Member of APEDA | Recognized by National Horticultural Board

Regd.no.S/1248 dt 31/01/13
Area of operation – All India

Walnut & other Nut fruit Growers Association of India (WANGAI)

The Walnut and Other Nut Fruit Growers Association of India (WANGAI) was registered on 31st Jan 2013 having received clearance from Ministry of Agriculture and Cooperation, Government of India & Ministry of Consumer affairs, for the promotion of nuts in the country.

The major emphasis at present is to bring awareness to the farmers about the benefits of walnut and other nut crops in terms of nutrition and income generation and for the ecology. The WANGAI has a strong mandate to bring at least 10000 farmers as their members and will try to solve the major crises of unavailability of planting material of both walnut & other nut crops.

WANGAI is bringing the information and technology from CITH, Srinagar, UHF Nauni and other state universities, NGO's, farmers groups working on research and development of walnut in the country and from abroad to the walnut growers doorstep. WANGAI has signed a Material Transfer Agreement (MTA) with CITH Srinagar, J & K. And has signed a MOU with M/s Pepinieres Coulie, Chasteaux, France for supply and technology transfer of High density lateral bearing Walnut plants.

WANGAI is assisting the producers for:

1. Continuity in Plantations
2. Mechanization of product and collect tools
3. Control of the quality and of the environmental impact
4. Communication – for latest technology and development

Growers / Members

WANGAI has already identified Walnut Growers in Uttarakhand & Himanchal who have shown willingness to grow walnut & take up plantation. In a short span of time about 1000 Growers have taken WANGAI Membership. Further efforts are on to bring growers of Arunachal, Jammu & Kashmir and other himalayan states on board

Technology Transfer Plantation and Varieties

The advisory panel (technical) of WANGAI is providing assistance in all the production steps, from plantation to the harvest.

The Plantation

Area identification, selection of farmer, rope in as member in association, soil survey and varieties selection.

The grafted plants from known traditional varieties and focus is on lateral bearing new more productive varieties like Franquittee, Ferner, Lara, Chandler, Tulare, Pyne etc.

The orchard Management

Help and recommendations in the following process

- Availability of grafted plants
- Production Technology
- Fertilization & Irrigation
- Plant Protection

Our commitment

- Quality approach
- Following of regulations
- Environment friendly practices
- Training of growers and nurserymen

Village & Post Bayeri, Block Tarikhet, District Almora-263663, Uttarakhand-India
Regd office: 3/1 Nehru Enclave, Kalkaji Extention, New Delhi - 110019, Tel: 9811107502, 9456544777, Fax: 011-26109651
Email: walnutassociation@gmail.com website: www.wangai.co.in

SOUVENIR

NATIONAL WORKSHOP

on

Promotion of Walnut in Arunachal Pradesh

10-11 April, 2015

at Itanagar, Arunachal Pradesh

Organised by

Amity Directorate of Science And Innovation
Amity University, Uttar Pradesh

&

Walnut & other Nut fruit Growers Association of India (WANGAI)

in collaboration with

Directorate of Horticulture and Mission for
Integrated development of Horticulture (MIDH)
Arunachal Pradesh

Sponsors

National Horticultural Board
Govt. of India, Gurgoan

Walnut & other Nut fruit Growers Association of India (WANGAI)

Directorate of Horticulture and Mission for Integrated development of Horticulture (MIDH) Arunachal Pradesh

Supported by

Agricultur

Central Institute of Temperate Horticulture (CITH), (Indian Council of Agricultural Research)

G. B. Pant University of Agriculture & Technology Pantnagar

Pepinieres Coulie, Chasteaux, France

Javikkala Nursery Uttarakhand

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Directorate of Horticulture and Mission for
Integrated development of Horticulture (MIDH)
Arunachal Pradesh

Shri Radha Mohan Singh
Agricuture Minister
Arunachal Pradesh

सत्यमेव जयते

Minister of Agriculture
Government of India

MESSAGE

I am happy to know that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh in collaboration with Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh is organizing a two days National Workshop on "Promotion of Walnut in Arunachal Pradesh" from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

I am sure the scientists, policy planner, exporters and the farmers participating in the Workshop will deliberate and bring out certain recommendation and an action plan for walnut promotion in Himalayan states.

I wish the workshop a grand success.

Radha Mohan Singh

01st April, 2015

RADHA MOHAN SINGH

Shri Nabam Tuki
Chief Minister

सत्यमेव जयते

Arunachal Pradesh
Phone : (O) 0360 – 2212456, 2212173, 2212341
Fax : 0360 – 2212579, 2211467
Delhi : 011-23013915, 23012152

MESSAGE

I am glad to learn that the Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh in collaboration with Mission for Integrated development of Horticulture (MIDH) -Arunachal Pradesh is organizing a two days National Workshop on **"Promotion of Walnut in Arunachal Pradesh"** from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

As we all are aware, due to global warming, the microclimate is changing fast adversely affecting our production base, so there is a need to re-look into the horticultural scenario in the country in general and Arunachal Pradesh in particular. This is essential to earmark the areas for different horticulture crops accordingly. Special attention needs to be given to eco-friendly and sustainable management practices for increasing productivity in the changing scenario of shrinking land and water resources. From the last one decade, the production of walnut and other nut cultivation in the country is stable. Therefore, it is highly imperative to formulate perspective planning to increase the area and production of nut crops especially in Arunachal Pradesh and other Himalayan states. These are some of the issues, I think, that need immediate attention of scientific community.

I am sure that the outcome of this workshop will help us in addressing these issues for further development of horticulture especially walnut in Arunachal Pradesh as well as in the country.

I wish the organizers all success.

31st March, 2015

NABAM TUKI

Shri Harish Rawat
Chief Minister
Uttarakhand

उत्तराखण्ड शासन
Government of Uttarakhand

Uttarakhand Secretariat,
Dehradun - 248001
Ph. : 0135-2755177 (0)
0135-2650433
Fax : 0135-2712827

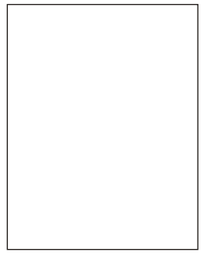
MESSAGE

It is indeed a pleasure to learn that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh in collaboration with Mission for Integrated Development of Horticulture (MIDH)-Arunachal Pradesh is organizing a two days National Workshop on "Promotion of Walnut in Arunachal Pradesh" from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh with the objectives to assess the existing status and future prospects of walnuts in Arunachal Pradesh and in the country.

Walnut and other nuts are most potential productive resource which can provide livelihood to the vast majority of the population in hills whether in agriculture and or forest land. The promotion of livelihood will retain people through local employment, income generation and to enhance the quality of life of the people living in the villages. In this Endeavour, I extend my greetings and good wishes to the participants, dignitaries and organizers and wish the workshop a success.

31st March, 2015

HARISH RAWAT



Shri Chowna Mein
Horicultue Minister

सत्यमेव जयते

Arunachal Pradesh

MESSAGE

I am g

Shri Harak Singh Rawat
Horicultue Minister

उत्तराखण्ड शासन
Government of Uttarakhand

Uttrakhand

MESSAGE

It is a pleasure to hear about that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh and Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh is organizing a national workshop on a very pertinent topic "Promotion of Walnut in Arunachal Pradesh" from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

The selection of theme of the Seminar is very appropriate in the present situation where there is urgent need to expand walnut cultivation and provide means of income for the farmers of Himalayan states. Walnut being an important horticultural industrial crop plays a pivotal role in the national economy.

The efforts of Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture & (MIDH)-Arunachal Pradesh are sincerely appreciated.

I wish the workshop a grand success.

HARAK SINGH RAWAT

Dr. Ashok K. Chouhan
Founder President

Ritnand Balved Education Foundation (RBEF)
(The Foundation of Amity Institutions &
Sponsoring Body of Amity Universities)
Chairman, AKC Group of Companies

MESSAGE

Among dried fruits, walnut is one of the most important species from economic and botanical point of view, and in many countries it has a rich cultural heritage. Today walnut is grown in over 60 countries around the globe, and is harvested from both cultivated orchards and wild populations. Modern techniques of production have resulted in the cultivation of selected varieties; machinery is now responsible for much of the processing and the range of processed products has been expanded.

It is a matter of great pride for Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh (AUUP) in collaboration with Walnut & Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture and Mission for Integrated development of Horticulture (MIDH), Arunachal Pradesh being entrusted to organise a National Workshop on a very pertinent topic **"Promotion of Walnut Arunachal Pradesh"** from 10th to 11th April, 2015 at Itanagar, Arunachal Pradesh.

I am confident that deliberaration in the Workshop will open up new avenues for walnut and other nut deliberations in the Workshop will open up new avenues for walnut and other nut promotion in the country and also result in economic development in the North Eastern part of our country.

I wish the Workshop a good success.

ASHOK K. CHOUHAN

Shri Ramesh Negi, IAS
Chief Secretary

Government of Arunachal Pradesh
0360:2212595/2212540
Fax: 0360-2212446/2215719
Camp Office: 011-26117724
Fax: 011-26117723
E-mail: rameshnegi56@gmail.com

MESSAGE

I am happy to know that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh in collaboration with Mission for Integrated development of Horticulture (MIDH) -Arunachal Pradesh is organizing a two days National Workshop on "Promotion of Walnut in Arunachal Pradesh" from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

The selection of theme of the Seminar is very appropriate in the present situation where there is urgent need to provide ways and means of income for the poor farmers of Himalayan States. As we all are aware that due to global warming, the microclimate is changing fast which is adversely affecting our production base, so there is need to re-look the horticultural scenario in the country in general and Himalayan States in particular to earmark the areas for different horticulture crops.

I hope the deliberations of the seminar will provide valuable inputs in formulating a strategic plan for the walnut promotion in Arunachal Pradesh and in the country.

I wish the seminar a great success.

RAMESH NEGI

Dr. S. Ayyappan
Secretary & Director General

Government of India
Department of Agricultural Research & Education
And
Indian Council of Agricultural Research
Ministry of Agriculture, Krishi Bhavan, New Delhi 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

MESSAGE

India has emerged as the second largest producer of fruits and vegetables in the world, owing to diversified agro climatic conditions, technological advancement and policy environment provided by the Government. With the progress already made and tremendous potential due to natural endowment, the country now needs a strategy for the scientific transformation of Indian horticulture for commercialization on sustainable basis conserving natural resources. In the rapidly changing agriculture scenario, it has become imperative to focus on emerging issues in formulating coherent planning and strategies for the accelerated development of Indian Horticulture with the application of science and technology. It is clear that the strategies will emerge only after in depth debate among policy makers, scientists and stake holders, including progressive farmers and industry personnel on a common platform.

It is indeed a mater of great pleasure to know that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh in collaboration with Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh is organizing a two days National Workshop on 'Walnut Promotion in Arunachal Pradesh' from 10-11 April, 2015 at Itanagar, Arunachal Pardseh, with a focus on formulating a strategic plan for the promotion of walnut and other nuts in the Himalayan states of India.

I hope that technologies and strategies identified in this symposium shall help to pave way for scientific development of horticulture in India.

23rd March, 2013
New Delhi

S. AYYAPPAN

Dr. S.K. Malhotra
Horticulture Commissioner

सत्यमेव जयते

Government of India
Ministry of Agriculture
(Department of Agriculture & Cooperation)
Krishi Bhawan, New Delhi - 110 001
Tel : 011-2338 1012
Fax : 011-2338 3712
Email: hc-dac@nic.in

MESSAGE

I am happy to know that a **National Workshop on "Promotion of Walnut in Arunachal Pradesh"** is being organized by Walnut and other Nut Growers Association of India and Directorate of Horticulture, Arunachal Pradesh from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

Walnut is one of the most important valuable nut grown in India. In the last one decade there has been unprecedented growth in the production as well as export of walnut owing to increasing demand and technological interventions, but in the emerging scenario of climate change and declining natural resources the situation has become more challenging. There is scope for introduction of walnut in the new areas such as Arunachal Pradesh to meet the increasing demand. Also there is need to refine the production technologies for improving productivity and production of walnuts in the hill eco system including state like Arunachal Pradesh.

I am hopeful that all related issues will be discussed to develop strategy for improving production and productivity of walnut in the country. I am sure, the deliberations shall provide road map for harnessing the potential of this crop for the well being of the people, farmers and processors.

I wish the workshop a grand success.

30th March, 2015
New Delhi

30.3.15

DR. S.K. MALHOTRA

Shri Atul Chouahn

Chancellor, Amity University
President, Ritnand Balved Education Foundation
CEO, AKC Group of Companies

MESSAGE

I am happy to learn that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh, Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh being entrusted to organize a national workshop on a very pertinent topic “Promotion of Walnut in Arunachal Pradesh” from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

Walnut is very well known for its medicinal and therapeutic properties from the ancient times in India. Arunachal Pradesh is endowed with rich agroclimatic diversity and as such has vast potential for cultivation of various horticulture crops including walnut and other fruit nuts. Arunachal Pradesh having the favorable climate, topography and congenial environment and keeping in view the potential for cultivation of walnut in the State, its farming is certainly being promoted.

Organizing this Seminar is, therefore, timely and appropriate and I hope that the deliberations in the Seminar will help in formulating suitable policy regime for promoting the cultivation, marketing and processing of walnut in the country as well as in the State of Arunachal Pradesh.

I wish the Seminar all success.

ATUL CHOUHAN

Prof. (Dr.) Balvinder Shukla

Vice Chancellor
Amity University
Uttar Pradesh

MESSAGE

The horticultural scenario of the country has been changing fast owning to good natural resource base, diversified gene pool, adequate research & development infrastructure etc. Both production and productivity of several crops has increased manifold which has made India - a leading horticultural country of the world. The demand of horticulture produce is on the rise due to increasing population, changing food habits, realization of high nutritional value of horticultural crops and greater emphasis on value addition and export. However, several challenges are yet to be met such as fast eroding gene pool, fast population build up, shrinking land and other natural resources, serious production constraints-both biotic and abiotic, huge post harvest losses, etc.,. Further, in the era of globalization, produce has to be of international quality and globally competitive.

To address all such emerging issues in the frontier areas of walnut research and development, I am glad to learn that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh and Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh, has organised a Two Day National Workshop on “Promotion of Walnut in Arunachal Pradesh” on April 10-11, 2015 at Itanagar, Arunachal Pradesh.

The discussions and deliberations of the workshop will surely immensely benefit all the delegates, farmers, exporters, policy makers, researchers, and speakers and will lead to further advancement and promotion of walnut in the country. The souvenir will also be a good referral source to those who strive to update their knowledge and advances of recent research in this sector.

I appreciate and commend the high spirit and efforts of the organising team and with the Workshop a grand success!

PROF. (DR.) BALVINDER SHUKLA

Dr. W. Selvamurthy
Ph.D., D.Sc.
FAMS, FABMS, FIMSA, FIANS, FIAY

President
Amity Science, Technology and Innovation Foundation (ASTIF),
Director General, Amity Directorate of Science & Innovation,
Chancellor, Amity University, Chhattisgarh and
Chair Professor for Life Sciences
(Former Distinguished Scientist and Chief Controller R&D(LS), DRDO)
Tel: 91(0)120 4392045 / 91-9871372441 / 91-9818801028
Fax: 91(0)120 4392114, E-mail: wselvamurthv@amity.edu

MESSAGE

Walnut cultivation, in general, is confined to 30 to 60 degrees latitude North in the Northern Hemisphere and 30 to 50 degrees South in the Southern Hemisphere. The cultivation of this crop may further extend towards the equator in cooler regions at higher altitude. Walnut cultivation in India is confined to its lower ranges and foothills. The Himalayas form a source of many perennial rivers providing much needed water to the alluvial plains in the North. Its cultivation in the Northern Himalayan region dates back 9,500 to 12,000 years.

According to Agricultural and Processed Food Products Export Development Authority (APEDA) the total area under walnut cultivation in India was recorded as 85,000 hectares with an annual production of 107,000 metric tons in 2011-12. In the same year India exported 58,410 metric tons of walnut valued at about $ 4.60 million to different parts of Asia, Africa, and Europe. Considering its export potential, several initiatives are under way to bring more area under improved cultivars of walnuts that give higher yields of world quality nuts. However the rising population puts limits on increasing the area; but the productivity can be increased from the present 1.26 tons/ha to world average of 3-5 tons/ha.

It is a matter of great honour for Amity Directorate of Science and Innovation (ADS!), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture and Mission for Integrated development of Horticulture (MIDH), Arunachal Pradesh being entrusted to organize a National Workshop on a very pertinent topic "Promotion of Walnut in Arunachal Pradesh" from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

Amity Directorate of Science and Innovation (ADS!) will bring out a publication in the form of Souvenir of the National Workshop. It highlights the work carried out as status of walnut cultivation and production and to formulate a future strategy for promotion of walnut in Arunachal Pradesh and the other Himalayan States of India.

The efforts of Dr. Navin Nainwal, Amity Directorate of Science and Innovation (ADS!), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India

(WANGAI), Directorate of Horticulture & (MIDH)-Arunachal Pradesh and organizing committee in arranging various facilities in befitting manner and timely bringing out the above publication at the occasion are sincerely appreciated.

I wish the workshop a grand success.

DR. W. SELVAMURTHY

Shri Mangala Rai
Vice-Chancellor

Vice-Chancellor
G.B. Pant University of Agriculture & Technology
PANTNAGAR – 263145
Distt. Udham Singh Nagar (Uttarakhand) INDIA

MESSAGE

In India, most walnuts are consumed raw as a snack food. Walnuts have primarily been consumed during the festival season, but they are now beginning to be consumed year-round as awareness of their health benefits grows and as they become available in smaller and medium cities. Due to extra-ordinary health benefits walnuts are getting popular especially among health conscious young Indians as a part of their regular diet. While the demand for Walnuts in India grows, domestic walnut production has remained almost stagnant. Growing economy, changing lifestyles, rise in disposable incomes and and preference for quality products have increased the demand of good quality walnuts.

I am happy to know that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture and Mission for Integrated development of Horticulture (MIDH) Arunachal Pradesh are organizing a national workshop on “Promotion of Walnut in Arunachal Pradesh” from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

I hope the workshop will be useful for the walnut growers, scientists, researchers, exporters and policy markets.

I wish the workshop a grand success.

MANGALA RAI

Dr. N. K. Krishna Kumar
Deputy Director General (Horticultural Science)

Indian Council of Agricultural Research
Krishi Anusandhan Bhawan - II
Pusa, New Dellhi - 110 012

MESSAGE

Walnuts are rich in proteins, fats, minerals and have high nutritive values. In addition to nutritive kernels for human consumption walnut provide several ecosystem services for the benefit of humankind. There is great opportunity for the stakeholders to improve the area and production of walnut in India. Appropriate technology generation, timely dissemination and adoption by the stakeholders may further improve its productivity.Thereis urgent need to provide ways and means of improving income of farmers of Arunachal Pradesh through various agri-horticultural enterprises and walnut could be a good option to it.

