Symposium on Edible Alliums: Challenges and Future Strategies for Sustainable Production. ISA, Pune. 291p.
47. Thangasamy A., Gadge S.S. and Mahajan V. 2017. Nursery Management in Onion. Extension Bulletin No. 7. ICAR-DOGR, Pune. 6p.
48. Gorrepati K., Salunkhe V.N. and Gopal J. 2016. Pyaj bhandaran. Extension folder No.6. ICAR-DOGR, Rajgurunagar, Pune. 6p.
49. Gorrepati K., Khade, Y and Mahajan, V (2017). Kanda sathvan. Extension folder. ICAR-DOGR, Rajgurunagar, Pune. pp: 6.
50. Ganeshamurthy A.N., Thangasamy A., Mahajan V. And Gupta P.K. 2017. Soil fertility and crop nutrition in onion and garlic: Deliniation, deficiencies and management of nutrients. Technical Bulletin No. 25. ICAR-DOGR, Rajgurunagar, Pune. 61p.

c. Book Chapters (2012-2017): 26

Year 2012-2013

1. Singh BK, Gupta AJ, Singh L. 2012. Improvement of faba bean (*Vicia faba* L.) In: Faba Bean *(Vicia faba* L.) A Potential Leguminous Crop of India (Eds. Singh AK and Singh BP). ICAR RC for Eastern Region, Patna. 119-141.
2. Singh L, Singh AK, Singh P, Gupta AJ, Kumar P, Dimree S. 2012. Nutritional management in faba bean (*Vicia faba* L.) In: Faba Bean (*Vicia faba* L.) A Potential Leguminous Crop of India (Eds. Singh AK and Singh BP). ICAR RC for Eastern Region, Patna. 227-247.
3. Yalamalle VR, Shankar V, Kuchlan MK. 2013. Performance of Mega Seed Project at Directorate of Onion and Garlic Research, Pune. In: ICAR Seed Project- Seed Production In Agricultural Crops And Fisheries A Way To Sustainable Quality Seed Supply In India (Eds. Prasad R, Somasundharam S, Vijaykumar G, Tonapi HP, Kamble VA, Natarajan S, Dandapani R, Mandal AK). pp. 132-133.

Year 2013-2014

4. Gorrepati K. 2013. Packaging of value added products from soybean and millets. In Processing and value addition of soybean and course cereals, pp. 171-178

Year 2015-2016

5. Gawande S.J. 2015. Fungal Diseases. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 197-211.

6. Gopal J. and Murkute A.A. 2015. Onion R&D in India-Status and Prospects. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 9-29.

7. Gupta A.J., Veeragowda R. and Mahajan V. 2015. Breeding for hybrid technology. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 82-103.

8. Gupta A.J., Veere Gowda R. and Mahajan V. 2015. Breeding for hybrid technology. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 56-81.

9. Haldhar S.M., Karuppaiah V., Muralidharan C.M. and Sharma S.K. 2015. Insect-pests of Date Palm and Their Management. In: Insect Pests Management of Fruit Crops (Eds. Pandey A.K. and Mall P.), GB Pant University of Agriculture and Technology, Uttarakhand. pp. 405-421.

10. Karuppaiah V., Haldhar S.M. and Sharma S.K. 2015. Insect Pests of Ber (Ziziphus mauritiana Lamarck) and their Management. In: Insect Pests Management of Fruit Crops. (Eds. Pandey A.K. and Mall P.), GB Pant University of Agriculture and Technology, Uttarakhand. pp. 271- 294.

11. Lawande K.E. and Gupta A.J. 2015. Onion In: Olericulture-II: Vegetable Production and Improvement (Eds; Singh K.P. and Bahadur A.), Kalyani Publishers, Noida. pp. 245-281.

12. Lawande K.E. and Gupta A.J. 2015. Garlic In: Olericulture-II: Vegetable Production and Improvement (Eds; Singh K.P. and Bahadur A.), Kalyani Publishers, Noida. pp. 282-297.

13. Mahajan V., Negi K.S. and Gupta A.J. 2015. Biosystematics, botany and genetic resources. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 30-55.

14. Mishra G.P., Murkute A.A., Anandhan S., Kumar A. and Radhakrishnan T. 2015. Antifreeze Proteins: Cold Tolerance and other Applications. In: Modern Methods in Phytomedicine (Ed. Parimelazhagan T). Daya Publishing House, New Delhi. pp.1-15.

15. Murkute A.A. and Gorrepati K. 2015. Post harvest management and processing. In: The Onion. (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 247-271.