I am happy to learn that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut and Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture and Mission for Integrated development of Horticulture (MIDH), Arunachal Pradesh are organizing a National workshop on Promotion of Walnut in Arunachal Pradeshon 10 &11 April, 2015 at Itanagar, Arunachal Pradesh.

I am sure that scientists, policy makers, industrialists and farmers participating in the workshop will deliberate upon important issues and come out with useful recommendations for future action.

I wish the participants a fruitful workshop.

N.K. KRISHNA KUMAR

Shri Jombo Ratan

Director Horticulture
Government of Arunachal Pradesh
Tel:- 03602203397
Email:- arunachalhorticulture@yahoo.in

MESSAGE

I am delighted to learn that Amity Directorate of Science and Innovation (ADSI), Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture and Mission for Integrated development of Horticulture (MIDH), Arunachal Pradesh is organizing a two days National Workshop on **"Promotion of Walnut in Arunachal Pradesh"** from 10 to 11 April, 2015 at Itanagar, Arunachal Pradesh.

In the quest for diversification in Arunachal Pradesh, the fruit sector including walnut offers good scope to farmers to take up cultivation of these crops and hence the potential of the state should be capitalized by adopting scientific cultivation and the latest technologies. Keeping in view its potential for cultivation, walnut has been identified as one of the focused crops under Mission for Integrated development of Horticulture (MIDH) in Arunachal Pradesh.

I am sure the seminar will provide an opportunity to nurserymen, farmers and entrepreneurs of Arunachal Pradesh to better understand the cultivation of walnut, so that they could gain from this seminar, besides creating avenues for trade and marketing of the produce.

I wish the seminar all success.

02nd April, 2015
Itanagar

JOMBO RATAN

Shri K.C. Pandey
President

Walnut & other Nut fruit
Growers Association of India
(WANGAI)

MESSAGE

The Himalayan states occupy a special place in the mountain ecosystems of the world. These states are not only important from the standpoint of climate but they also harbor a rich variety of flora, fauna and cultural diversity. Despite the abundance of natural resources, most of its people are marginalized even after more than 65 years of Indian Independence.

The greatest challenge before the Himalayan states is of ensuring livelihoods and livelihood security for all individuals under working age category. Walnut and other nuts are most potential productive resource which can provide livelihood to a vast majority of the population in hills whether engaged in agriculture or forest land. The promotion of livelihood will retain people through local employment, income generation thereby enhancing quality of life of the people living in these villages.

Walnut orchard can provide full-part time employment to family labour and also permanent green cover to the soil. A walnut orchard besides acting as soil binder also helps in preventing soil erosion to a considerable extent. There is wide-scope of work walnut based on the nature of the industries i.e. cleaning, grading and packaging of nuts grown in the hills for market in the plains. Skills and support for processing and storing the fruits need to be provided. Initially market support would also be essential. In fact, no walnut and other nut product should be allowed to be transported out of the hilly area in a raw state. It should preferably go out in semi-processed and value added form.

Availability of quality planting material to the walnut growers is a real challenge. In order to sensitize the issues to the Growers & to attract attention of Scientists, researchers & policy makers, Walnut and Other Nut Fruit Growers Association of India (WANGAI) has been conducting workshop in the Himalayan states on regular intervals. WANGAI has taken up the agenda for establishing a separate mission on Walnut & other Nut with Ministry of Agriculture & Cooperation and Ministry of Finance, Government of India. Realizing the need for the introduction of new lateral bearing varieties and importance of good quality planting material and latest technology from abroad WANGAI is now motivating stakeholders to take a holistic approach. Recently, collaboration has been also formed between SANCHAR/JAVIKKALA (Nursery) and one of the best nurseries of walnut in the world M/S Pepinieres Coulie based in France. Through this collaboration growers will get the latest varieties, nursery management practices and production technology at their doorstep. The right blend of a strong political will, professional skill and grower's participation can help us to achieve seemingly difficult tasks.

I hope this seminar will stimulate action at all levels. The seminar will look into the best practices for walnut promotion and also serve as a catalyst to bring about desired changes.

I wish the seminar a grand success.

04th April 2015

K.C. Pandey

PREFACE

Dr. N. C. Nainwal

Assistant Director
Amity Directorate of Science and Innovation
Amity University Uttar Pradesh
Amity University Campus, Sector-125, Noida
Gautam Budha Nagar (UP)

India has one of the highest productions of walnuts in the world, in terms of area cultivated and quantity of nuts produced. Their industry is mainly based on seedling trees, the product of which is greatly affected by nut variability. In India, walnuts are grown in Jammu & Kashmir, Arunachal Pradesh, Himachal Pradesh and Uttarakhand. Jammu & Kashmir contributes around 98 per cent of the country's output. The domestic and external demand has been increasing over the years and is projected to 75,000 tonnes by 2020. Therefore, it is necessary to bring additional area to meet the projected demand which is about 30,800 hectares with the production at 36,000 tonnes. Presently, the productivity of walnut in India is around 1.2 tonne per hectare which is very low in comparison to 3-5 tonne/hectare in France because of non availability of good quality grafted plants and efficient methods and facilities for vegetative propagation are also lacking.

As in Jammu & Kashmir suitable land for its cultivation is scarce, it is therefore, required to expand walnut production to other states like Uttarakhand, Himachal Pradesh and Arunachal Pradesh to meet the targets as these states are having suitable agro-climatic conditions for growing walnut. There is huge possibility of expansion of area approximately 10,000 hectares in Himachal Pradesh and Uttarakhand and around 2,000 hectare in Arunachal Pradesh will require around 25,00,000 plants

The most visionary and philanthropist Founder President of Amity Group of Institutions has huge plan to support food security through research & development and innovation in agriculture and allied areas. The experts and scientists of Amity University Uttar Pradesh are doing research and development work on walnut, knowing its importance as high value cash crop.

This present workshop is being organized by Amity Directorate of Science and Innovation (ADSI) , Amity University Uttar Pradesh in collaboration with Walnut And Other Nut Fruit Growers Association of India (WANGAI), Directorate of Horticulture Arunachal Pradesh, Mission for Integrated development of Horticulture (MIDH), State-Arunachal Pradesh sponsored by National Horticulture Board, Ministry of Agriculture, Government of India, which is presided by Dr. S. K. Melhotra, Horticulture Commissioner, Government of India, New Delhi. The leadership of Dr. W. Selvamurthy and precious guidance motivated the organizing committee to take path breaking initiative to undertake the daunting task of organizing this seminar to address the emerging issues of walnut among the walnut growers, Government officers and scientific fraternity.

I am delighted at the overwhelming response, the seminar received from various sectors through out the country. Enormous enthusiasm generated by this seminar as evident from huge gathering of growers & stake holders from public and private sectors including 15 invited speakers of national and international fame, about 25 contributed articles from researchers stands a testimony to majestic success of the event

In the next two days, there will be an opportunity for all participants to share knowledge and experiences among the present scientific fraternity and enrich themselves with Keynote lectures delivered by renowned experts concerning most outstanding themes on walnut of national and international importance. The organizing committee of the symposium took painstaking efforts in scheduling the technical session so as to cover all the domains of walnut in today's perspective. During the seminar, it has been decided to bring out a Souvenir containing the lead lectures. It earnestly hope that this treasure will prove useful to the students, researchers and professionals working in the field of walnut as a detailed compilation covering various thematic areas.

I sincerely acknowledge the support from Ministry of Agriculture & Cooperation Govt. of India, New Delhi. My sincere thanks connected with congratulations on the success of this seminar goes to members of the organizing committee.

I take this opportunity to place on record our sincere and heartfelt gratitude for sponsors and co-sponsors of the workshop who contributed in making the event a grand success. Major assistance came from Government agencies National Horticulture Board, Department of Horticulture Arunachal Pradesh and Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh, Walnut & Nut Fruit Growers Association of India (WANGAI), Indian Council of Agricultural Research (ICAR) and Indian Agriculture Research Institute.

Finally I wish to thank the team of hard working colleagues of ADSI, AUUP, WANGAI, Department of Horticulture Arunachal Pradesh and Mission for Integrated development of Horticulture (MIDH)-Arunachal Pradesh, Indian Council of Agricultural Research (ICAR), Indian Agriculture Research Institute who toiled effortlessly for the successful organization of this seminar. I wish that all the participants will benefit from this great and deep exchange of knowledge and experiences on walnut, to let new ideas and projects grow and develop for the benefit of walnut growers.

We rededicate ourselves to take Walnut and other nuts to further heights and work hard to provide leadership in this sector towards becoming top nut producing country in the world.

NAVIN NAINWAL
Organizing Secretary

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Status of Walnut cultivation in Arunachal Pradesh and Possibilities of further extension in Arunachal Pradesh

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Arunachal Pradesh may be the natural home for Walnut (Juglans spp.). This is evident from existence of wild species of walnut in several parts of Arunachal Pradesh like West Kameng District, Lower Subansiri District, West Siang District, and other temperate/ semi-temperate areas of Arunachal Pradesh.Area under Walnut recorded during 2013-14 is 4925 Ha. with total production of 591 MT. The productivity is 0.12 MT/Ha. Most of the walnut plantation in Arunachal Pradesh is in stray plantations mixed with other horticulture crops. Pure walnut orchards are very few, and concentrated in West Kameng district.

Owing to vast available land resource in Arunachal Pradesh, there is immense potential for extension of walnut cultivation in Arunachal Pradesh. However, this potential could not be exploited due to various constraints as follows:-

1. Very long gestation of period:- The long gestation period (10-12 Years) of Walnut crop planted with seedlings is one major factor which discourages farmers from taking up walnut as pure crop. Very thin bearing of even matured walnut tree is also a discouraging factor.

2. Unavailability of improved quality planting materials:- Unavailability of improved, grafted/budded planting materials is one limiting factor for cultivation of walnut in Arunachal Pradesh.

3. Lack of awareness among farmers:- Lack of awareness among farmers regarding various aspects of Walnut cultivation is also a factor for the slow adoption of walnut as pure crop.

Among the nut crops, walnut is the only crop that is grown commercially in Arunachal Pradesh though other crops are also there but not grown commercially.

Area and production of Walnut in the table given below:

Area, Production and Productivity of Major Horticultural Crops During 2012-13				
	Component	**Total**		
		Area	**Production**	**Prdty(mt/ha)**
A	Fruit Crops			
1	Apple	14066	30945.2	2.20
2	Walnut	4805	574	0.12
3	Kiwi	3452	4720.5	1.37
4	Citrus	39396	175707	4.46
5	Pineapple	12280	66780	5.44
6	Banana	6132	18186	2.97
7	Others	6727	13288	1.98
	Total	**86858**	**310200.7**	

Improving walnut production through better fertilizer management practices

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Fertilizing Walnut trees is likely to produce best economic return

Walnut nitrogen nutrition Deficiency symptoms: In spring, N deficiency is characterized by unusually pale and small leaves. Shoot growth is reduced, resulting in sparse foliage. In autumn, leaves senesce early and the trees defoliate sooner than usual. Insufficient water availability may result in similar symptoms. Yield may decline before N deficiency symptoms are visible. Tree N status is therefore best monitored with leaf analyses

N fertilization of young trees

Application rate

Nitrogen is usually the only nutrient that may be required the first year. On fertile soils, N fertilization can be reduced or even omitted during the first year or two.

Nitrogen application rates for young trees. The lower rates refer to fertile soils and when the N is applied through the drip or micro sprinkler irrigation system

Table 1: N application rate for walnut trees

Tree age	N application rate	
	Kg/acre	Kg/tree*
First season	4.53-907	0.091-0.14
Second season	11.33-22.65	0.18-0.36
Third season	45.3-90.6	-
Fourth season	28.5-57.1	0.45-0.86
Fifth season	34.0-68.0	0.54-1.0
*The application rate per tree is based on tree density of 65 tree/acre.		

In a study with black walnut trees, N use efficiency and growth of first leaf trees were best with an application of 0.045 kg N/tree

Time and mode application

Fertilizer is best applied to young trees in mid-spring and early summer. Late applications (after August) should be avoided to prevent late fall growth which could be susceptible to freeze injury. Furthermore, N not taken up by leaf senescence is subject to leaching during the winter. Nitrogen fertilizer can be applied in the dry form or in the irrigation water. Avoid applying near the trunk.

In general, the application of fertilizer or organic material into the planting hole is discouraged. On a high fertility soil, the application of fertilizer blend containing N, P, K and different micronutrients into the planting hole or mixed into the soil used to fill the holes had minimal effect on tree growth and leaf nutrient levels in the first year. The amounts of nutrients applied per tree with the different treatments were: 16-54 g N, 14-27 g P2O5and 5-23 g K2O.

July leaf N concentration below 2.1% suggests N deficiency (see table)

Table 2: Critical nutrients level in walnut leaves

Interpretation	Nutrient (values in % dry weight)		
	N	P	K
Deficient	<2.1	-	<0.9
Adequate	2.2-3.2	0.1-0.3	>1.2
Excessive	-	-	-

Phosphorus

Soil Analysis

Soil samples for P analysis should be taken from the main root zone. Even though walnut roots may grow to a depth of 6 to 7 feet, the majority of the roots can be found in the top 2-3 feet of the profile.

P fertilization in young trees

In most cases, N is the only element required by new trees in most soils. On P fixing soils, application of 11.3 kg kg triple superphosphate per tree (5 kg P2O5) has been found to alleviate P deficiency of 2 to 10 year old trees for at least 5 years.

Applying P fertilizer in 6-inch deep trenches is more effective than broadcast applications. The trenches can 2 or more feet away from the trunk, depending on tree size. However, the trenches should be within the wetting zone of the irrigation system.

Soil applied P

Application rate

Approximately 1.95 kg (4.5 kg P2O5) is removed with one ton of harvested nuts. Higher application rates are required when trees show symptoms of P deficiency

Mode of application: Broadcast surface applications are not effective, especially on soils that fix P

Fertilizer type: Triple super phosphate has been shown to be effective

Time of application: Phosphorus fertilizer is generally applied during the dormant period in fall or winter

K Fertilization of Young Trees

In most cases, N is the only element required by new trees in most California soils. Exceptions may be soils with very low levels of available K, such as very sandy or K fixing soils.

Soil Analysis for Potassium (K)

Soil Sampling and Analysis

Soil samples for K analysis should be taken from the main root zone. Even though walnut roots may grow to a depth of 6 to 7 feet, the majority of the roots can be found in the top 2-3 feet of the profile. For detailed sampling instructions. Potassium availability is generally assessed by extracting a soil sample with ammonium acetate.

Interpretation of results

A response to K fertilization is likely when the extractable K is below 150 ppm (see Table). Walnuts growing on soils with extractable K values of 150 ppm or higher are not likely to respond to K fertilization.

For intermediate soil K values (see Table), applying the amount of K removed at harvest ensures the soil K availability remains at an optimal level over the years. Approximately 6.8 kg K2O are removed with one ton of nuts. If the hulls are not returned to the field, approximately 104 kg K2O/acre are removed with one ton of dry hulls. Higher application rates are required when trees show symptoms of K deficiency (See K Fertilization). In contrast, little or no K fertilizer is required when soil K availability is high.

Regular soil and leaf analyses indicate whether the K fertilization program is adequate.

Table 1: N application rate for walnut trees

Fertility level	Phosphorus (ppm PO4-P)		Potassium (ppm K)
	Bray P1 Method	Olsen Method	
Very low	-	-	<75
Low	<20	<10	75-150
Medium	20-40	10-20	150-250
High	40-100	20-40	250-800
Excessive	>100	>40	>800

Soil Applied K

Application Rate

The amount of K removed with one ton of harvested nuts is approximately 5.4 kg (6.8 kg K2O). The hulls contain a high concentration of K. If they are not returned to the field, approximately 15.9-18.1 kg K (18.1-22.6 kg K2O) are removed with the hulls of one ton of in-shell nuts (see below for calculations).

By replacing with fertilizer the amount of K removed at harvest, soil K availability can be maintained at the same level over the years. Higher application rates are required when trees are K deficient. Annual band applications of 108.8kg K2O/acre have been recommended to K deficient trees grown on sandy soil. On heavier clay or silt loam soils, up to 900 lbs K2O/acre may be required to alleviate K deficiency. In these trials, carried out in the 1980s, adequate levels of K could be maintained with annual applications of 108.8kg K2O/acre once deficiency was corrected.

Potassium fertilization to deficient trees may not show any effect until the second season after the application.

Mode of Application

Potassium fertilizer can be banded on either side of the tree or supplied with the irrigation water.

Band applied K fertilizer penetrates the soil to deeper depths and is a more efficient way to apply K than broadcast . Band applied K has also been found to correct K deficiency more effectively than when applied with the sprinkler system .

Fertilizer Type

Potassium chloride (KCl) or potassium sulfate (K2SO4) can be applied. Therefore, when repeated high doses of K are required, K2SO4should be favored over KCl to prevent a buildup of chloride in the root zone . Applying KCl on soils with clay pans or high water tables which do not allow adequate leaching of the Cl from the root zone is also not recommended.

Applying KCl on soils with clay pans or high water tables which do not allow adequate leaching of the Cl from the root zone is also not recommended.

Time of Application

Soil applications are generally done in the fall to allow winter rains to move K into the root zone. When KCl is used, applying the material in fall also allows winter rains to leach chloride ions, which move much more freely in the soil than K ions, out of the root zone.

With the exception of very sandy soils, K is not leached below the root zone. It is therefore possible to apply a larger dose of K fertilizer every three to five years instead of smaller annual applications.

Foliar K

The effects of foliar K applications to walnuts have not been studies widely. Soil K applications to deficient trees may not alleviate deficiency until the second season after the application

Very little is known about the effects of rootstocks on leaf nutrient concentrations. One study reported that under identical growing conditions, leaf P levels were found to be higher and K concentrations lower on trees on Paradox rootstocks compared to trees on N.C. Black rootstocks

Walnuts: Scoping for Indian Agroforestry

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Trees yielding nuts are having the potentials of providing tangible and intangible benefits, thereby, raising their scope for agroforestry systems in India and elsewhere. Walnuts (Genus: Juglans; Family: Jaglandaceae) a light demanding tree species has been known for its wind-breaking quality and also for drought tolerance.

In India walnuts are grown in the hilly Arunachal Pradesh, Himachal Pradesh, Uttrakhand and Jammu and Kashmir. The latter alone contributes to about 98% of the country's total walnuts. From the current 36000 tonnes of walnuts produced today in this country, it is projected that by 2020/21, the requirements would raise to 72,550 tonnes, necessitating India to bring in additional area to meet the projected demand. So, alike agro-climatic condition needs to be identified in order to enhance the spread of this tree crop. Existing reports, however, indicate a very high payback for walnut growers in India.

Indian Habitats for Walnuts

While the major walnut growing countries are China, USA, Iran, Ukraine, Turkey and Mexico, India stands 7th in global production of walnuts, mainly from the hilly states of in the Indian Himalayan region. The different varieties of walnuts grown in India are, (a) Indian special light half, (b) Indian light broken, (c) Indian light pieces, (d) Indian light crumbs, (e) Indian light my-fire, (f) Indian light amber halves, (g) Indian light amber broken and (h) Indian light amber pieces.

Jammu and Kashmir: Jammu and Kashmir, is the main center for commercial walnut production in India. In about ~61000 hectares, Jammu and Kashmir produce ~86,000 tonnes of walnutsthat is estimated 25 million Indian rupees.

Uttarakhand: Although not as commonly grown for commercial purposes, walnuts grow well in Uttarakhand. Walnuts grown in this state are generally of more variable quality than those grown further north. Uttarakhand is a state better known for its apple cultivation, and many walnuts are planted as seedlings in for personal consumption and local commercial sale. Walnuts grown in this state, and in Jammu and Kashmir, are Persian walnuts.

Himachal Pradesh: Walnuts, also Persian walnuts, are also grown in a couple districts of Himachal Pradesh. Around 50 hectares are under walnut cultivation in the Mandi district. Just over 55 hectares are also under cultivation in the Chamba district of Himachal Pradesh. The Shimla district also reports 33 hectares under private cultivation and another 28 hectares under cultivation in the Mandi district. A walnut cultivation development station has been established at Nohra, District Sirmour, Himachal Pradesh to help develop and adapt technologies to promote walnut cultivation.

Arunachal Pradesh: The biodiversity rich and ecological fragile environmental settings of the hilly state of Arunachal Pradesh do have potential agro-climatic regime for walnut cultivation.

Walnuts for Nutrition

Walnuts are collected from the ground between September and October every year, cleaned, washed and dried. Generally, the walnuts are generally consumed during winter season.

Nutritionally, the walnuts have proteins, fats and minerals and are therefore a concentrated source of biological energy. Given its qualities, the species is in high demand in bakery, chocolate and ice-cream industries. The walnut oil is high in unsaturated fat and could be used as a substitute for olive and other cooking oils.

Walnuts for Agroforestry

As agroforestry dwells upon integrating tree component into the agricultural practice for food production purposes, the walnuts have good scope in agroforestry systems, particularly in the hilly environment, where it can also provide some intangible benefits such as soil erosion control and carbon sequestration, apart from the mundane advantages of trees on floor crops. It is warranted that efforts of developing suitable agroforestry models integrating walnuts needs priority in sub-tropical to sub-temperate agro-climatic setting, given the ecological and market potentials walnuts.

Micropropagation of Walnut and Almond - A review

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Walnut

English or Persian Walnut (Juglans regia) is a member of the family Junglandaceae. This is the most horticulturally developed and widely cultivated of all the Walnut species (McGranaham and Leslie 1990). This crop was probably introduced into European Commerce and Agriculture by the ancient Greeks. For several thousand years, this crop has been globally and commercially cultivated for its nuts and in some areas for its timber. Walnuts are very high in nutritional content, containing up to 24% protein and up to 70% fats, most of which are polyunsaturated (Britton et al. 2009). Its physical and chemical characteristics together with its Aesthetic qualities, makes it a most beautiful and valuable tree. It was utilized in Medievel Europe as an herbal medicine particularly for brain and scalp treatment. Three leading producers, USA, China and Turkey account for over half the world's Walnut production. Its increasing importance and the difficulties encountered in the conventional rooting methods are the major impetus for developing various micropropagation strategies. A reliable method for rooting could lead to the development of disease and pest resistant, dwarfing or most efficient rootstocks. Day by day as the Technology advances, micropropagation is becoming an important tool for the production of new clones containing specific novel genes of Agronomic traits.

Micropropagation of J. regia may be initiated from zygotic embryos, shoots, branches or adult plant species (Leslie and McGranahan 1992). The major problem associated with the in vitro production of Walnut is endogenous contamination and phenolic exudation from the cut surfaces of the explants. However various approaches are now being available, to overcome this problem, viz addition of Polyvinyl pyrollidone (PVP), citric acid, ascorbic acid, activated charcoal, thiourea, cysteine, glutamine, asparagine, arginine, use of antibiotics or by frequent subculturing, micrografting etc. (Payghamzadeh and Kazemitabar 2011; Sanjuan et al. 1996).

Chalupa (1981) for the first time reported successful micropropagation of J. regia from nodal stem segment of 2-3 month old seedlings and cultured them on MS media containing varying concentrations of BAP and NAA. In the same year, Rodriguez and Sanchez Tames initiated the culture from stem segments, leaf disks, whole peeled cotyledons and root segments of seedlings (Leslie and McGranaham 1992). In 1983, Cassio and Minolta tested various medium at half and full strength and obtained best results on MS and B5 (Leslie and McGranaham 1992). In 1984, Driver and Kuniyuki published a new medium (DKW) for micropropagation of hybrids. After a preliminary comparison between DKW-C medium (McGranahan et al 1987), MS medium (Murashige and Skoog 1962) and woody plant medium (WPM) (Lloyd and McCown 1980), the DKW medium was found to be best for the establishment and multiplication of various Juglans sp. (Driver and Kuniyuki 1984; Sanjuan et al. 1996). The pre treatment of plant material with the antibiotic resulted in 5% recovery after 1-2 months (Revilla et al. 1989). In 2001, Marques and Dias reported sucrose as the most appropriate source of carbohydrate for in vitro walnut propagation (Leal et al. 2007). Sanjuan et al. (1996) also reported the effect of different concentrations (0, 15, 30 g/l) of sucrose on root elongation and found that the percentage of microcuttings forming roots as well as the number of primary roots per rooted shoot increased when the sucrose level was reduced from 30 to 15 g/L. lowering the sucrose content presumably stimulated the photosynthetic capacity, and consequently the survival of plantlets during acclimatization to soil was improved (Sanjuan et al. 1997; Sanjuan et al. 1996).

Revilla et al. (1989) reported 1 mg/l BAP and 0.1 mg/l IBA as best growth regulator for micropropagation of nodal segments from both embryonic and juvenile material. Also, increased micropropagation rate was reported in double phase cultures. In

the same year, Gruselle and Boxus (1989) initiated the culture on modified MS medium having 0.5 mg/l BAP and proliferation was carried out on full strength macroelements with varying concentrations of BAP (0.8-1.0 mg/l). Sanjuan et al. (1996) used DKW medium containing 5 μM BA and 0.05 μM IBA for shoot proliferation.

Revilla et al. (1989) initiated the rooting by dipping the shoot base into liquid medium containing 2 mg/l IBA for 24 hr and further transferred it onto solidified medium containing 1% activated charcoal. Most of the workers have used a sequence of two rooting media, one with auxin (for induction) and other with vermiculite (for elongation) and have noticed positive results. Gruselle and Boxus (1989) after 3 weeks of elongation transferred the microcuttings in dark for 10 days on DKW medium containing 2 mg/1 IBA and 1 mg/1 riboflavin for rooting. Sanjuan et al. (1996) cultured shoots in DKW medium with 1/4th macronutrients, no glutamine and 25 μM IBA in dark for 5 days and subsequent transfer to 55% vermiculite (250 ml vermiculite + 200 ml modified DKW medium per flask) under normal light for 3 weeks. The number of roots, root elongation and formation of secondary roots was improved by the addition of vermiculite to the gelified medium. (Allemand et al. 1992; Sanjuan et al. 1996). Allemand et al. (1992) used a mixture of diluted gelified medium (DKW, 1/4th macroelements) and vermiculite, in the proportions 250/200 (v/v) which strongly promoted root elongation (two to seven-fold) and the development of secondary roots of induced shoots (IBA 24.6 μM) after 2 weeks of culture. On the other hand, distilled water added to vermiculite gave the poorest rooting. Saadat and Hennerty (2001) carried out a set of experiments to find the best medium for rooting of Walnut microshoots and best results were noticed on DKW medium (1/2-strength macronutrients) containing 4 mg/l IBA for 9 days in darkness and transferring to Jiffy-7 pots for root development without auxin treatment. Using this procedure about 83% of surviving shoots in Jiffy-7 pots rooted. The use of Jiffy-7 pots allowed rapid development of the root system and improvement in the quality of plantlets (higher number of roots, presence of secondary roots), and root development was synchronised with shoot elongation and development of new leaves. Also, on transferring the plantlets to the greenhouse, their growth continued and more than 90% of plantlets survived. They also concluded that IBA was better for rooting of microshoots than NAA.

Almond

Almond, Prunus dulcis (Miller) D. A. Webb, is one of the oldest and most important nut crops worldwide. It is an agronomically important crop, cultivated mainly for its kernel and oil. The conventional breeding processes are too slow and difficult due to high levels of heterozygosity and long generation cycles (Ainsley et al. 2000). Also, most common commercial cultivars are self- incompatible. Hence, in vitro protocols of micropropagation are to be focussed, as they have the potential to increase multiplication rate of elite genotypes as well as ability to produce new and improved cultivars when combined with other tools of modern biotechnology (Martins et al. 2004).

To maintain clonal purity, seed derived material are generally not used for propagation. Thus, development of in vitro adventitious shoots from explants of mature trees will greatly facilitate the process (Miguel et al. 1996). Andreu and Marin (2005) compared the effect of origin of explants (micropropagated or conventionally propagated plants) on both establishment and multiplication of the in vitro cultures and found that cumulative number of shoots increased sharply in cultures originated from micropropagated plants, whereas moderate increase was seen in cultures originated from cutting-derived plants. Ainsley et al. (2000) initiated shoot formation from the leaf explants which were obtained from micropropagated shoot cultures of commercial cultivars. Micropropagation was carried out on Almehdi and Parfitt's (AP) basal media with varied growth regulators. They also found that inclusion of 0.1% w/v casein hydrolysate improved the callus morphology and increased regeneration frequency for different cultivars (Ainsley et al. 2000).

The induction of roots in vitro is an important step in plant micropropagation, but has often proved difficult, particularly when rooting shoots of mature woody plants (George 1996). Rooting of several Prunus sp. including apricot, cherry, peach, and plum has been reported, in vitro rooting of almond has proven difficult. Reports describing rooting of adult almond explants are limited, and have primarily focused on hard shell cultivars grown in Europe (Ainsley et al.2001).

An efficient method was developed for rooting of almond cultivar, Nonpariel (Namli et al. 2011). Apical shoots of almond Nonpareil were cultured on Murashige and Skoog (MS) medium containing 1.0 mgl-1 BA for micropropagation. After 3 weeks cultured elongated shoots were excised and their response to a range of rooting treatments investigated. Three experiments were conducted. (1) Elongated shoots were excised and their response to a range of rooting treatments investigated. Basal end of almond shoots were dipped into 1.0 g/l of IBA at different durations (10, 20, 30, 40, 50 seconds) and (10, 15, 20, 25, 30, 35 minutes) for rooting of almond shoots. Then, the dipped shoots were cultured on modified hormone free MS medium (1/2 and 1/4), respectively. (2) Shoots (2–3 cm in length) were excised and the basal end dipped in 2.5, 5.0, 7.5 and 10.0 mM IBA for 3 min, then placed in the modified half strength MS medium with 2% sucrose, 0,7 % w/v agar (Agar-Agar, Sigma) without plant growth regulators. Cultures were placed in the dark for 4 days prior to transfer to a 25 $\pm$ 2^{o}C with 16 h photo period (40 μmol m-2 s-1) provided with mercury fluorescent lamps. (3) Shoots were cultured basic MS culture medium containing 2.5, 5.0, 7.5 and 10.0 μM IBA. The best root formation observed on the MS media (half strength) and dipped shoots 10, 15, 30 and 35 minutes at 1.0 g/l of IBA.

Ainsley et al. (2001) carried out a set of rooting experiments using in vitro propagated shoots. Various concentrations of IBA and NAA were compared over a range of incubation periods. The best rooting treatment came out to be shoot insertion for 12h into water-agar (0.6% w/v) with 1 mM IBA, followed by 2wk in basal medium without auxin but with 100 mM phloroglucinol (PG). Also, extending the darkening period did not improve rooting ability. Miguel et al. (1996) carried out the regeneration of adventitious shoots from almond leaves, cv. Boa Casta, excised from in vitro cultures of juvenile and adult material and found that leaf explants of juvenile origin yielded the highest regeneration rates and required higher concentration of TDZ for shoot induction than leaves of adult origin.

One of the problems in Almond micropropagation is culture medium development (Nas et al. 2013). The current methods are time-consuming, laborious, and require a large amount of experimental materials. The Nas hypothesis for the development of a micropropagation medium offers a less time-consuming and a less laborious approach.

According to this hypothesis, the composition of a culture medium for a particular species should resemble the seed composition. In accordance with this hypothesis, first, an almond culture medium [Nas Almond Medium (NAM)] was developed based on almond kernel composition. Then, using mature tissues of almond cultivars, the growth of cultures on NAM was compared to that on Murashige and Skoog medium (MS), Woody Plant Medium (WPM), Driver and Kuniyuki medium (DKW), and Nas and Read medium (NRM). Medium composition had profound effects on the 3 growth parameters of number of shoots per explant, mean shoot length, and the productivity. With respect to mean number of shoots and mean shoot length, NAM was the best medium. NAM was also the most productive medium. NAM was up to 35%, 49%, 68%, and 69% more productive than NRM, MS, DKW, and WPM, respectively. The results suggest that formulating the composition of a culture medium based on the seed content can be a straightforward universal method of medium development for micropropagation (Nas et al. 2013)..

Conclusion

Micropropagation of walnut and Almond is feasible on large scale. However, protocols need to be standardized depending upon the genotypes.

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WALNUT EXPORT: STATUS, HANDLING, CHALLENGES AND STRATEGIES

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Introduction

Walnuts are a high energy food, rich in oil (including the preferred omega-3 fatty acids), vitamins and minerals. It is also valued as a healthy snack food and bakery. Walnut is a rich source of alpha linolenic acid which has substantial cardio protective effects in human beings. Besides being a source of powerful antioxidant named melatonin, which is produced by pineal gland and inducting and regulating sleep, walnut is a perfect evening food for the sound sleep during night.

Western Himalayan region of India has a potential to produce high quality walnuts as it possesses suitable agroclimatic conditions. Jammu and Kashmir State of India has the monopoly on the production of export quality walnut. The state alone produces more than 98% of nation's crop with an average productivity of 2.69 metric tonnes/ ha. Walnut industry has the great role in national economy. More than 6000 metric tonnes walnut kernel is being exported annually mainly to the France, Germany, Spain, Portugal, Austria, United Kingdom, Kuwait, Bahrain, Dubai and Saudi Arabia, worth of rupees 130-150 crores. Besides, the domestic demands of kernel and inshelled walnut worth of Rs. 70-100 crores is also being fulfilled by the state, per annum. The whole need of export quality walnut in the state is catered by the trees of seedling origin, and the product sold in the national and international markets by the suppliers has a lot of variability in nut size, shape, shell type (thin/ hard) and kernel quality, as they collect the produce from different sources making mixture with in a lot.

Walnuts found at altitudes of 1500 m a m s l and above are superior in quality compared with those found at lower elevations, but very high phenotypic variation in walnut plantations exist in this region due to their seedling origin. Given the quite large and so far unexploited variability within the J. regia L. species, it is considered that it would be useful to make selections from naturally existing populations or to create new cultivars through hybridization by combining the improved characters like climatic adaptations, precocity, high productivity, tolerance to disease and quality nut crop. Selection of walnut has a long history, and it was carried out by method of simple selection out of natural seed population having intended traits with high quality walnuts to assure the sustainability of walnut growers, and so far, this method is the basic one.

Status

The walnut export status of last three years is given in Table 1.

Table 1.Comparative export status of walnut

Product	2011-12		2012-13		2013-14	
	Qty (MT)	Value (Rs in lakhs)	Qty (MT)	Value (Rs in lakhs)	Qty (MT)	Value (Rs in lakhs)
Walnuts	5841.56	23108.40	5295.47	19983.57	6726.36	32453.50
Fresh Mangoes	63441.29	20974.30	55584.99	26471.78	41279.97	28542.85
Fresh Grapes	108584.56	60288.15	172744.42	125942.78	192616.91	166647.45
Other Fresh Fruits	270437.20	75541.11	263970.29	77975.78	240552.45	102159.21
Total	**448304.6**	**179912**	**497595.2**	**250373.9**	**481175.7**	**329803**

Source: DGCIS Annual Data

Share (%age) of Top Five Destination of walnut (2013-14)

Vietnam Social Republic (14.49 %), Egypt Arab Republic(11.20 %), Netherland (11.07 %), United Kingdom (9.03 %) and Spain (7.82 %)

Minimum requirement for export

Walnuts in shell should be intact, shall not be split or perforated; slight superficial damage is not considered a defect; partially open walnuts are considered to be intact provided that the kernel is physically protected, sound, well matured, clean, practically free of any visible foreign matter, dry, free of abnormal external moisture, free from residues of husk, free from damage caused by pests, free from oil stains, sunburns and residue of chemical bleaching and should not be empty and stony.

Kernels should be firm, normally developed, shriveled kernels are to be excluded, clean, practically free of any visible foreign matter, free from living insects, mites or other parasites, free of damage caused by pests, free from rancidity or oily appearance, free from visible mould free of abnormal external moisture, free of foreign smell or taste, free from darkening, oil seepage or rancidity . Kernels should comply with the requirements of residue levels of heavy metals, pesticides and other contaminants and other food safety parameters as laid down by the Codex Alimentarius Commission for exports. The moisture content for fresh walnuts shall be 20 % and above.

Moisture content of dry walnuts in shell shall not be more than 12 % and not more than 8% for the kernels.

Postharvest handling

1. Inshelled walnut

   Collection of nuts Size Grading → Washing with chlorinated water → Brushing and washing → Drying (4-5h in summer and 2 days in winter) → Deshelling → Sorting → Packing in vacuum pouches of 5kg capacity (2 puches /cartoon)

2. Shelled walnut

   Collection of kernel → Drying (at 70-800C for 2-3h + air circulation) → Cooling for 3h → Fumigation colour sorting → Packing

Grading

Grades of export quality walnuts (shelled and in-shelled) are given in Table 2&3.