16. Palaniappan R. and Thangasamy A., 2015. Nutrient management. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 162-175.

17. Rao E.S., Mahajan V. and Pathak C.S. 2015. Genetics and breeding of open pollinated varieties. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp.56-81.

18. Reddy D.C.L., Anandhan S. and Aswath C. 2015. Biotechnology. In: The Onion (Eds. Krishnakumar N.K., Gopal J. and Parthasarathy V.A.), Indian Council of Agricultural Research, New Delhi. pp. 121-144.

Year 2016-2017

19. Mahajan V. 2017. Potato onion In: Genesis and evolution of horticultural crops. Ed. Peter K.V., Kruger Brentt Publishers, UK. pp. 251-262.

20. Mahajan V., Gupta A.J. and Lawande K.E. 2016. Genetics and breeding: White onion varieties status for processing. In: Edible Alliums: Challenges and Future Strategies for Sustainable Production. Eds. Mahajan V. et al., ISA, Pune. pp. 60-70.

21. Pathak C.S., Mahajan V. and Gupta A.J. 2016. Onion history, breeding and improvement needs In: Edible Alliums: Challenges and Future Strategies for Sustainable Production Eds. Mahajan V. et al., ISA, Pune: 1-19.

22. Singh R.K., Gupta R.P. and Mahajan V. 2017. Garlic In: Genesis and evolution of horticultural crops. Ed. Peter K.V. pp. 157-175.

23. Gupta R.P., Singh R.K. and Mahajan V. 2017. Onion In: Genesis and evolution of horticultural crops. Ed. Peter K.V. pp. 223-250.

24. Gupta A.J. and Singh, B.K. 2016. Development of hybrids and hybrid seed production of onion. In: Training manual on principles and production techniques of hybrid seeds in vegetables. 27 September-8 October. ICAR-IIVR, Varanasi. pp. 101-111.

25. Devi A., Anandan S., Khar A., Mahajan V. and Lawande K. E. 2016. Application of haploidy as a technique in short day onion improvement program in “Edible Alliums: Challenges and Future Strategies for Sustainable Production. Eds. Mahajan V. et al., ISA, Pune. pp. 71-73.

26. Kumar R., Kuldip P.S., Ahuja R.K., Sharma 2016. Status and opportunities of molecular breeding approaches for genetic improvement of tea. In: Molecular Breeding for Sustainable Crop Improvement, Sustainable Development and Biodiversity 11, DOI 10.1007/978-3-319-27090. Eds. Rajpal V.R. et al., Spinger International Publishing Switzerland. pp. 6-5.

Annexure-V

Awards and Recognitions

Year 2013-2014

1. IPA medal for the best paper published in Potato Journal by Tiwari, J., Jai Gopal and B.P. Singh (2012). Marker assisted selection for virus resistance in potato: Options and challenges. Potato Journal. 39:101-117.
2. First prize for poster paper entitled "Management of biodiversity in onion" authored by Dr. A. J. Gupta and Dr. V. Mahajan at National Conference on Agro-biodiversity management for sustainable rural development" held at NAARM, Hyderabad during November 14 – 15, 2013.

Year 2014-2015

3. ICAR-DOGR has got ISO 9001:2008 accreditation.

Year 2015-16

4. Dr. Vijay Mahajan was invited by International Symposium on Edible Alliums, Turkey, 21-25 May, 2015 to Chair Crop Improvement session and deliver key note lecture

Year 2016-2017

5. Dr. S. Anandhan has been awarded for the best oral presentation on "Evaluation of genetic diversity among the Allium species using SRAP markers" authored by Anandhan S., Dukare S., Ingle A.A., Pingle P.S., Mahajan V. in 2nd National Symposium on Edible Alliums: Challenges and future strategies for sustainable production during 7- 9 November, 2016 at Jalna.
6. Dr. S. Anandhan has been awarded as ICAR-National fellow for the project entitled: Haploid induction onion (*Allium cepa* L.) through genome elimination.
7. Dr. Vanita Salunkhe has been awarded for the best poster on "Screening for resistance to anthracnose (Colletotrichum gloeosporiodes Penz.) in wild onion" authored by Vanita Salunkhe, V. Mahajan and Jai Gopal in 2nd National Symposium on Edible Alliums: Challenges and future strategies for sustainable production during 7- 9 November, 2016 at Jalna.
8. Dr. Pranjali Ghodke has been awarded for the best oral presentation on "Identification of critical growth stages in onion for water deficit stress" authored by Pranjali Ghodke and A. Thangasamy in 2nd National Symposium on Edible Alliums: Challenges and future strategies for sustainable production during 7- 9 November, 2016 at Jalna.
9. Dr. Vijay Mahajan has been honoured by appreciation letter for special achievement in 2nd National Symposium on Edible Alliums: Challenges and future strategies for sustainable production during 7- 9 November, 2016 at Jalna.
10. Mr. Dilip Mundharikar has also been awarded by appreciation letter in 2nd National Symposium on Edible Alliums: Challenges and future strategies for sustainable production during 7- 9 November, 2016 at Jalna.