Table 2.Grade designation and definition of quality of in-shell walnuts produced in India

Grade designation	Special requirements			General Requirements
	Size (Min)	Tolerance limit for nuts having		
		invisible or internal defects	visible or superficial defects	The walnuts shall :- 1) be of current year crop only 2) be well developed, well washed or bleached and present a clean and attractive appearance and have bright shells 3) be free from artificial colouring; 4) be reasonably dry so that the loss in weight may not exceed 1 percent on arrival at the destination; 5) be free from live pests, grubs, eggs and the like; 6) give 90 percent and above good cracking and yield kernels of agreeable taste and aroma; 7) be fairly free from invisible or internal defects and stony (hard or katha) or empty nuts; 8) be fairly free from visible or superficial effects. 9) be clean, well graded, and fairly free from foreign matter.
India super special	30-32 mm	10 % of which stony nuts (hard or Katha) not to exceed 2 %	15%	
India special	28-30mm	10 % of which stony nuts (hard or katha) not to exceed 2 %	15%	
India-I	26-28 mm	10 % of which stony nuts (hard or katha) not to exceed 2 %	15%	
India-B	24 -26mm	10 percent of which stony nuts (hard or katha) not to exceed 2 %	15%	

Table 3.Grade Designations of quality of shelled walnuts produced in India

Grade designation	Special requirements					General Requirements The Kernels shall:-
	Colour	Size	Maximum limits of tolerance for			
			Colour	Size	Other defects	
Indian light Halves	Light creamy or light golden yellow	Compl-ete halves	10% darker than grade color of which not more than 2 % shall be darker than light amber to lighten	Ecornee 13% which shall not contain 5% kernels smaller than pieces (large)	4%	I) Be obtain From walnuts Current year crop only; ii) be edible, having agreeable taste and aroma; (iii) iii. be free from meal or flour at the time of walnut packing (iv) be properly cured that is,
Indian special small light Halves	Light creamy or light golden yellow	Small compl-ete halves	As laid down for Indian light halves	18% kernels of which smaller than pieces (large) shall not exceed 5% and over sized kernels shall not exceed 6% the oversized kernels shall not exceed 26mm in breadth or length	4%	efficiently dried, so that they reach the destination in good and sound condition and loss in weight on arrival at destination may not exceed 1% v) be reasonably free from partially or wholly shrunken or shriveled, oilbled, darkend blighted, sunburnt, wormeaten, rancid, bitter, excessively oily or unpalatable, tainted, or blemished kernels; vi) be free from diseased and moldy pieces, cobwebs, rodent excreta, human hair, live pests,
Indian Light Quarters	Light Creamy or light golden yellow	Ecornee down to quarters	As laid down for Indian light halves	13% of Kernels not conforming to grade size of which crumbs not to exceed 1%	4%	grubs or eggs, shell grits, wood splinters, husk and other fore
Indian Light Brokens/ Pieces(large)	Light creamy or light golden yellow	Ecornee down to pieces which shall not pass through 7mm sieve	As laid down for Indian light halves	13% of kernels not conforming to grade size of which crumbs not to exceed 1%	4%	

Packing

Method of marking
(I) Serial number
(ii) Grade
(iii) Type (in-shell or shelled walnuts)
(iv) Year of harvest
(v) Date of packing

Method of packing
a) In-shell walnuts
(i) Shall be packed in sound, clean gunny bags or
High density polyethylene (HDPE)
bags or in wooden boxes or card board cartons.
The bags shall be neatly stitched. All the Packaging

Packaging

Packages for inshelled walnut should be stenciled and sealed in such manner as may be prescribed by the Agricultural Marketing Adviser to the Govt. of India. The standard packages should be of 10 kilograms ; 12.5 Kg, 25 Kg, 25.5. Kg, 50 Kg, 51 kg, gross weight. For kernel sound, seaworthy, seasoned wooden boxes, card board cartons, tins or aluminum / aluminum lined polythene / laminated detailed polyester nylon/plastic flexible film pouches for nitrogen / carbon dioxide gas filled or flushed vacuum packing are used. For introducing other types of packages, prior approval of the Agricultural Marketing Adviser to the Government of India or of such officer as may be authorised by him in this behalf are necessary. The standard packages are of 10 Kg, 12.5 Kg, 25 Kg, net weight, proper lining material (at least double lining, the first lining of brown or Kraft paper and the second lining of the stout white, grease-proof, waxed or thick white parchment paper) is used.

Fumigation

Fumigation of new crop (from the 1st of October of each year to the last day of January of the succeeding year) in case of in-shell walnuts is not compulsory. From 1st February to 30th September each year, fumigation of all consignments of in-shell walnuts is compulsory. Shelled walnuts packed in vacuum or in nitrogen or carbon dioxide filled/ flushed pouches of tings or aluminum containers may not be fumigated. Fumigation of all other shelled walnuts is compulsory prior to export. Export consignment should be fumigated not earlier than 15 days before shipment. Fumigation of both in-shell and shelled walnuts and prophylactic treatment of containers should be undertaken in accordance with the instruction issued by the Agricultural Marketing Adviser to the Government of India and a certificate to this effect should be produced by the exporter or his agent in respect of each exported lot to the officer who issued the relevant certificate of grading within 15 days from the date of shipment as a proof that the said lot was fumigated by the fumigator recognized for the purpose by the Agricultural Marketing Adviser to the Government of India .

In case an Agmark graded consignment is not shipped within the stipulated period of validity from the date of grading, the consignment can be exported only after it has been re-inspected by the officer authorised by the Agricultural Marketing Adviser to the Government of India and the Certificate of AGMARK grading revalidated. The revalidated certificate of Agmark grading shall also remain effective for a fixed period, after which it shall again require revalidation. The period of validity should be as under:

(a) Shelled walnuts packed in vacuum or in nitrogen or carbon dioxide filled/ flushed pouches tins of aluminum containers ninety days from the date of inspection ;

(b) shelled walnuts packed other than (a) above and in shell walnuts;-

(i) sixty days for consignments packed from the beginning of the season to end of February next year ;

(ii) Forty five days for consignments packed from the first March to the end of the season.

(c) The period of revalidation in all cases shall be forty five days from the date of re-inspection

An additional tolerance of 5 % for nuts having “hull stains” not exceeding 50% of shell surface area is allowed.

NOTE : All percentage for calculating tolerance shall be on the basis of count.

Pest control

The three most economically significant of these pests are codling moth (Cydia pomonella L.), navel orangeworm (Amyelois transitella Walker), and Indianmeal moth (Plodia interpunctella Hubner). Larvae of codling moth and navel orangeworm are field pests and may be present in harvested walnuts. Codling moth is targeted by quarantine regulations in Japan and South Korea,

and navel orangeworm is of phytosanitary concern in Australian and European markets. Indianmeal moth is a common pest of stored walnuts and is the insect most often responsible for consumer returns and complaints.IN India, pest control is not followed in proper way hence, some countries like Japan and Korea still do not accept Indian walnuts because of unaccepted quarantine protocol. In other walnut exporting countries, pest control is essential with different techniques.

Conventional hot air is currently used for initial and final drying of in-shell walnuts after bleaching and washing. The final drying process typically requires 4–6 h in 52 °C air. The slow heating is due to the interior air pockets in in-shell walnuts . Radio frequency (RF) treatment has the potential for use as an alternative thermal treatment for quarantine as well as a fast dryingmethod . This is because RF energy interacts directly with dielectric materials to provide fast heating. A practical process protocol has been developed to control insect pests in in-shelled walnuts using a 27 MHz pilot scale radio frequency (RF) system. Fifth-instars, that had been determined to be the most heat resistant life stage for navel orangeworm using a heating block system, were selected as the targeted insect in the protocol development. RF heating to 55 °C and holding in hot air for at least 5 min resulted in 100% mortality of the fifth-instar navel orangeworm. Rancidity, sensory qualities and shell characteristics remainedunaffected by the treatments. The process slightly reduced the moisture content of the walnut kernels, which could prove an additionalbenefit by providing even nut moisture content and reducing the growth of microorganisms. If this method can be economically integrated into the handling process, it should have excellent potential as a disinfestation method for in-shell walnuts . A combined system of radio frequency heating with hot air has the potential to accelerate or even replace batch drying of walnuts in the future .

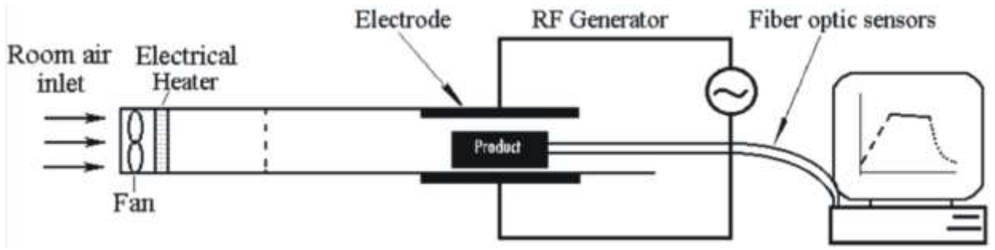

Fig. 1.Schematic view of the combined RF and hot air treatments of in-shell walnuts for insect control

Aflatoxins are considered to be potent carcinogens and teratogens to humans and farm animals. A variety of species of the fungal genus Aspergillus (mainly A. flavus and A. parasiticus) synthesize aflatoxins. Spores of these fungi are common in air and soil of agricultural areas of temperate and tropical environments. Because aflatoxigenic fungi are ubiquitous and opportunistic, aflatoxin contamination has become a food safety concern. Additionally, aflatoxin contamination has also become an international trade issue. Major trading partners of U.S. agricultural products have set total aflatoxin action threshold levels at four ng/g (ppb). This action level is far below the 20 ppb level recommended by the U.S. Food and Drug administration for domestic foods. Walnuts are one of the major food commodities affected by food safety and trade issues associated with aflatoxin contamination. Scientists at the USDA's Western Regional Research Center and the University of California, Davis' Department of Pomology and Kearney Agricultural Center have developed products and methods to reduce aflatoxin contamination of tree nuts. Control of insect pests in tree nut orchards is a major strategy to curtail aflatoxin contamination. Insect feeding damage can lead to fungal infection and concomitant aflatoxin contamination. This is especially the case with navel orangeworm on pistachio and almond. Through breeding and genetic engineering, new varieties of almonds and walnuts have been developed which are resistant to insect attack. New orchard management strategies have been prescribed to reduce reservoirs of A. flavus in tree nut orchards. A number of saprophytic yeasts, natural to tree nut orchards, have been discovered which show promise as biological control agents of A. flavus, in vitro, and are awaiting field testing. New and improved risk assessment models have been developed for sampling and measuring aflatoxin contamination through the processing stream and in bulk shipping lots of tree nuts. An automated sorter that detects and removes aflatoxin contaminated nuts from a processing stream in real time was developed. It is also concluded that methods currently used for hand-cracking of closed shell nut result in a higher risk of aflatoxin contamination. Perhaps the foremost breakthrough to date, however, is that constituents of walnut seed coat, especially from the cultivar 'Tulare', are potent inhibitors of aflatoxin biosynthesis, capable of rendering aflatoxigenic A. flavus virtually atoxigenic.

Quality test

Free Fatty Acids : <1% (for fresh)-1.5%
Peroxide : <2-3%
Aflatoxins (B1,B2,G1,G2): -I've
Yeast & mould : <15000cfu/g
Salmonella : Absent

Pesticide residue limits
The pesticides MRL limits recommended by CAC are given in Table 4.

Table 4. MRL limits for pesticides

Maximum residue limit (MRL)		
Pesticide	MRL (mg/Kg)	Year of adoption
Abamectin	0.01	2001
Diazinon	0.01	1995
Deltamethrin	0.02	2004
Chlorpyriphos	0.05	2003
Tebufenozide	0.05	1999
Methidathion	0.05	1997
Phosalone	0.05	2001
Azinphos-Methyl	0.3	1995
Propargite	0.3	2007
Fenbutatin Oxide	0.5	1997
Ethephon	0.5	1997

Challenges

- Non-availability of organized orchards
- Mixture of seedling produce
- Non-availability of progeny orchards
- Non-availability of quality planting materials
- Elevation constraint
- Very low production as compared to China and USA
- Very high domestic demand (increased from 10 to 30%)
- Interrupted produce supply
- Disagreement about plant and quarantine protocol
- Competition with non-traditional exporters like Hungary, Ukraine, Uzbekistan, Turkey etc.

Strategies

- Exploitation of underutilized area
- Mass multiplication of identified selections
- Fresh planting under export quality walnut planting
- Strict adherence to the country specific standards and quarantine protocol
- Strengthening of postharvest infrastructure
- Mass awareness among farmers about harvesting and handling issues

Status of Walnut Cultivation in Himachal Pradesh - Problems, prospects and future strategies

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Introduction

Walnut (Juglans regia L.) is one of the most important nut fruit and cultivated mainly in temperate regions of the country. The climatic conditions of North-Western Himalayas is very congenial for its commercial cultivation and is found growing between the elevation of 1200 to 2700 m above mean sea level. In India, it is grown mainly in the state of Jammu and Kashmir, Himachal Pradesh , Uttarakhand and Arunachal Pradesh in an area of 1,49,502 hectare with a total production of 2,84,409 MT (NHB, 2013). Jammu and Kashmir is the major walnut producing state contributing 91 per cent of total production of the country. In Himachal Pradesh, it is grown in the districts of Kinnaur, Shimla, Kullu, Chamba, Mandi, Sirmour, Kangra and Solan in 4720 hectare area with the production of 1700 MT (Anonymous, 2013). Although, the state has made tremendous development in the cultivation of temperate fruits during the last two decades, however, cultivation of walnut on scientific lines remained neglected due to several reasons like non-availability of grafted/ budded plants, lack of superior and high yielding varieties, long gestation period and pollination problem. In the state majority of tress are of seedling origin which takes about 15-16 years to come in fruiting and are highly variable producing nuts of inferior quality with low shelling. However, in recent years the researchers and planners have made some efforts to popularize this fruit crop in the state, with a result the grafted plants of some promising varieties of walnut are being multiplied in the University and research stations and are made available to farmers.

Problems

During the last two decades there has been phenomenal increase in area and production of most of the temperate fruits in Himachal Pradesh, but there was no appreciable increases in area and production. The development of walnut industry in the state has been constrained mainly due to

1. The non-availability of grafted/ budded plants of high yielding varieties with desirable nut attributes.
2. Lack of mother tree orchards of good varieties varieties
3. Lack of lateral bearing varieties
4. Scarcity of scion-wood for grafting and budding
5. Plantation in marginal areas
6. Long gestation period and low productivity
7. Low density plantation due to non-availability of dwarfing rootstocks
8. Competition with apple as the walnut is also grown in areas where apple is grown

Efforts made for the promotion of walnut

In Himachal Pradesh, some efforts were made by the University of Horticulture and Forestry, Solan, IARI, Research Station, Shimla and the State Horticulture department for the promotion and popularization of walnut. The work done is as under:

1. **Selection of local strains with desirable traits:** The extensive survey in walnut growing areas of the state was conducted to select some superior strains of seedling origin. Some superior stains identified or selected are Wilson Wonder, Kainthal Selection, Gobind, Pratap , Solding Selection, Kotkhai Selection, Kn- 5, K-12, Sh-23, Sh-24, Sr-11 and Pusa Khor. Some promising varieties like CITH 1 to 10, Suliaman, Hamdan and Kashmir budded were introduced from Kashmir.

2. **Introduction of Varieties from abroad:** Some promising varieties were introduced from France and USA by the university and State Horticulture department to assess their performance under Indian conditions. The exotic varieties are Hartley, Lara, Payne, Franquette, Maytee, Sorrento Ronde De Montignel, Meylannaise, Grandjeen, Marrbot and Lateral bearing variety Chandler.

3. **Establishment and management of bud-wood bank:** In order to meet out the demand of scion-wood for production of planting materials of walnut, about 2545 plants (20-25 plants each of above mentioned local strains as well as exotic varieties) have been planted in the bud-wood bank in the University. Beside this, bud-wood banks have also been established by the state departments in their PCDO's. Mother trees are planted at close spacing of 4 x 4 meter. Trees are hard pruned every year to develop hedges for the production of scion-wood in bulk. Mother trees should be frequently irrigated and fertilized with higher dose of nitrogen to get more vigorous shoot growth. Rigorous plant protection measures are followed for the control of insect-pests and diseases.

Mother tree orchard of superior cultivars of walnut

4. **Standardization of propagation techniques:** Walnut is commercially propagated through asexual method of propagation i.e. grafting and budding on rootstocks.

A. Propagation of rootstock:-

In India, seeds of hard shell walnut known as katha walnut are generally used to raise seedlings rootstocks. Although, walnut germinates without stratification under some conditions, yet proper stratification is desirable for good seed germination and growth of seedlings. The seeds are stratified for 90-110 days in alternate layers of moist sand during December to February in pits. Soaking of seeds in 100 - 200 ppm GA3 for 24 hours after stratification is very effective in stimulating seed germination and growth of seedlings. The stratified seeds are sown in nursery beds in line 30 cm apart at a distance of 15-20 cm and at a depth of 5-6 cm in March. The rootstock attain graft able or buddable size in a year, which are grafted or budded in next year, thus takes two or three years to produce grafted or budded nursery plants. However, a technique has been developed by sowing stratified seeds either in polybags or in nursery beds under polyhouse conditions in the month of Mid February and these seedlings attain buddable size in July.

B. Propagation of scion

1. Grafting:

In grafting, generally tongue, cleft and side veneer methods are used. Tongue and cleft methods are performed during the month of February and March and graft success in these methods depend upon the climatic conditions particularly the temperature at the time of grafting and subsequent healing of graft union. A good bud-take success is obtained in tongue and cleft methods of grafting if the temperature remains around 24- 25oC during grafting time. However, poor success is obtained if the temperature remains less than 20oC at the time of healing of graft union. The average graft success in these methods generally ranged from 40 to 55 per cent. In Jammu and Kashmir, some refinement has been made with the use of hot callusing cables at graft union by which the temperature is maintained around 25oC at graft union. They obtained about 77 per cent graft take success by using this technique. Better success with these grafting methods is obtained when grafting is done in green house having 25-28oC temperature and 80-90 % relative humidity. The best time for veneer grating under mid hill conditions has been found in August with a success rate of about 60-65 per cent.

2. Summer budding methods (Chip, patch and annular):

A significant achievement in the propagation of walnut has been made with the summer budding methods particularly chip budding by the University of Horticulture and Forestry, Solan (HP). The studies were conducted on the standardization of time and methods of summer budding viz. chip, patch, annular and shield at 10 days intervals from Mid of May to last week of August at Solan in Himachal Pradesh for four years. Among these methods, chip method was found superior and gave as high as 87 - 92 per cent bud take success during last week of May to first week of June. The best time for Patch and Annular budding methods was found mid of June to mid of July under mid hill conditions. However, time of budding should to standardize in different agro-climatic conditions as the best time for chip budding at higher elevation of Himachal Pradesh was found in mid of June.

Chip budding

Bud-take success in chip budding (92%)

3. Production of budded plants in a year under protective conditions:

Generally it takes 2 to 3 years to produce grafted and budded plants; however, an agro-technique has been standardized to produce budded plants in a year. The seeds are put for stratification in alternate layers of moist sand in first week of December and stratified seeds are sown in well prepared nursery beds in polyhouse during mid February. The seedling rootstocks attain buddable size in July and budded with chip and patch methods from mid July to first week of August with a bud-take success of 80-87 per cent. The budded plants become saleable by December.


Raising of Chip budded plants in one year under polyhouse conditions

4. Hypocotyl grafting:

the work on the standardization of hypocotyls grafting in walnut is progress and 70-80 per cent bud-take success have been got in this method. The seeds are stratified during December and after stratification they are sown in polybags in mid February. The polybags are kept in polyhouse for early germination of seeds. Ten to fifteen days after germination, the rootstock is grafted with wedge method near the stone or nut. The scion-wood should be collected in January- February and stored in moist moss grass in cold storage at 1-2 oC temperature.

Germinating seedling

Hypocotyl grafting with wedge method

Bud-take success

5. Top-working technique:

Large number of young seedling trees producing inferior quality nuts is abundant in the hills of north-west Himalayas, which can be top-worked by scion of some superior varieties using budding methods. Top-working technique with dehorning has been standardized for higher bud-take success. In this technique, the seedling trees are dehorned by heading back main branches in dormant season (December-January). New branches will emerge from dehorned branches in spring season and these new branches are budded with chip method in second week of May and annular method in first week of July. Chip method gave 85 per cent bud-take success in second week of May and annular budding also registered more than 80 per cent bud-take success. This technique can be adopted for changing the seedling trees with some superior cultivars.


Nursery raising techniques:

Wanut has deeep tap root system and at the time of uprooting of nursery plants the tap root got damaged or broken. It has been observed that such nursery plants show poor survival in the orchard site. The results of nursery raising techniques shows that undercutting of newly germinating seedling produced more secondary roots and showed better field survival

Wrenching of newly germinating seedlings

Control

Future strategies

For the promotion and popularization of walnut cultivation on a commercial scale the following points need to be taken care of;

1. Introduction of lateral bearing varieties like Tulare, Chico, Howard, Chandler, Sexton, Solano, Gillet, Forde and Ashley
2. Extensive survey of walnut growing areas to identify promising strains with desirable traits.
3. Establishment of bud-wood bank of superior, high yielding and lateral bearing varieties.
4. Large scale multiplication of nursery plants of superior varieties
5. Introduction and mass multiplication of dwarfing rootstocks
6. Development of high density plating and hedge row orcharding
7. Identification of suitable pollinizer varieties to overcome pollination problem
8. Standardization of post-harvest handling, shelling, grading and packing of kernels

उत्तराखण्ड राज्य में अखरोट उत्पादन : वर्तमान परिदृष्य एवं सम्भावनायें

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प्रस्तावना

अखरोट एक शीतोश्ण फल है। इसका उत्पादन मुख्यतः देश के हिमालयी राज्यों (जम्मू–कश्मीर, उत्तराखण्ड एवं हिमांचल प्रदेश) में किया जाता है। वर्तमान में अरूणांचल प्रदेश में भी अखरोट उत्पादन के प्रयास किये जा रहे है।

अखरोट के गुण

1. अखरोट एक अत्यन्त उपयोगी फल है। इसका उपयोग विभिन्न बीमारियों के उपचार में परम्परागत औशधियों में किया जाता है।
2. अखरोट मात्र एक ऐसा फल है, जिसमें उपयुक्त मात्रा में उमेगा–3 फेटी अम्ल (omga-3 fatty acid), एल्फा–लिनोलेनिक अम्ल (alfa-linolenic acid), रेशा (fiber) तथा प्रोटीन पाये जाते हैं।
3. अखरोट के अन्दर कैंसर अवरोधी, मधुमेह अवरोधी तथा रक्त शुद्व करने वाला टॉक्सीक विरोधी गुण विद्यमान है।

उत्तराखण्ड राज्य की भौगोलिक स्थिति एवं कृशि जलवायु अखरोट उत्पादन हेतु अनुकूल है, जो कि प्रदेश के समस्त पर्वतीय जनपदों के 1200 से 2200 मी0 ऊचाई तक के क्षेत्रों में प्राकृतिक रूप से पाया जाता है। अखरोट उत्पादन से किसानों को अधिक आय प्राप्त होती है। वर्तमान में राज्य में प्राकृतिक रूप से उगने वाले समस्त अखरोट के वृक्ष बीजू प्रजाति के काठी फल हैं। विगत वर्शों में राज्य के समस्त पर्वतीय क्षेत्रों में अखरोट का रोपण भी किया गया है, परन्तु यह सभी पौधे बीजू प्रजाति के काठी अथवा कागजी फल हैं। विगत कुछ वर्शों में उच्चगुणवत्तायुक्त पौधों का चयन कर, बडी मात्रा में क्षेत्रफल विस्तार किया गया है, जिसमें चकराता सलैक्शन प्रजाति का रोपण मुख्य है। बीजू प्रजाति के वृक्षों का आकार बहुत बडा होता है तथा फल वृक्ष के ऊपरी/शीर्श भाग में लगते हैं, जिससे इनकी तुडाई में कठिनाई उत्पन्न होती है। साथ ही इनकी उत्पादकता भी बहुत कम है। बीजू पौधों से 10 वर्श के उपरान्त ही उत्पादन प्राप्त होता है, परन्तु कल्मी (ग्राफ्टेड) पौधों से 05 वर्श पश्चात ही गुणवत्तायुक्त एवं अधिक उत्पादन प्राप्त हो जाता है। वर्तमान में उच्च गुणवत्तायुक्त चारों तरफ से फल लगने वाली (लेटरल वियरिंग) प्रजातियॉ एवं नवीनतम उत्पादन तकनीक विकसित की जा चुकी हैं। अतः आवश्यकता है कि राज्य में अखरोट के केवल उच्च गुणवत्तायुक्त कल्मी पौधों का ही रोपण किया जाय।

उत्तराखण्ड में अखरोट उत्पादन की वर्तमान स्थिति

यद्यपि अखरोट उत्पादन में उत्तराखण्ड का देश में जम्मू–कश्मीर (2.61 लाख मै0टन) के बाद द्वितीय स्थान है, परन्तु उत्तराखण्ड राज्य में अखरोट का उत्पादन बहुत कम है। वर्श 2012–13 के उत्पादन आंकडों के अनुसार राज्य में अखरोट का उत्पादन कुल 19265 है0 क्षेत्रफल में किया जा रहा है, जो कि मात्र 21464 मै0टन है। इसके साथ ही इसकी उत्पादकता भी बहुत कम (1.11 मै0टन/है0) है। राज्य में अखरोट का उत्पादन समस्त पर्वतीय जनपदों में किया जाता है।

अखरोट उत्पादन हेतु उद्यान एवं खाद्य प्रसंस्करण विभाग द्वारा किये गये प्रयास

अखरोट की खेती, उत्पादन और उत्पादकता में वृद्वि हेतु उद्यान एवं खाद्य प्रसंस्करण विभाग, उत्तराखण्ड द्वारा पूर्व में प्रयास किये गये हैं। इस हेतु विभिन्न प्रजातियों के उच्चगुणत्तायुक्त पौध रोपण सामग्री के उत्पादन हेतु मातृ वृक्ष खण्डों की स्थापना कर बडी संख्या में पौध रोपण सामग्री का उत्पादन कर क्षेत्रफल विस्तार के लिये किसानों में वितरित करने

हेतु वर्श 2007–08 में उद्यान विभाग द्वारा विदेशों से कुल 4453 अखरोट की उच्चगुणत्तायुक्त पौध रोपण सामग्री की प्रजातियों का आयात किया गया, जिनका विवरण निम्नवत् हैः–

क्र0सं0	प्रजाति	पौधों की संख्या
1	लारा (Lara)	620
2	फरनर (Fearnor)	800
3	चाण्डलर (Chandler)	630
4	फ्रन्क्यूएट (Franquette)	795
5	परसेनेन (Peresinenne)	90
6	फरनेट (Fernett)	58
7	मलनेसिया (Melnesiya)	40
8	प्रोनक्वीट (Pronkwit)	30
	योग	3063

इन उन्नत किस्मों की प्रजातियों के मूल्यांकन हेतु राज्य की विभिन्न पौधशालाओं में मातृ वृक्ष खण्ड की स्थापना हेतु रोपण किया गया, जिसका विवरण निम्नवत् हैः–

क्र0 सं0	पौधशाला	रोपित पौधों की संख्या	जीवित पौधों की संख्या
1	राजकीय उद्यान, सोनी, अल्मोड़ा	460	236
2	राजकीय उद्यान, चौबटिया, अल्मोड़ा	1303	990
3	राजकीय उद्यान, मगरा, टिहरी	950	510
4	राजकीय उद्यान, जरमोला, उत्तरकाशी	100	70
5	राजकीय उद्यान, बरौंथा, देहरादून	250	198
	योग	3063	2004

इसके अतिरिक्त केन्द्रीय शीतोश्ण बागवानी संस्थान, श्रीनगर से अखरोट की उच्चगुणत्तायुक्त पौध रोपण सामग्री की विभिन्न प्रजातियों के कुल 125 पौधों को प्राप्त कर उनके मूल्यांकन हेतु राज्य की निम्न पौधशालाओं में मातृ वृक्ष खण्ड की स्थापना हेतु रोपण किया गया हैः–

क्र0 सं0	पौधशाला	Varieties								
		W7	W10	W13	W16	W19	W21	W23	W24	कुल योग
1	राजकीय पौधशाला, कोटी, चमोली	5	30	5	30	3	2	20	5	100
2	राजकीय पौधशाला, पाटन, चम्पावत	5	-	5	-	3	2	5	5	25
	योग	10	30	10	30	6	4	25	10	125

वर्तमान में उपरोक्त पौधशालाओं में अखरोट के कल्मी पौधों का उत्पादन नगण्य है एवं अधिकांश पौधशालाओं में आयातित पौधों की जीवितता बहुत कम है तथा जीवित पौधों की स्थिति भी अच्छी नहीं है।

राज्य में अखरोट के उत्पादन को बढ़ावा देने हेतु वर्तमान में निरन्तर प्रयास किये जा रहे हैं, जिनमें से निम्न 02 परियोजनाऍ स्वीकृत की गयी हैः–

1. बागवानी मिशन के अन्तर्गत वित्तीय वर्श 2013–14 में शीतोश्ण फलों के समग्र विकास हेतु औद्यानिकी एवं वानिकी विश्वविद्यालय, भरसार को Centre of Excellence की स्थापना हेतु ₹4.98 करोड़ की राज सहायता स्वीकृत की गयी है, जिसके अन्तर्गत अन्य शीतोश्ण फलों के अतिरिक्त अखरोट भी सम्मिलित है।

2. राश्ट्रीय कृशि विकास योजनान्तर्गत अखरोट एवं गिरिदार फलों को बढ़ावा देने हेतु औद्यानिकी एवं वानिकी विश्वविद्यालय, भरसार को वित्तीय वर्श 2013–14 में Germplasm Centre with Nursery of Nut Fruits including Walnut & Apricot की स्थापना हेतु ₹ 2.07 करोड़ लागत की परियोजना स्वीकृत कर क्रियान्वित की जा रही है। इसके अन्तर्गत विश्वविद्यालय द्वारा वर्श 2014–15 में अखरोट के 10,000 रूट स्टॉक (बीजू पौधे) तैयार किये गये हैं, जिन पर वर्श 2015–16 में अखरोट की विभिन्न प्रजातियों के पौधों से ग्राफ्टिंग कर पौध रोपण सामग्री का उत्पादन किया जायेगा।

इसके अतिरिक्त अखरोट एवं अन्य नट फ्रूटस के उत्पादन को बढ़ावा देने हेतु WALNUT AND OTHER NUT FRUIT GROWERS ASSOCIATION OF INDIA (WANGAI) एवं राज्य बागवानी मिशन के सहयोग से गोविन्द बल्लभ पन्त हिमालय पर्यावरण एवं विकास संस्थान, कोसी कटारमल, अल्मोड़ा में दिनांक 24–25 अक्टूबर, 2013 को दो दिवसीय राश्ट्रीय संगोश्ठी आयोजित की गयी।

अखरोट उत्पादन हेतु व्यक्तिगत क्षेत्र में किये गये प्रयास

राज्य में कुल 144 व्यक्तिगत पंजीकृत पौधशालायें हैं, जिनमें से 31 पौधशालायें राश्ट्रीय बागवानी बोर्ड द्वारा मान्यता प्राप्त हैं। मान्यता प्राप्त पौधशालाओं में से मात्र 01 पौधशाला मै0 भण्डारी पौधशाला, ग्राम बियाली, उत्तरकाशी में 25000 लोकल कागजी अखरोट की पौध रोपण सामग्री का उत्पादन किया जा रहा है, जो कि केवल बीजू है। इसके अतिरिक्त 01 अन्य पंजीकृत पौधशाला मै0 ग्रीन हिमालयन पौधशाला, विकासनगर, देहरादून द्वारा अखरोट के लगभग 3000 बीजू तथा 1000 ग्राफ्टेड कागजी पौधों का उत्पादन किया जा रहा है। बागवानी मिशन द्वारा वर्श 2014 में मै0 जैविककला पौधशाला, ग्राम बैडी, ताडीखेत, अल्मोड़ा को 04 है0 की 01 बड़ी पौधशाला स्वीकृत की गयी है, जिसके द्वारा अन्य फलों के अतिरिक्त अखरोट के लगभग 1.00 लाख कल्मी पौधों का उत्पादन प्रतिवर्श किये जाने का प्रावधान है।

अखरोट उत्पादन एवं उत्पादकता में वृद्विहेतु रणनीति

उत्तराखण्ड राज्य को अखरोट उत्पादन में द्वितीय स्थान से प्रथम स्थान पर लाने हेतु निम्नानुसार रणनीति अपनायी जाने की आवश्यकता हैः–

1. राज्य में उच्च गुणवत्तायुक्त कल्मी पौध रोपण सामग्री की उपलब्धता सुनिश्चित करने हेतु राजकीय एवं व्यक्तिगत क्षेत्रों में निम्न स्थानों पर स्थापित पौधशालाओं का सुदृढिकरण किया जायेगाः–
   - i. राजकीय उद्यान, सोनी, ताडीखेत, अल्मोडा।
   - ii. राजकीय उद्यान, चौबटिया, रानीखेत, अल्मोडा।
   - iii. राजकीय उद्यान, पाटन, चम्पावत।
   - iv. राजकीय उद्यान, कोटी, चमोली।
   - v. राजकीय उद्यान, जरमोला, उत्तरकाशी।
   - vi. राजकीय उद्यान, बरौथा, देहरादून।
   - vii. राजकीय उद्यान, मगरा, टिहरी।
   - viii. राजकीय उद्यान,सतबुंगा, नैनीताल
2. अखरोट की उच्च गुणवत्तायुक्त लेटरल वियरिंग (चारों तरफ फल लगने वाली) प्रजातियों का विदेशों से आयात कर उपरोक्त चयनित पौधशालाओं में मातृ खण्ड (डवजीमत ठसवबा) की स्थापना की जायेगी। इस हेतु बागवानी मिशन अथवा राश्ट्रीय कृशि विकास योजनान्तर्गत प्रस्ताव तैयार किये जायेगें।
3. राज्य में राजकीय एवं व्यक्तिगत क्षेत्र में केवल अखरोट की कल्मी पौध रोपण सामग्री के उत्पादन हेतु नयी हाईटैक पौधशालाओं की स्थापना की जायेगी तथा समस्त पौधशालाओं को राश्ट्रीय बागवानी बोर्ड से मान्यता प्रदान करायी जायेगी।
4. उपरोक्त पौधशालाओं में अखरोट की उन्नतशील उच्चगुणवत्तायुक्त प्रजातियों के पौधों का अधिकाधिक मात्रा में उत्पादन कर प्रगतिशील कास्तकारों में वितरण किया जाय।
5. अखरोट का उत्पादन एवं उत्पादकता में वृद्विहेतु क्लस्टर अवधारणा के आधार पर क्षेत्रफल विस्तार किया जाये, जिस हेतु समुचित च्वजमदबपंस क्षेत्रों का चयन किया जाय। वर्तमान में राज्य के विभिन्न जनपदों में अखरोट क्षेत्रफल विस्तार हेतु कुल 32 (अल्मोडा–8, बागेश्वर–1, पिथौरागढ–1, देहरादून–2, टिहरी–1, पौडी–3, रूद्रप्रयाग–1 एवं उत्तरकाशी–15) क्लस्टरों का चयन किया गया है।
6. राज्य में क्रियान्वित की जा रही विभिन्न केन्द्रपोशित एवं राज्यपोशित योजनाओं के अन्तर्गत अखरोट क्षेत्रफल विस्तार हेतु अधिक मात्रा में लक्ष्य निर्धारित किये जायेगें। राश्ट्रीय बागवानी मिशन के अन्तर्गत एक उप मिशन के रूप में अखरोट के सर्वांगीण विकास हेतु कार्यक्रम क्रियान्वित किये जायेगें, जिसमें पौध रोपण सामग्री का उत्पादन, क्षेत्रफल विस्तार, प्रशिक्षण, तुडाई उपरान्त प्रबन्धन एवं विपणन इत्यादि गतिविधियॉ संचालित की जायेगीं।
7. अखरोट के वृहद स्तर पर वृक्षारोपण हेतु वन पंचायत के तर्ज पर अखरोट पंचायत योजना पूरे प्रदेश में प्रारम्भ की जायेगी। क्लस्टर आधारित इस योजना में पंचायत स्तर पर जाकर व्यक्तिगत व सामयिक रूप से योजना क्रियान्वित की जायेगी। योजना के अन्तर्गत किसानों को उच्च गुणवत्तायुक्त पौध रोपण सामग्री के अतिरिक्त गढ्ढा खुदान तथा तारबाड हेतु भी राज सहायता प्रदान की जायेगी।
8. भारतीय कृशि अनुसंधान परिशद के संस्थानों एवं कृशि/औद्यानिकी विश्वविद्यालयों को अनुसंधान कर स्थानीय जर्म प्लाज्म को संरक्षित करने तथा सलैक्शन के माध्यम से नयी प्रजातियॉ विकसित करने हेतु अनुरोध किया जायेगा। इसके अन्तर्गत चकराता सलैक्शन तथा चम्बा सलैक्शन जैसी प्रजातियों को बढ़ावा दिया जायेगा।
9. राज्य में स्थापित पुराने एवं अनुत्पादक अखरोट के वृक्षों का जीर्णोद्वार किया जायेगा। इस हेतु पुराने वृक्षों पर टॉप वर्किंग कर नवीनतम उन्नतशील प्रजातियों की कलम लगायी जायेगी।
10. अखरोट के विपणन को बढ़ावा देने हेतु तुडाई उपरान्त प्रबन्धन एवं प्रसंस्करण अवस्थापना सुविधाओं की स्थापना की जायेगी।
11. कास्तकारों एवं विभागीय कार्मिकों, राजकीय पौधशालाओं के प्रभारियों एवं व्यक्तिगत पौधशाला स्वामियों को अखरोट उत्पादन को बढ़ावा देने हेतु जनपद एवं ब्लाक स्तर पर व्यापक प्रचार किया जायेगा तथा अखरोट उत्पादन की नवनीनतम तकनीकों की जानकारी देने हेतु केन्द्रीय शीतोश्ण फल संस्थान, श्रीनगर (कश्मीर) तथा यशवन्त सिंह परमार औद्यानिकी एवं वानिकी विश्वविद्यालय, सोलन के माध्यम से समयवद्व प्रशिक्षण प्रदान किया जायेगा। विशेश रूप से विभागीय मालियों को अखरोट ग्राफ्टिंग की नवनीतम तकनीकी का प्रशिक्षण प्रदान कराया जायेगा।
12. राज्य में अखरोट के सर्वांगीण विकास हेतु अखरोट विकास परिशद (Walnut Development Board) की स्थापना की जायेगी, जिसमें विशय विशेशज्ञों सहित पौधशाला स्वामियों एवं प्रगतिशील किसानों को भी सम्मिलित किया जायेगा।

Status of Walnut in Himachal Pradesh

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Walnut (Juglans regia L.) is a native to North-West Himalayas and grown at an elevation of 1200 to 2150 Mtrs a.m.s.l in Himachal Pradesh. Persian walnut is the most important temperate nut grown in India. It is mainly grown in Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Arunachal Pradesh and other Himalayan States. Walnut is grown in some of the districts of Himachal Pradesh viz. Mandi, Kullu, Shimla, Solan, Sirmour, Kinnaur, Chamba etc. The total area under Walnut in Himachal Pradesh is about 4720 hectare with the production of around 1500 MT annually. As such, the productivity of walnut in the State is around 0.32 MT per ha. In the past, efforts have been made in Himachal Pradesh to help develop and adapt technologies to promote walnut cultivation on commercial lines. The germplasm of walnut trees is limited to a few varieties in the state and most of the walnut trees being grown are of seedling origin and are terminal bearing. Most plantations are in scattered form that produces nuts of variable quality. Breeders over the years have exploited the variation amongst these seedling trees to select superior genotypes with desirable traits. Besides this, the improved cultivars were introduced from other countries and after evaluation, some recommendations have been made. Extreme summer heat, if temperature rises above 400C, accompanied by low humidity affects the production. On the whole, walnut has remained a low priority crop in otherwise apple dominated regions. Walnut growing suffers from lack of suitable methods of propagation, inadequate number of vegetatively propagated plants, lack of standard rootstocks/ cultivars, problems of re-establishment of nursery plant in the orchard, specific climatic requirements, pollination behavior and lack of suitable Pollinizers, long juvenile period and harvesting of fruits.