Annexure-VI

Staff Position

Manpower Sanctioned

Plan (Period)	Scientific		Technical		Administrative		Supporting		Total	
	Approved*	Sanctioned	Approved*	Sanctioned	Approved*	Sanctioned	Approved*	Sanctioned	Approved*	Sanctioned
VIII (92-97)	11	11	8	8	9	9	7	7	35	35
IX (97-2002)	16	16	17	7	11	8	23	7	67	38
X (2002-07)	16	16	20	10	11	8	27	11	74	45
XI (2007-12)	16	16	27	10	13	12	27	11	83	49
XIIth Plan	16	16	10	10	11	11	11	11	48	48

*Approved in EFC but permission not given to create

Staff Position as on October 2017

Sl. No.	Category	Approved	Sanctioned Post	Filled Post	Vacant Post
1.	Scientific	16	16	18*	+2
2.	Technical	10	10	10	-
3.	Administrative	11	11	9	-2
4.	Skilled Supporting Staff	11	11	11	-
	Total	**48**	**48**	**48**	

List of Staff as on 31.10.2017

Position of Scientists from 2012 till date:

Sl. No.	Name	Qualifications	Date of Joining the Institute	Date of transfer/ leaving DOGR
1	Dr. Major Singh, Director	M.Sc. (Ag) Ph.D	13.04.2017	
	* Dr. Jai Gopal, Director	M.Sc. (Ag) Ph.D	09.01.2012	31.10.2016
2	Dr. Vijay Mahajan, Pr. Scientist	M.Sc. (Ag) Ph.D Horti, PGDTMA	30.11.2000	

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Sl. No.	Name	Qualifications	Date of Joining the Institute	Date of transfer/ leaving DOGR
	* Dr. Anil Khar, Sr. Scientist	M.Sc. (Ag) Ph.D Horti	13.03.1998	31.05.2013
	* Dr. V. Sankar, Sr. Scientist	M.Sc. (Ag) Ph.D Horti	25.11.1999	30.04.2013
3	Dr. A.J. Gupta, Pr. Scientist	M.Sc. (Ag) Ph.D Veg. Science	06.12.2008	
4	Dr. S.J. Gawande, Pr. Scientist.	M.Sc (Ag.) Plant Pathology	01.01.2010	
5	Dr. S.S. Gadge, Sr. Scientist	M.Sc. (Ag) Ph.D Extension	10.07.2009	
	* Dr. A. A. Murkute, Sr. Scientist	M.Sc. (Ag) Ph.D	10.01.2011	22.08.2014
6	Dr. S. Anandhan, Sr. Scientist	M.Sc. (Ag) Ph.D Plant Biotechnology	18.01.2011	
7	Dr. A. Thangasamy, Scientist	M.Sc. (Ag) Ph.D Soil Science	20.10.2007	
8	Sh. V. R. Yelmalle, Scientist	M.Sc. (Ag)	23.04.2010	
	* Mrs. Jayanthimala, Scientist	M.Sc. (Ag)	17.09.2010	11.01.2013
9	Mrs. A. P. Benke, Scientist	M.Sc. (Ag)	15.09.2011	
10	Dr. Kalyani Gorepatti, Scientist	M.Sc. (Ag) Ph.D Post Harvest Technology	26.11.2012	
	* Dr. V. N. Salunkhe, Scientist	M.Sc (Ag.) Plant Pathology	21.04.2014	31.05.2017
11	Dr. V. Karuppaiah, Scientist	M.Sc. (Ag) Ph.D Entomology	29.11.2014	
12	Dr. K. P. Bhagat, Scientist	M.Sc. (Ag) Ph.D Plant Phy.	29.05.2017	
13	Dr. Pranjali Ghodke, Scientist	M.Sc. (Ag) Ph.D Plant Physiology	09.04.2014	
14	Sh. Manjunatha Gowda D.C., Scientist	M.Sc. (Horti)	09.04.2014	
15	Sh. Kuldip, Scientist	M.Sc. (Botany)	09.04.2015	
16	Sh. Yogesh P. Khade, Scientist	M.Sc. (Horti)	09.10.2015	
17	Dr. Soumia P.S., Scientist	M.Sc. (Ag) Ph.D Entomology	09.10.2015	
18	Dr. R. B. Kale, Scientist	M.Sc. (Ag) Ph.D Extension	11.07.2017	

* Not in position at ICAR- DOGR as on 31.10.2017

Administrative Staff

Sl. No.	Name	Date of Joining
1.	Sh.Shitanshu Kumar, Administrative Officer	03.04.2017
2.	Mrs. Vijaya Amol Bhumar, Asstt. Finance & A/c. Officer	07.09.2009
3.	Sh. P.S. Tanwar, Asstt. Admin.Officer	02.12.1998
4.	Sh. D. B. Mundharikar, PS	29.10.1998

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Sl. No.	Name	Date of Joining
5.	Sh. S.P. Kandwal, Assistant	05.06.1995
6.	Mrs. M.S. Salve, Assistant	01.05.2001
7.	Mrs. N.R. Gaikwad, Assistant	06.11.1998
8.	Sh. R.K. Dedage, UDC	25.11.1998
9.	Sh. N.S. Warkar, UDC	21.05.2010

Technical Staff

Sl. No.	Name	Date of Joining
1.	Sh. HSC Shaikh, Sr. Technical Officer	01.08.1997
2.	Sh. R. B. Baria, Sr. Technical Officer	24.07.2006
3.	Sh. D.M. Panchal, Sr. Technical Assistant	23.04.2006
4.	Sh. S.P. Yeole, Sr.Technical Assistant	11.08.2006
5.	Sh. A.R. Wakhare, Sr. Technical Assistant	16.12.2006
6.	Sh. V. Gurav, Technical Assistant	09.06.1997
7.	Sh. B.A. Dahale, Technical Assistant	29.06.2006
8.	Sh. H. S.Gawali, Sr. Technician	12.12.2006
9.	Sh. R. Y. Bomble, Technician	18.02.2013
10.	Mrs. P. V. Shelke, Technician	01.03.2013

Skilled Supporting Staff

Sl. No.	Name	Date of Joining
1.	Sh. S.K. Said,	05.09.1998
2.	Sh. P.K. Khanna	01.04.2005
3.	Sh. R.S. Kulkarni	01.04.1997
4.	Sh. P.R. Sonawane	19.07.1996
5.	Sh. P.E. Tadge	19.07.1996
6.	Sh. M.S. Kale	23.07.1996
7.	Sh. S.D. Waghmare	11.04.1997
8.	Sh. N.H. Sheikh	20.10.1997
9.	Sh. S.B. Tapkir	01.12.2006
10.	Sh. A.D. Fulsunder	13.12.2006
11	Sh. S.S. Gopale	22.06.2007

Annexure-VII

Information about the Directorate

Onion and garlic are the world famous spice commodities, used for flavouring the dishes. Besides culinary purposes, these are considered as valuable medicinal items. Realizing the importance of these commodities in the country, Indian Council of Agricultural Research established National Research Centre for Onion and Garlic in VIII Plan with its headquarter at Nasik. However, due to technical and working constraints, the Centre could not be established well at Nasik and was shifted to Rajgurunagar in June 1998. It is located at 553.8 m above MSL with a temperature range of 5.5 °C - 42.0 °C having annual mean rainfall of 669 mm. Considering the achievements of the centre, importance of the commodities in trade and intricate future challenges, the NRC was further strengthened and upgraded as Directorate of Onion and Garlic Research (ICAR-DOGR) in 2009 along with All India Network Research Project on Onion & Garlic (AINRPOG) with 13 centers including coordinating unit at ICAR-DOGR and 16 voluntary centers in XI plan and at present have 12 main & 14 voluntary centers. Over a decade, the centre has created infrastructure facilities of high rank and has contributed significantly in increasing the production and productivity of onion and garlic in the country by breeding improved varieties, developing new agricultural practices and by imparting training to stakeholders. The center has identified sustainable and eco-friendly practices for production as well as post-harvest management of onion and garlic to enhance profitability and welfare of the farming community. In XII plan the project was continued with addition of some new centers and special attention to north eastern region as given below, to promote and increase onion and garlic production.