The nursery production work of walnut trees is confined to few nurserymen in the State. The walnut trees are being grown by these nurserymen in general as seedling stock, which has long gestation period and low productivity. The promising cultivars of walnut in the state are Gobind, Pratap and Soldling Selection, Kashmir Budded, Eureka, Placentia, Wilson, Franquette etc. & most of them are terminal bearing.

There is a need to improve the existing germplasm of by introduction of lateral bearing varieties like Chandler, Fernette, Howard, Tehama, Sunland, Tulare etc. along with their pollinizing cultivars such as Cisco, Payne Pedro, Franquette etc, which have higher fruit productivity and a better nuts and kernel ratio, large ecological adaptability to variable climatic and edaphic conditions of the State. This will certainly help farmers in taking up walnut cultivation on commercial scale and can be an important step in improving their economic status.

WALNUT CULTIVATION

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INTRODUCTION

Walnut (Juglans regia) is a native of the North -western Himalayas and is grown in all parts of the Himalayan region between the elevation of 1,200 to 2,150 m above mean sea level. It belongs to the family Juglandaceae. Walnut is grown extensively in France, Italy, Rumania, U.S.A. and China. The major walnut growing states in India are Jammu & Kashmir, hilly areas of Punjab, Himachal Pradesh and Uttarakhand. Jammu & Kashmir is the leading walnut producing state in India with 98% of the total production in the country. There are no regular orchards of walnuts in India because the existing plantations are generally of seedling origin. The seedling trees attain giant size and start bearing nuts of variable sizes and shapes after 10-15 years, whereas vegetatively propagated plants are true-to-type and remain within manageable size. Low success rate is a major constraint in vegetative propagation. Limited availability of scion material from desired trees results in very few vegetatively propagated plants. Walnuts are rich in protein, fat, carbohydrate and minerals. The nuts stand transportation better; hence cultivation of walnut can be taken up in remote and neglected areas of hills where other temperate fruits like apple, pear and plum cannot be cultivated commercially. The nuts are in great demand in abroad and thus have a high potential of earning foreign exchange.

CLIMATE AND SOIL

Walnut is highly sensitive to the extremes of winter and summer temperatures as well as to its duration. It requires a climate which is free from frost in spring and from extreme heat in summer. A temperature of even 2 or 3 degree below freezing point (0oC) kills leaves, shoots and flowers and thus resulting into a crop failure. High temperature of about 38°C causes sun-burning of hulls and shriveling of kernels resulting sometimes in empty nuts. Hot summers with low humidity result in blank nuts. An annual rainfall of about 80 cm is considered sufficient for the cultivation of walnut which can be supplemented drier regions with irrigations, particularly for young plants.

A well drained, deep silt loam soil containing an abundance of organic matter is the most suitable for walnut cultivation. Walnut requires a ferthe and well drained top soil and the sub-soil should be free from solid rock, impervious clay or gravel layers which restrict root growth. A soil depth of 2-3 metres give the best results, because walnut roots penetrate up to a depth of about three metres. It requires a soil pH of neutral range i.e. 6 to 7.

UNFAVOURABLE CLIMATE

Pollination in walnut is carried out by wind. It is self fertile but pollination is not satisfactory in certain varieties mostly because these varieties fail to mature their pollen at the time when the female flowers are receptive. Hot spring weather hastens the development of catkins and makes them shed their pollen quickly. It does not have great effect on the development of pistillate flowers. The pollination difficulty in the established orchards can be overcome temporarily by bringing catkins from the neighboring plantations and hanging them in the trees. It can be permanently overcome by top working certain limbs with the desirable varieties. The new plantations of walnuts should be located near the existing bearing trees. Snowfall or very cold weather at the time of flowering causes poor setting of the crop.

FLOWERING AND FRUITING

Walnut is a monoeicous plant i.e. staminate (male) and pistillate (female) flowers are borne separately on the same tree. Staminate flowers are borne on the previous seasons growth and hang in catkins (elongated structures) and pistillate flowers appear in pairs in the form of nutlets in the current season's growth.

Walnut trees start flowering from April to May. Fruit bud formation is initiated during summer and the final development occurs shortly before anthesis in the following spring. The setting of fruits starts from the last week of May to June and maturing of fruits is over by September to October.

VARIETIES

Leading Varieties For Cultivation

Walnut (Juglans sp.) is the most important temperate nut fruit of the country. Walnut in India are found in different sizes and shapes. The Indian walnuts are categorized into 4 categories viz., paper-shelled, thin-shelled, medium-shelled and hard-shelled. Walnuts flourished at altitudes of 900 to 3000.

Walnut varieties grown in different states of India are:	
Jammu and Kashmir	Lake English, Drainovsky, Opex Caulchry and CITH Selections
Himachal Pradesh	Gobind, Eureka, Placentia, Wilson, Franquetfe, Kashmir Budded and Pusa Khor
Uttarakhand	Chakrata Selections

Source: APEDA, 2013

I. Hartley

It is one of the most popular commercial cultivars of California. It is a selection from a seedling. The nuts are large with broad flat base and pointed tip. The shell is light coloured, thin and seals well. The variety is tolerant to codling moth and blight disease.

2. Payne

It is the second leading cultivar of California which originated as a seedling. Nut is medium to small in size with a good seal. Trees are moderately vigorous, round in shape and require heavy pruning to maintain vigour.

3. Franquette

It is an old and leading cultivar of France. Nut is small, good shell seal and kernel is light. in colour. Tree is large and upright in nature and is known for its late bud break thus escaping injury from frost during late spring.

4. Serr

It was evolved from a cross of Payne X PI 159568. It is heavy yielding and well adapted to warm conditions. The tree is very vigorous and gives poor yield on very ferthe soils. The kernel is light in colour and good in quality. It is susceptible to codling moth and blight disease.

5. Ashley

It is a high yielding, early bearing cultivar which requires heavy pruning to keep the tree vigorous. Kernel is of high quality, good in flavour and light tan in colour. This variety is unsuitable for high rainfall areas due to blight problem.

6. Sunland

It is a mid-season variety obtained from a cross of Lompoc X PI 159568 in California. The nut is very large, long, oval with good seal and kernel colour is good. It is susceptible to blight-and late spring frost.

7. Chico

It is evolved from a cross of Sharkey and Marchetti. The variety is fruitful on lateral buds and the nut is small but excellent in quality with light coloured kernel. Heavy pruning is required to maintain nut size.

8. Vina

It was evolved from a cross of Franquette and Payne. The kernels are light in colour, high in quality and shelling percentage is 48. It requires good pruning to maintain its vigour and nut size.

9. Howard

Howard is a lateral fruiting and high yielding cultivar. Nuts are large, round and smooth with a good seal. Kernel is light in colour and shelling percentage is 50. Tree is small, semi upright and tolerant to blight.

10. Pedro

It is an early bearing variety due to which it has become popular cultivar in many walnut growing regions. The nuts are large shell heavy and seal fair. It sheds its pollen over a long period becoming a good pollinizer.

11. Chandler

It is a very promising cultivar which has been evolved from a cross of Pedro X VC 56 -224. The nut is large, oval, smooth with a good seal and excellent colour. Kernel percentage is 49. Tree is moderately vigorous and semi-upright.

12. Tehama

It is a heavy yielding midseason and lateral fruiting cultivar evolved from a cross of Waterloo and Payne. Nut size is large but shell seal is not so good because sometimes it cracks at the suture exposing the kernel to damage. Kernel colour is good witl1 50% shelling. Tree is large and vigorous and mainly serving as a pollinizer.

PROPAGATION AND ROOTSTOCK

Walnut can be propagated either by seed or by vegetative methods. Both of these methods are described here.

A. Seed Propagation

Walnut seedlings are generally used as rootstock. Healthy and disease free walnuts procured from current season's crop should be sown directly in well-prepared seed beds during November. If land is not ready for sowing and inclement weather prevails, nuts can be stratified in moist sand till soil becomes workable. They may be sown in lines 50 cm apart and the seed to seed distance should be kept at 25 cm. The big nuts should be selected with bright brown colour having good cracking quality of the shell, good taste and flavour of the kernel. The beds should be covered with grasses after sowing and irrigation. While preparing the beds, proper drainage facilities should be provided.

B. VEGETATIVE PROPAGATION

Walnut can be propagated vegetatively by grafting, budding and stooling.

1. Grafting

Tongue or whip grafting, cleft and veneer grafting during February and early March have given good results. Epicotyl grafting has also given encouraging success in the propagation of walnut. The best period for grafting is January -February. For propagating the plants through veneer grafting, 5-6 month old scion wood of 15 cm is grafted on the rootstock of same thickness. The selected scion wood should be defoliated 15 days prior to its detachment from the scion cultivars. The optimum time for veneer grafting under mid -hill condition is July -August. One year old seedlings of hard shelled walnut or black walnut can be used as rootstock. Scion for tongue grafting should always be selected from the tree which has already started fruiting.

2. Budding

Patch budding is generally practiced to propagate walnut plants vegetatively. The best period for budding is July/August. Scion should always be selected from the tree which has already started fruiting.

3. Stooling

Stool layering is a suitable method of walnut propagation and is useful for the multiplication of true to type rooted plants from a rootstock bed. One year old seedlings of a known cultivar are planted in a nursery bed at I sq. m. distance and headed back from 6 .8 cm above the ground in March before bud swelling. All the cut ends are painted with Chaubatia paste. In April, buds start swelling and 3 -4 shoots come out from the stock. In July, 2 -5 cm bark is removed and the ringed portion is treated with IBA 6000 ppm in lanolin base. After a week the upper end of the ringed part swells and development of root primordia is initiated. The treated shoots are then earthed up, covering the shoot even beyond the ringed portion. Fortnightly irrigation is given to the stool bed to keep the moisture constant. During the second fortnight of February the shoots are unearthed. These shoots show rooting and are detached from the mother plant and planted in the main field in the month of March.

Top Working

Top working is a very useful choice for walnut production in the hilly tracts of India since a large number of young seedling trees are found producing inferior quality of nuts. Top -working is usually carried out by modified cleft grafting or bark grafting late in the spring season or when new growth occurs. The dormant scion wood should be removed from the parent tree in advance and stored in refrigerator after proper packing. Bleeding is a problem in walnut top-grafting especially when it is done in early spring which can be avoided by heading back the stock two weeks before actual operations. After grafting, the open wounds must be covered by grafting wax and if required rewaxing may be done. White washing of the stem may be done to protect them from sunburn. As the rootstock is already well established, the scion makes rapid growth and bears earlier than the transplanted trees.

Most of the existing plantations in the country are of seedling origin and there is varying success in vegetative propagation by different methods and at different timings of the year. However, temperature of 250 +- 10-20 and 75 +- 5% relative humidity are required for scion take.

Planting

Square system of planting is commonly adopted in walnut because it is easy to layout and convenient for cultural operations and tree thinning. Pits of 1.25 X 1.25 x 1.25 m size at a distance of 10 X 10 m should be dug during September. The pits should be filled up with orchard soil mixed with 50 kg well rotten FYM, 150 g Aldrin dust, 150 g urea, 500 g each of superphosphate and muriate of potash. The best season for walnut plantation is December to January. The plant should be well fixed in the soil and the adjoining portion of scion and stock union should be at least 15 cm above the ground surface. Watering should be done soon after plantation. To protect the plant from collar rot it should be treated with Dithane Z- 78 before planting.

Manures And Fertilizers

Walnut tree has a very extensive root system and vigorous growth, thus it requires heavy feeding. A balanced nutrition of nitrogen, potassium and phosphorus should be applied for the proper vegetative and reproductive growth. A one year old seedling requires 500 g urea and 750 g each of superphosphate and muriate of potash. The doses of fertilizer may be increased with the increase in the age of the tree. The full dose of superphosphate and muriate of potash and half dose of urea should be applied in October after picking the fruits and the remaining half dose in the month of February every year. These fertilizers should be well mixed with the soil and applied at least 30 cm away from the main stern of the plant. Every year in the month of October, 50 kg of well decomposed farmyard manure should be applied as a normal feed. Foliar application of all the micronutrients like zinc, copper, manganese, boron, iron and magnesium may be done in the month of March. For correcting Zinc deficiency, 0.4 % zinc sulphate should be applied as a foliar spray.

Irrigation

Watering is very essential for the establishment of grafts and young plants. The water requirement, however, decreases with the development of roots in adult trees. When the trees start bearing, irrigation should be given from the time of fruit set till its maturity to reduce the fruit drop and for better filling of nuts. When the trees are grown under rainfed conditions and when the rainfall is not sufficient and well distributed, irrigation is essential for walnut cultivation. The common irrigation systems followed are flood, furrow, sprinkler and drip irrigation.

Training And Pruning

Walnut is both terminal and lateral bearer. It bears fruits on one year old wood which is produced either terminally or both terminally and laterally. Terminal bearing cultivars are thinned , but not headed back because vegetative growth keeps on increasing in absence of early fruiting. On the other hand, lateral bearing cultivars are both thinned and headed back in order to encourage shoot growth which gets suppressed due to early fruit production. Modified leader system of training (refer booklet No. 18 on "Horticultural Practices") is followed in walnut. After the first year's growth the plant is headed back above 2 m of its height. All lateral shoots on the leader are removed leaving one or two shoots at lower level on the trunk.

The primary objective of pruning of mature walnuts is to obtain regular and high production of quality nuts which is often hampered by overcrowding of branches, insufficient production of new wood and inadequate availability of sunlight.. Selective thinning out of limbs in the top and sides of the tree should be done to avoid overcrowding. The pruning operations are carried out in the dormant season but early spring is preferable. Further delay causes excess bleeding. All the cut surfaces should be treated with a tree wound dressing.

Weed Control

The herbicides such as Simazine and Diuron have been successfully used to control weeds in young and established walnut grooves. Simazine and Diuron @ 2-4 lb/acre have effectively controlled annual weeds throughout the season.

Harvesting And Yield

Harvesting at proper maturity is of prime importance in the production of quality nuts. Any delay in picking after maturity of kernels deteriorates the quality and increases the incidence of mould and pests. Two indices for maturity are commonly used. A thick hull covering the nut splits on maturity causing the fall of the nut on the ground. Sometimes. kernel matures earlier than hull splitting. In such cases. proper maturity is assessed by observing the packing tissue between and around the kernel halves which turns brown on maturity.

Walnuts are ready for harvesting in August, September and October. In Himachal Pradesh harvesting commences from August and extends up to last week of September, whereas in J&K walnuts are harvested in September –October. Some nuts fall on the ground after splitting of the hull while others are forced to drop down by beating with long poles. The nuts are collected from the ground, cleaned, washed and dried in the sun by spreading them on a canvas sheet or floor. The dried nuts are graded according to the cultivar, size and colour, Sometimes in order to improve the appearance of nuts, these are bleached either with acid or alkali solution.

Yield of walnut varies depending on the age, size and variety of trees. A 40-year old large tree can produce as much as 175 kg nuts while an average yield is around 40 kg/tree. Full commercial bearing starts after 18 -20 years in seedling trees and 8 -10 years in grafted trees.

Drying, Storage And Marketing

Walnuts are dried to remove excess moisture from the shell and kernel. Drying prevents deterioration in kernel quality, makes bleaching efficient and prolongs the storage life. The nuts are dried up to 8% moisture level. The drying of fruits can be done in mild sunlight or by a dehydrating machine at 44.5°C temperature. They are then stored in gunny bags in small ventilated rooms free from excessive humidity. Packing cases are used to send produce to distant markets. The boxes are lined with paper on all sides to avoid shaking and breaking of walnuts.

Future Steps:

A unique walnut plant is being evaluated at the IARI regional station, Shimla. It was collected from Chamba region of Himachal Pradesh which came into bearing in the second year of its grafting. The known varieties of walnut normally take 10 to 15 years to come into bearing. Sometimes it takes even more. The fruit appears to be borne in lateral position as well as terminally. This is a characteristics of newly evolved early, good quality and heavy bearing walnut cultivars. However, no such cultivar is reported

in India so far. The leaf size and annual shoot increment is also much more than other walnut plants collected during the same survey. They are also not yet in bearing stage. The fruit weight with husk was 58.85gm; where as, without husk (nut) weight recorded 23.5gm.The length of the fruit with husk (nut) it was 43.85cm.The nut is thin shelled and kernel colour of light yellow and good in taste. This is christened as “Pusa Khor”.

According to Ramos et al.(1984) selection of clones that produce pistillate flowers on lateral buds has resulted in Persian walnut, Juglans regia lateral bearing Persian walnut cultivars tend to be more precocious and are better suited to high yielding, high density plantings.