For resolving major constraints in production of onion and garlic in major growing areas, the centre has following mandate:

Mandate

- Basic, strategic and applied research on genetic resource management, crop improvement and production technologies for enhancing and sustaining production of onion and garlic
- Transfer of Technology and capacity building of stakeholders for enhancing productivity of onion and garlic
- Coordinate research and validation of technologies through AINRP on onion and garlic

Infrastructure

Farm: The centre has 55 acres of research farm at Rajgurunagar, 55 acres at Kalus and 10 acres at Manjri with perennial irrigation facilities.

Laboratories: DOGR has advanced laboratory facilities including for Biotechnology, Soil Science, Plant Protection, Post-Harvest Technology, Seed Technology and DUS.

ARIS Cell: DOGR is having a well established ARIS cell with 43 computers interlinked with LAN and two servers

for high speed broadband internet connectivity with firewall protection. ARIS cell is having most advanced research software like SAS, data management system, application packages, word processing software *etc*. DOGR is having its own website www.dogr.res.in, which is regularly updated.

Library: Directorate of Onion and Garlic Research has library facility to support research and other extension activities. Library as on today has a total collection of 798 books and 1416 Annual Reports and subscribe major foreign and Indian journals. The library also has online access to premier journals (Hort. Database 1972-2013).

Guest houses: The institute has one Guest House within the DOGR Campus. The guest house has four rooms with AC facility.

Farmers Hostel: The institute has also a farmer's hostel which can accommodate 25 members.

Vehicles: At present, the Directorate possess one staff car and qualis.

Residential Quarters: DOGR has nine residential quarters and one director's bungalow.

Other: Administrative block, museum, storage structures, cold storage, guest house, farmers hostel, stores, poly and net houses, conference room and committee room.

Exhibition hall and Conference room: An exhibition hall has been established in the centre of the building so that the visitors can have first-hand information about onion and garlic varieties developed by the institute and research being conducted at DOGR. There is also a conference room with a seating capacity of 75.

Staff Position

The Institute has a strength of 17 scientists, 10 technicians, 8 administrative and 11skilled supporting staff. A list of staff in position is furnished in **Annexure VI**.

Budget and Revenue Generation

During 2012-2017, the total plan and non-plan expenditure of the institute was **Rs. 2134.34 Lakhs** and **Rs.1738.72 Lakhs**, respectively. During this period the institute also generated revenue amounting to **Rs. 358.07 Lakhs**.

Plan

Rs. in lakhs

Head of Account	2012-13	2013-14	2014-15	2015-16	2016-17
Establishment charges	0.00	0.00	0.00	0.00	0.00
Traveling Allowances	13.49	6.00	8.00	10.00	10.00
Recurring Contingencies	316.85	288.75	327.00	342.00	487.00
	Non-Recurring Contingencies				
1. Equipment	18.00	74.25	10.00	20.38	44.52
2. Works	46.66			72.96	38.48
Total	**395.00**	**369.00**	**345.00**	**445.34**	**580.00**

Non-Plan

Rs. in lakhs

Head of Account	2012-13	2013-14	2014-15	2015-16	2016-17
Establishment charges	254.18	266.05	300.10	314.73	348.68
Traveling Allowances	3.96	4.00	3.90	4.00	4.45
Recurring Contingencies	50.36	19.09	54.73	27.85	76.66
Non-Recurring Contingencies					
1. Equipment	0.10	0.97	1.37	0.51	0.94
2. Works	2.09	0.00	0.00	2.00	0.00
Total	**310.69**	**290.11**	**360.10**	**347.09**	**430.73**

External Funding Mobilized

Institute has eight externally funded projects under plan as well as non-plan schemes (Rs.).

Head	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Institute Technology Management Unit (ITMU)	324277	459548	433082	573433	725600	2515940
Outreach Research Programme on sucking pests	245647	263362	786916	370102	229898	1895925
IPM project: Formulation, Validation and Promotion of Adaptable IPM Technology for Bulb (Onion) Vegetable Crops	-	14336	171953	93368	200000	479657
National Innovations on Climate Resilient Agriculture	-	-	12649	2170220	5456715	7639584

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Head	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Studies on Male sterility systems to increase the efficiency of F_1 hybrids in horticultural crops	-	-	266294	261500	197631	725425
CRP on Agrobiodiversity	-	-	-	-	250000	250000
Development of hybrid in onion: A joint venture with Beejo Sheetal	97167	84000	279150	96000	94452	650769
DUS testing through ICAR-SAUs system	385871	349397	550000	341690	503317	2130275

ICAR-Directorate of Onion and Garlic Research

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