High development costs for establishing a walnut orchard demand the crops at an early age. Cultivars displaying lateral bud fruitfulness generally come into production well in advance of non-lateral bearing cultivars. Shell thickness and structure are the most important determinant of percent kernel and nut crack-ability. The highest quality walnuts have a thin outer shell with no internal convolutions protruding into the nut meat. The inner shell partition between Kernel halves should be very thin to allow easy removal of Kernel pieces. The nuts of the tree collected from Chamba appear to meet this standard.

An Overview of Walnut Rootstocks, Cultivars and Propagation in California

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Walnuts have been grown in California for more than 200 years. During the late 1700's, Spanish missionaries brought English or Persian walnut (Juglansregia) to California. Earlier plantings consisted of seedling trees of English walnut varieties selected for better vegetative growth as well as better nut quality. Later in the 19th century, budding or grafting the desirable varieties onto different rootstocks became a preferred way of growing and propagating walnut trees. The rootstocks were selected based on their ability to adapt to different soil and climatic conditions as well as for their vigor and disease resistance. In the early 20th century, Northern California Black Walnut (Juglanshindsii) became a widely used rootstock based on its high vigor and characteristics like salinity and disease resistance. Since the 1950s, Paradox hybrid is being extensively used as a major rootstock in California walnut industry. Paradox is a hybrid of Northern California Black walnut (J. hindsii) and English walnut (J. regia).

ROOTSTOCKS:

Rootstocks are selected and developed on the basis of their vigor, ability to provide good anchorage, ability to grow under various soil conditions and to resist or tolerate soil borne pathogens. Among the commonly used walnut rootstocks in California, different rootstocks are known for their different characteristics. Therefore, rootstock selection should be made according to specific soil and climatic conditions of a particular orchard site. Traditionally, two rootstocks have been used as industry standard in California- Northern California Black walnut and Paradox hybrid. Apart from these two, own-rooted English cultivar seedlings are also used in some situations where walnut blackline disease is prevalent, as English walnut is known to resist this disease.

Northern California Black walnut (Juglanshindsii): This was the preferred rootstock during early to mid-twentieth century. This rootstock was more vigorous than own-rooted Englishwalnut. It was an old standard, which is still used in some plantings. Black walnut is less vigorous than Paradox and less susceptible to crown gall, but is more susceptible to phytophthora crown and root rot.

Paradox hybrid: It is a hybrid of Black walnut and English walnut. Traditionally, Paradox hybrid seedlings have been produced by sexual propagation by collecting seeds from black walnut trees pollinated by English variety. However, more recently many clonal Paradox rootstocks have become popular- Vlach, RX1, and VX211.Each of these clonal rootstocks has their own merits. For example, Vlach is more tolerant to crown gall than Paradox seedlings, VX211 is more tolerant to nematodes while RX1 shows some resistance to Phytophthora spp.Paradox hybrid rootstock has been a standard in California walnut industry for a few decades now.

English walnut:English walnut was used as rootstock in early plantings during late 19th century. English walnut generally shows poor performance as compared to later rootstocks, therefore it has limited commercial use. However, there is a renewed interest in this rootstock mainly due to its tolerance to walnut blackline disease. Since both Black walnut and Paradox hybrid do not show any tolerance to blackline disease, English walnut cultivars are grown on their own roots,in areas where this disease is prevalent.

CULTIVARS:

Chandler: This is the most commonly used cultivar in recent plantings in California. It is a lateral bearing cultivar with moderately vigorous growth and strongyields. It is a thin shell cultivar with oval, smooth and light colored shell, which becomes stronger in older trees. Kernels have excellent color and are easily removed in halves. Chandler is harvested relatively late in the season.

Howard: It is a moderately vigorous cultivar but often less vigorous than Chandler. It is a lateral bearing variety with strong yield. Nut size is large with strong shell-seal, while the kernel color is light. This is often marketed as in-shell variety.

Ivanhoe: This is a new early variety with strong yields and precocious bearing. It is harvested early in the season, almost a month earlier than Chandler. It has thin, smooth shell with excellent kernel color. However it tends to be susceptible to walnut blight.

Serr: Serr is a very vigorous cultivar, which is moderately fruitful on laterals. It has a thin, well-filled shell with good seal and excellent kernel quality. It has a high quality and high production potential but can exhibit flower drop if it is exposed to excess pollen. It is often planted without pollinizer varieties.

Tulare: This cultivar has an upright canopy and vigorous growth with lateral bearing habit. It is a mid-season variety, which is a little more susceptible to low temperatures during fall and winter seasons. It is also grown without pollinizers.

PROPAGATION:

Walnut trees are propagated using different methods of propagation. While rootstock seedlings are produced by sexual propagation, vegetative propagation methods like budding or grafting can be used to produce finished trees with desirable scion cultivars. More recently, micropropagation techniques are also being used extensively to produce clonal seedlings of walnut rootstocks.

SEXUAL PROPAGATION:

Sexual propagation is mainly used for producing walnut rootstock seedlings. Seeds of commonly used rootstocks, Black walnut and Paradox hybrid are sownin fall to grow seedlings, which would then be budded or grafted with desired cultivars during the next season. Seeds are collected by shaking nuts off the trees. To avoid contamination with Agrobacteriumtumefaciens(which causes crown gall disease), nuts are collected on tarps and are not allowed to be in contact with the ground. In walnuts, the dormant embryo is the major constraint in sexual propagation and the seeds need to go through cold stratification (moist pre-chilling at 3-50 C for 3-4 months) to ensure germination. Sowing seeds in fall can also break dormancy, as temperature conditions for seed stratification are met during winter months.

VEGETATIVE PROPAGATION:

Micro-propagation:This method is being used increasingly for the production of clonal rootstock. When compared to traditional propagation methods, the advantage of micropropagation is that we can produce genetically identical individuals in large numbers in a short period of time. Micropropagation in walnuts consists of following steps:

i). Preparation of aseptic cultures by surface-sterilization of stem segments.

ii). Shoot multiplication by culturing these explants on agar medium with added plant growth regulators, sugars and other nutrients.

iii). The clonal microshoots thus produced are rooted in-vitro. Plant growth regulator indole-3-butyric acid (IBA) has been used to obtain higher root proliferation.

iv). Acclimatization and hardening of these microplants is achieved by transferring them to polystyrene trays in peat-based growing medium in greenhouse conditions. After hardening, these plants are transferred to the nursery.

Budding: Budding is a preferred method for propagating walnut trees asexually, by inserting buds from desired cultivars onto the rootstock seedlings. When the rootstock seedlings are well established and develop girth matching the budwood, buds from English varieties are budded onto them. Patch budding is the most commonly used budding method, resulting in good budding success. Traditionally, the rootstock seedlings are fall-budded from late August to Mid-September and a finished tree is produced by next fall. However, a more recent technique called June budding is being adopted by commercial nursery operations in California. In June-budding, the seedlings sown in fall are pushed hard to achieve buddable size in June, which will coincide with the development of current season scion buds. The rootstock seedlings are budded in June, which typically provides the finished tree within the cycle of a year. Patch budding is performed using a double bladed knife (see Figure 1). A square piece of bark is removed from the rootstock seedling and the same size patch containing a well-developed bud is cut from the scion. The patch of bud is placed on the rootstock and tied with a budding tape. Generally, the bud is kept naked while the rest of the patch is tied thoroughly with the tape. The bud union is usually formed in a couple of weeks, after which the tape is removed. Buds are usually pushed by topping off the rootstock seedlings a couple of feet above the inserted bud.

Some nurseries also use T-budding, where a T-shaped cut is made on the rootstock and a shield-shaped bud cut from the scion is inserted into the T-cut.

Grafting: Whip or tongue grafting is the technique used to graft walnut seedlings. Scion wood is collected during dormant season and the grafting is performed during spring season. For performing tongue grafting, first a slanting cut is made on both rootstock and scion and then the second vertical cut is made in the middle. The scion is inserted in the tongue-like cuts in the rootstock as they lock each other. The graft union is tied with a tape. Grafting is considered more labor-intensive and time –consuming than budding, therefore budding is usually a preferred method.

Cutting: Walnut is a difficult-to-root species. Conventionally, semi-hardwood and hardwood cuttingshave been used in walnut propagation by cutting. Depending on the type of genotype being rooted, the rooting success varies profoundly. Currently, research is being conducted to further improve this method.

GUIDE TO ROOTSTOCK AND CULTIVAR SELECTION:

The choice of rootstock and cultivar depends on the soil and climatic conditions of the proposed orchard site. Based on the description of different characteristics of various rootstocks and cultivars, the most suitable types can be selected for a given site. Rootstock selection should be based on characteristics like-

- Resistance to environmental stresses like cold injury, soil conditions like high salinity.
- Resistance to pests and diseases like blackline disease, root rot/crown rot, crown gall and root lesion nematodes.
- In areas where blackline disease is prevalent, English walnut trees are grown as own-rooted trees because English walnut is resistant to blackline disease.

Scion selection depends on a variety of factors like available chilling hours, local climatic conditions and severity of some pests and diseases in a given area. Walnut trees require exposure to certain number of chilling hours during dormant winter months in order to break dormancy. Different cultivars vary regarding their chilling requirements and this can be judged from their relative leaf-out dates. Among the cultivars described earlier in this article, Ivanhoe and Serr varieties leaf out relatively early, signaling that they have lower chilling requirement as compared to Chandler, Tulare and Howard, which leaf out relatively later. Another consideration is climatic conditions. For example, in areas of high precipitation, cultivars like Ivanhoe should be avoided because of its susceptibility to walnut blight.

Figure 1: Steps in Patch-budding in walnuts. (Photos: GurreetBrar)

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Usefulness of Walnut

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INTRODUCTION

Walnut (Juglans regia L.) is the most widespread tree nut in the world. The tree is commonly called as the Persian walnut, white walnut, English walnut or common walnut. It belongs to family juglandaceae and has the scientific name Juglans regia. The point of origin for the Persian walnut (Juglans regia) lies in Central Asia, where the tree grows in a wild and semi-cultivated state. In pre-historic times, it spread to western China, the Caucasus, Persia, and Europe. At present, walnut is cultivated commercially throughout southern Europe, Northern Africa, Eastern Asia, USA and Western South America. China is the leading world producer, followed by the Iran, USA, Turkey, Ukraine, Mexico, France, India Romania, and Chile (FAO, 2011).

HISTORICAL VIRTUES OF WALNUT

Walnuts were likely an important food gathered by early humans. The last glacial epoch greatly restricted the extent of Persian walnuts in Western Europe, but archaeologists have found their remains in southern France dating to 17,000 thousand years ago. Neolithic peoples cultivated walnuts by 7,000 years ago, but they were not widely cultivated in the Mediterranean until ancient Roman and Greek times, when economic factors contributed to their dispersion throughout Europe. Walnuts were an item of trade and amphora filled with walnut residue has been salvaged in sunken Roman ships in the Mediterranean.

The walnut was the most important nut from a health standpoint in the ancient Mediterranean world. Its medicinal virtues were detailed in many Greek and Roman medical writings. Dioscorides, a Greek physician esteemed walnuts for medicinal purposes. He believed that when they were eaten with rue and figs, the nuts counteracted poisons. Walnuts along with honey and rue helped with “inflammation of the breasts, abscesses and dislocations.” With onions, salt, and honey, walnuts would heal those bitten by dogs or men. When burnt, they assuaged colic. He also wrote that if walnut kernels were burned, ground with wine and oil, and applied to an infant's head, the child's hair would grow abundantly and bald spots would disappear. Walnut if chewed and laid on as a plaster cures gangrene, carbuncles, style in the eye, and hair loss. They were also mixed with garlic and applied as a poultice to remove bruises on the body. Many of these recommendations would appear in subsequent medical works for almost two thousand years.

EUROPEAN HERBALS

The early-seventeenth-century physician Daniel Sennert, claimed that walnuts, ground up and combined with dates, raisins, egg yolks, and wine, could be employed as a plaster to heal carbuncles. It may have been the carbuncle's resemblance to the walnut that inspired this treatment. Schroder believed that candied walnuts aided digestion, which is why they were usually included among desserts. The Bolognese herbalist Baldassare Pisanelli, in an early-seventeenth-century treatise on diet and health, pointed out that walnut candied with sugar or honey were good “to use in cold weather to heat the stomach.” He also reported that they “offer much nutrition, increase the brain, and cooked with honey heal an old cough, and roasted and eaten with pepper.”

The herbalist John Gerard proclaimed in 1597 that walnuts consumed with rue prevented infection of the plague which had devastated Europe for centuries. When the plague hit England again in the mid-seventeenth century, walnuts (combined with other ingredients) were often recommended for those wishing to avoid “this pestilence.” Another source recommended combining rue, salt, garlic, and a walnut to prevent the plague. Ralph Austen, one of the authors of A Treatise on Fruit-Trees (1653), verified this, writing that walnuts “distilled and drunk with vineger,” were thought to be a “preservative against the Pestilence.”

The English physician Robert James, in his Pharmacopoeia Universalis, noted that candied nuts were “gently emetic.” The nuts were also used to cure colic and counteract diarrhea, and to prevent “contagious Distempers,” while the tree's leaves were recommended for treating gout, ulcers, and even cancer. Walnuts even cured hiccups, “perhaps more effectually, than any other Medicine”—or so reported Robert James.

CULINARY ENJOYMENT

Walnuts were readily available, cheap, and easily preserved, and during the eighteenth and nineteenth centuries they were incorporated into a vast array of recipes from salads, sauces, and soups to pickles, preserves, and pies. The unripe fruits are pickled in vinegar. Among the more common uses were in salads—in combination with apples, bananas, cherries, chicken, cream cheese, dates, or pineapple— culminating in the highly popular Waldorf salad. One favorite way of preserving walnuts was to make ketchup from them. For the past half millennium, cooks and chefs in the western world have used walnuts and walnut products in every imaginable type of dish. The seed part of the fruit (kernel) is consumed fresh, toasted, or mixed with other confectionaries. In the Middle East walnuts are added alone or along with almonds, date, and raisin as a special pastry preparation called Ma'moul.

WALNUT NUTRITIONAL AND NON FOOD USAGE

Walnut has been used globally in human nutrition since ancient times. The high protein and oil contents of the kernels of Juglans regia L. (Juglandacea) make this fruit indispensable for human nutrition. Therefore, the walnut is classified as a strategic species for human nutrition and is included in the FAO list of priority plants (Gandev, 2007). Nutritional assets and medicinal benefits of the walnut include omega-3 fatty acids, antioxidants, fiber, and numerous vitamins and minerals. Researchers have shown the diverse benefits of the walnut through many clinical studies. Because of the strong evidence of the walnut's potential role in cardiovascular health, the U.S. Food and Drug Administration approved one of the first qualified health claim for a whole food in March of 2004: “Supportive but not conclusive research shows that eating 1.5 ounces of walnuts per day, as part of a low saturated fat and low cholesterol diet, and not resulting in increased caloric intake, may reduce the risk of coronary heart disease.” In addition to heart health, studies have shown walnut consumption to benefit people with diabetes and cancer, promote bone health, assist with weight management, improve cognitive performance, and counteract some effects of aging. The husk yields valuable oil and a yellow dye when pressed; the oil is used in soaps, paints, and dyes. The oil from walnut kernels is high in unsaturated fats and can be used in cooking. The wood is heavy and fine-grained and is used mostly for furniture and gum stocks.

Walnuts are nutrient-rich food due to high contents of fats, proteins, vitamins and minerals as depicted in Table 1. They are also good source of flavonoids, sterols, pectic substances, phenolic acids and related polyphenols. The nutritional contents differ from a cultivar to another which can be influenced by genotype, different ecology and different soil (Martinez et al., 2010). **The major components of walnut oil are triacylglycerols (980 g/kg oil), in which monounsaturated fatty acids (FAs) (mainly oleic acid) and polyunsaturated FAs (PUFAs; linoleic and α-linolenic acids) are present in high amounts in all genotypes (Table 1).** Walnuts have high amount of omega-6 and omega-3 PUFA, which are essential dietary fatty acids. Clinical studies suggest that omega-3 PUFA have significant role in prevention of coronary heart disease (Davis et al., 2007). Oil rich in oleic acid displays greater oxidative stability therefore; it could be widely used as frying oil.

Table 1: Comparison of nutrient profile of English and Black walnuts

Nutrient (per 100 gram)	English walnut seed	Black walnut seed
Carbohydrates (g)	13.7	9.9
Protein (g)	15.2	24.1
Unsaturated fatty acids (g)	56.1	50.1
Poly to mono unsaturated fatty acids ratio	47:9	35:15
Fiber (g)	6.7	6.8
Calcium (mg)	98	61
Iron (mg)	2.9	3.1
Zinc (mg)	3.1	3.4
Vitamin B-6 (mg)	0.54	0.58

Walnut cultivars analyzed have recorded rich mineral composition, especially potassium, magnesium, and calcium. Walnuts contain high levels of potassium, phosphorus and magnesium and lower sodium. These elements play an important role for many enzymes activity especially as cofactor.

ETHNO BOTANICAL USE

Across the world the leaves of Juglans regia have been used mostly in traditional medicines as antimicrobial, antihelmintic, astringent, keratolytic, antidiarrhoeal, hypoglycaemic, depurative, tonic, carminative, and for the treatment of sinusitis, cold and stomach ache. Curing with folk medicine in Turkey, fresh leaves applied on the naked body or forehead to reduce fever or on swelled joint to alleviate the rheumatic pain. Juglans regia kernel has been used for the treatment of inflammatory bowel disease in Iranian traditional medicine In Palestine, it is used for treatment of diabetes and asthma and to treat prostate and vascular disturbance .The plant is used as a topical remedy for dermal inflammation and excessive perspiration of the hands and feet. It is also a common home remedy for the treatment of chronic eczema and scrofula. The leaves of this plant is used topically to treat scalp itching and dandruff, sunburn and superficial burns as well as an adjunctive emollient in skin disorders. It also has high anti-atherogenic potential and a remarkable osteoblastic activity that adds to the beneficial effect of a walnut enriched diet on cardio-protection and bone loss. The bark, branches and exocarp of the immature green fruit of this medicinal plant have been used to treat gastric, liver and lung cancer a long time in China. It is used by traditional healer in northeastern region of Mexico to protect against liver damage. The bark is used as miswaks for teeth cleaning. In Nepal the bark paste is useful in arthritis, skin diseases, toothache, and hair growth. Seed coat is used for healing wounds. The shell of Juglans regia is used in Calabria folk medicine to heal malaria.

ANTIBACTERIAL ACTIVITY

Broad spectrum antibacterial activity of hot and cold solvent and aqueous extract of leaves, barks, fruits and green husks of J. regia has been reported from different countries against gram-positive and gram-negative bacteria viz. Bacillus cereus, Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae, Staphylococcus epidermidis, Micrococcus luteus, Salmonella typhimurium, Enterococcus faecalis, Bacillus thuringiensis, Protomonas extroquens, and Proteus sp. using agar streak method, disc diffusion method and microplate alalmar blue assay. Over 45% of Iranian clinical isolates of Helicobacter pylori strain were inhibited by J. regia aqueous and equal mixture of methanol, diethyl ether and petroleum benzene extract.

ANTIFUNGAL ACTIVITY

The fruits, leaves and bark aqueous and solvents extract of J. regia exhibited antifungal activity against wide range of fungi using disc diffusion method, agar dilution method, agar streak dilution and Raddish method. It has been reported that all the walnut varieties exhibited antifungal activity against Candida albicans and Cryptococcus neoformans when soxhleted with light petroleum ether (b.p. 40-60°C). Cold extraction of fruit, leaves and bark inhibited the growth of Microsporum canis, Trichophyton mentagrophytes, and Trichophyton violaceum. The bark extract prepared in methanol, acetone, chloroform and ethyl acetate revealed antifungal activity against A. niger, Alternaria alternata, Trihoderma viresn, fusarium solani, Pichia guiliermondii, Pichia jadinii and all Candida species tested.

ANTIVIRAL ACTIVITY

A concentration of about 95% ethanol and ethyl acetate leaves extract of J. regia, inhibited tobacco mosaic virus (TMV) (Mei-zhi et al., 2007). The methanol extract of J. regia inhibited Sindbis virus at a minimum concentration of 1.5 μg/ml (Mouhajir et al., 2001).

ANTICANCER ACTIVITY

Ellagic acid is found in walnut leaves and fruits; it is being studied for use as a cancer therapy drug, in addition to having many other biological effects. Shells are ground and used as antiskid agents for tiers, blasting grit, activated carbon, and sometimes an adulterant of spices.

Juglone has been reported to inhibit intestinal carcinogenesis induced by azoxymethane in rats and might be a promising chemo-preventive agent in human intestinal neoplasia. Walnut methanolic extracts obtained from J. regia seed, green husk and leaf showed concentration dependent growth inhibition against human renal cancer cell lines A-498, 769-P and the colon cancer cell line Caco-2. Concerning A-498 renal cancer cells, all extracts exhibited similar growth inhibition activity, walnut leaf extract showed higher antiproliferative efficiency than green husk or seed extracts (Carvalho et al., 2010).

CLINICAL STUDY

A daily intake of 43 to 57g of walnuts incorporated into Japanese diet for 4 weeks to 40 healthy Japanese men and women lowered blood cholesterol, particularly in women (Iwamoto et al., 2000). In double-blind case with either plasma triglyceride (TG) concentration more that 350 mg/dl or total cholesterol concentration more that 250 mg/dl were randomized into two groups, group A subject were administered 6 capsules, each filled with 500 mg of the extracted walnut oil, per day for 45 days, group B individual serve as control and received placebo for 45 days. The result of this lowered plasma triglyceride level by 19 to 33% (Zibaeenezhad et al., 2003). Ros et al. (2004) reported that substituting walnuts for monounsaturated fat in a Mediterranean diet improves endothelium-dependent vasodilation (EDV) in hypercholesterolemic subjects. A daily intake of 8-13 walnuts for 4 weeks significantly improves the EDV of 21 hypercholesterolemic males and females. On the other hand, walnut-enriched meals effectively prevented post prandial lipidemia where triacylglycerol was significantly reduced (Bellido et al., 2004).

TOXICITY

Walnuts have some toxic properties also. Juglone is excreted by the roots of black walnut and other walnuts and is toxic to many other plants (i.e., it is allelopathic). Even dead roots can release juglone for years after the tree is gone. Black walnuts should be kept away from most other plants, particularly vegetable gardens. The most susceptible plants include asparagus, cabbage, eggplant, pepper, tomato, potato, apple, pear, blueberries, baclberries, azaleas and rhododendrons, some pines, silver maple, ornamental cherries and crabapples, crocus, some chrysanthemums, columbine, lilies and petunia. The 95% ethanol, petroleum ether and ethyl acetate extract of green walnut hull have obvious anti-feeding effect on armyworm and the small vegetable-moth (Me-zhi et al., 2006).

USES OF WALNUT BARK:

Juglone from black walnut fruits and bark acts against dermatomycosis (skin fungi), being first used for this purpose by Greeks and Romans. Juglans insularia is used in Cuba as an herb decoction in bath water to treat various skin diseases of children. Walnut bark is used as a dentifrice in Pakistan. Black walnut tincture, an extract made with grain alchol, is derived from fresh green hulls of the black walnut tree. It is said to kill adult and developmental stages of atleast 100 parasites. It is touched as a great antiseptic that is high in iodine, and excellent for the treatme t of any kind of fungal condition. It is good vermifuge for pineworm, ringworm, and other parasites, and it even removes warts and treats psoriases. The tincture is generally used in conjunction with wormwood and cloves as part of a complete parasite-eradication program. The benzene, methanol and ethanol soxhlet extracts of J. regia stem bark on adult Indian earthworm, Pheretima posthuma exhibited significant anthelmintic activity as comparable to that of standard drug Piperazine citrate (Upadhyay et al., 2010a).

OTHER USES

The seeds contain unusual fatty acids which are industrially important, as they are used in protective coatings, dispersants, pharmaceuticals, cosmetics, soaps and a variety of synthetic intermediates as stabilizers in plastic formulations. The wood is of very high quality, and is used to make furniture, and gunstocks. The dye is used as a coloring and tonic for dark hair.

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Status of Walnut cultivation in Himachal – Problems and future strategies

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The walnut (Juglans regia L) popularly known in English on Persian walnut is a native of the North-Western Himalayas and is found growing between the elevations of 1200 to 2200 m above mean sea level. At present about 4625 ha area is under walnut with a production of about 1700 metric tones. In fact, there has been a rapid development in the cultivation of temperate fruits in the state, however cultivation of walnut on scientific lines has remained neglected due to several reasons like non availability of vegetatively propagated planting material, long Juvenile period, raising of plantations on marginal lands, large tree size, lack of suitable varieties, pollination problems, lack of proper cultivation practices etc. There are no established walnut plantations in the state, however, seedling trees are found growing scattered in the districts of Kinnaur, Shimla, Kullu, Mandi, Chamba, Sirmour, Solan and Kangra. By far, great majority of trees in Himachal are of seedling origin that have a long Juvenile phase, are highly variable in vigour, quality with low yields. In certain parts of the state, the planting of walnut tree is not considered to be auspicious and no serious attempt seems to have been made to plant budded on grafted trees. Any seedlings that come up in nature are allowed to grow which has resulted in the preponderance of inferior trees.

There is still a great potential for bringing more area under this fruit in the form of regular plantations where large areas of wasteland are lying vacant. Besides, the demand for walnut kernel is increasing both in the Indian and International market due to its high nutritive value especially the omega -3-fatly acids which has been reported to reduce the risk of cardiac arrest.

No doubt, some selections (Gobind Pratap, Solding, Kainthla, Roopa etc.) have been made in the recent past but still there is a great scope for new selections with desirable traits as the genetic variability of walnut in the state has not been fully harnessed. Efforts are required to be made to explore the niche area of walnut and identify potential seedlings from the germplasm that could be released as a cultivar or seedling selections. The following characters should be taken into consideration while selecting a new cultivar/selection.

1) The nuts should be medium to large in size.
2) The nuts should be smooth and light coloured.
3) Should be medium shelled with good shell seal.
4) High kernel to shell ratio.
5) The most important character is the colour of kennel which should be preferably white.
6) Should separate easily from the shell.
7) Should have good taste and flavour.

PROBLEMS

The walnut production in Himachal is beset with the problems of;

a) Low productivity.
b) Lack of suitable root stocks and superior scion cultivars.
c) Non availability of vegetatively propagated planting material in sufficient number.
d) Inadequate knowledge of cultural practices (Training, Pruning, Fertilization, irrigation etc.).
e) Existence of dichogamy - pollination problems.

f) Ignorance about the knowledge of insect pests and diseases.

g) Improper harvesting and handling techniques.

h) Inadequate knowledge about processing and marketing.

FUTURE STRATEGIES

In order to popularize walnut cultivation on a commercial scale the following points need to be taken care of;

1) Extensive survey of walnut growing areas to identify promising strains with desirable traits.

2) Introduction of new varieties with lateral bearing habit. These varieties achieve fruit set more quickly and have an elevated level of productivity. Some of the lateral bearing cultivars that needs to be imported are Chandler, Chico, Gillet, Payne, Tulare, Fernor. These varieties have all the desirable traits as mentioned above.

3) Production of sufficient planting material of improved strains for supply to the orchardists.

4) Strengthening of research on the standardization of rootstock, training and pruning, standardization of harvesting stage for quality kernel production.

5) Strong coordination among different walnut growing states for exchange of germplasm to study their performance under different agro climate zones in the country.

6) Top working of inferior seedling trees with improved scion cultivars on a large scale.

7) Development of protocol for micro-propagation of walnut.

IMPROVING THE EFFICIENCY OF WALNUT INDUSTRY IN INDIA: LATERAL BEARING VARIETIES AND IMPROVED POST HARVEST PRACTICES

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ABSTRACT

There is a huge demand for walnuts in the country because of its immense use in food, pharmaceutical and cottage industries. To expand the area the availability of grafted plants of walnuts is a primary requirement; and especially introduction of new and improved and high yielding lateral bearing varieties having quality kernels for getting good economic returns to the farmers. The recommended varieties are Chandler, Serr, Howard, Pedro, Ashley, Tahma and Lara, Hartley, Franquette, Meylanaise, Ronde de Montignac, Fernor, Fernette, as per the soil and climatic condition of the region.

Emerging technological innovations will provide greater opportunity for more rapid communication and the benefits of increased exchange of ideas as we address the walnut problems of the future. Walnut growing suffers from lack of suitable methods of propagation, inadequate vegetatively propagated plants, lack of standard rootstocks/ cultivars, problems of re-establishment of nursery plant in the orchard, specific climatic requirements, pollination behaviour and lack of suitable pollinizers, long juvenile period and harvesting. The progress made in the recent years to overcome the above cultivation problems with a view to revive the walnut industry with export potential has been discussed (Sharma & Kumar, 2001).

The Himalayan State i.e. Arunanchal Pradesh, Himachal Pradesh and Uttarakhand have massive scope of expansion of area under walnut by convincing and motivating farmers, by providing them good quality grafted plants, by establishing nurseries and mother orchards of lateral bearing high yielding varieties. The walnut growers also have to come forward united in a form of walnut grower associations to formulate strategy with government to get incentives under some scheme or mission.

The emphasis should be given on identification of areas for expansion in these states, establishment of Mother Nurseries for preparation of good quality lateral bearing disease free grafted plants. The cultivation and production of walnut certainly improve the nutrition status, employment and economy of the rural farmers of Himalayan states in India.

INTRODUCTION

Walnuts (Juglans regia) are plants in the family Juglandaceae. These are light demanding species that benefit from protection from wind, and are also drought-tolerant. Walnut is believed to have originated in Iran and the areas surroundings it. The army of Alexander the Great brought it to Europe. Then it moved from Italy to Spain, France, etc to the southern USSR and went to China from Tibet. In India, walnut production was earlier confined to Jammu & Kashmir and it appears that it spread to Himachal Pradesh and Uttarakhand states of the country. Some limited variability may also exist in eastern and north-eastern regions, viz. Darjeeling, Sikkim and Arunachal Pradesh. The most common vernacular name for walnut in the region is akhrot, but other names are also known, such as dun in Kashmir and khod in parts of Himachal Pradesh and Uttarakhand.

Jammu and Kashmir is a major walnut producing state contributing more than 85 per cent of total production of the country. Around 30,800 hectares is under walnut cultivation in the country, with the annual production at 36,000 tonnes (Nainwal et al, 2004). The domestic and external demand has been increasing over the years and is projected to 75,000 tones by 2020. Therefore, it is necessary to bring additional area to meet the projected demand.

Presently production of walnut in India is around 1.2 tonne per hectare which is very low in comparison to 3-5 tonne/hectare in advanced countries. India exports walnut to more than 40 nations with earnings of more than Rs 300 crores (USD 54 Million/ EUR 43 Million) of foreign exchange annually. The top importers of Indian walnut include Egypt, UK, China, Germany, France, Netherlands, UAE, Greece, US, Kuwait, Australia, Hong Kong and Spain.

Walnuts are rich in proteins, fats and minerals and are a concentrated source of energy. These contain a good amount of vitamin B group and are the richest in vitamin B6 among all the nuts. Walnut is having very high nutritive values and good for curing heart diseases. Immature fruits of walnut can be utilised for preparing various products like pickles, chutneys, fresh juices and syrups. The fruit has excellent flavour and is mainly consumed as a dry fruit. Commercially, it is used for preparation of bakery products, chocolates, ice-creams, ornaments, oils, and confectionary and salad products. Shells are used in glue and plastics and for making solutions for cleaning and polishing surfaces.

WORLD PRODUCTION

The major walnut growing countries are China, Iran, USA, Turkey, Ukrain, Mexico, France and India. Table I shows world production of walnuts and it is evident that China stands first followed by Iran, USA, Turkey, Ukrain, etc. India stands eighth in production.

Table-1 TOP PRODUCTION WALNUT WITH SHELL (FAO-2011)

Rank	Area	Production (Int $1000)	Flag	Production (MT)	Flag
1	China	2570386	*	1655510	
2	Iran (Islamic Republic of)	753023	*	485000	F
3	United States of America	649326	*	418212	
4	Turkey	284503	*	183240	
5	Ukraine	174825	*	112600	
6	Mexico	149791	*	96476	
7	France	59536	*	38346	
8	India	55894	*	36000	*
9	Romania	54455	*	35073	
10	Chile	54 341	*	35000	F
11	Greece	46268	*	29800	
12	Serbia	37166	*	23938	
13	Eygpt	28551	*	18389	Im
14	Italy	27591	*	17771	Im
15	Belarus	24798	*	15972	Im
16	Uzbekistan	23929	*	15412	Im
17	Germany	23418	*	15083	Im
18	Spain	22710	*	14627	
19	Afghanistan	21584	*	13902	
20	Republic of Moldova	21517	*	13859	

*: Unofficial figure; [ ]: Official data; F: FAO estimate; Im: FAO data based on imputation methodology

INDIAN SCENARIO

In India, walnuts are grown in Jammu & Kashmir, Arunachal Pradesh, Himachal Pradesh and Uttarakhand. Jammu & Kashmir contributes around 98 per cent of the country's output. In Jammu & Kashmir walnut cultivation is common in Badrawah, Poonch, Kupwara, Baramulla, Bandipora, Gandarbal Budgam, Srinagar, Anan-tanag and other hilly areas. Walnut is grown in Himachal Pradesh and Uttarakhand to a limited extent.

Table-2 STATEWISE AREA & PRODUCTION REPORT OF ALMONT/WALNUT

S.No.	Year	State	Area ('000'MT.)	Percentage of Total Area	Production ('000'HA.)	Percentage of Total Production	Productivity
1	2007-2008	Arunachal Pradesh Jammu & Kashmir Uttarakhand H.P.	3.800 98.900 18.600 11.000	33.333 32.373 33.333 33.233	0.100 156.800 16.300 3.300	33.333 29.981 33.333 32.039	0.026 1.585 0.876 0.300
2	2008-2009	Arunachal Pradesh Jammu & Kashmir Uttarakhand H.P.	3.800 103.000 18.600 11.100	33.333 33.715 33.333 33.535	0.100 152.500 16.300 3.700	33.333 29.159 33.333 35.922	0.026 1.481 0.876 0.333
3	2009-2010	Arunachal Pradesh Jammu & Kashmir Uttarakhand H.P.	3.800 103.600 18.600 11.000	33.333 33.912 33.333 33.233	0.100 213.700 16.300 3.300	33.333 40.860 33.333 32.039	0.026 2.063 0.876 0.300
	Total		**405.8**	**400.000**	**582.5**	**400.000**	**2.925**

NHB Data 2012

VARIETIES GROWN IN DIFFERENT STATES

Significant increases in walnut production can be expected in many countries where local selections and new cultivars are being evaluated which will require expanded market development. Those engaged in production research must become more closely aligned with the processing and marketing industry to ensure that the quality aspects of walnuts are considered in relation to commercial demand and processing technology (Ramos, 1997).

In India the seedling populations exhibit tremendous genetic variation in tree and phenological traits, colour, shell sealing and in hardness of nuts as well as quality and percentage of kernel. Therefore, systematic evaluation of this genetically diverse germplasm needs to be taken up immediately for selecting superior genotypes to build gene repository. Fortunately the selection for most of the traits, being highly heritable, can be accomplished easily (Sharma & Kumar, 1994).

The several varieties of walnuts grown in different states of India are:

Jammu & Kashmir	Lake English, Drainovsky and Opex Caulchry
Himachal Pradesh	Gobind, Eureka, Placentia, Wilson, Kashmir Budded
Uttarakhand	Chakrata Selections

The Black More, Hartley, Tutle-31, Franquette, Serr, Ashley, Vina, Howard and Tutle-16 are some of the varieties grown in India. The planting distance recommended for area expansion of lateral bearing varieties are 8 X 6 Meter and a grower can plant 200 trees per hectare of grafted walnut. Walnuts produced in India have different sizes and shapes and are categorized into paper-shelled, thin shelled, medium-shelled and hard-shelled (APEDA-website-**www.apeda.org**).

Walnuts in India are found in different sizes and shapes. The Indian walnuts are categorized into 4 categories viz., paper-shelled, thin-shelled, medium-shelled and hard-shelled.

These are classified on the basis of their size and shell cracking rate also. The main grades are:

1. Indian special light half
2. Indian light broken
3. Indian light pieces

4. Indian light crumbs
5. Indian light my-fire
6. Indian light amber halves
7. Indian light amber broken
8. Indian light amber pieces

As a whole, the walnut crop in India has cyclical production with year-to-year fluctuations ranging from 5 to 20 per cent depending on the weather.

HARVESTING

Nuts are collected from the ground between the months of September and October. After collecting nuts, these are cleaned, washed and dried by spreading them on sheets or floor. Sometimes in order to improve the appearance of nuts, these are bleached with either alkali or acid solution. Nuts which fall down with their husks intact are generally second-grade. After removal of the husks, cleaning and drying, they should be stored and marketed separately to fetch a higher price. Delay in drying causes rapid loss in nut quality and makes walnuts susceptible to the mold. Drying of nuts stabilizes the product's weight and prolongs storage life.

Kernels are considered mature when oil accumulation is complete. This is generally indicated by browning of the internal packing tissue. However harvest should not begin until the husk is well split and separated from the shell. Low temperature and high Relative Humidity advance dehiscence.

The edible kernel is surrounded by a husk that dehisces as the kernels near maturity. The husk, which should be well split and relatively dry at harvest, is generally lost when the nuts fall to the ground. Harvested nuts (the shell and kernel) may be 35% or more water. Nuts are quickly swept from the orchard floor to avoid damage to the fragile nut, and are then dehydrated in forced air dryers to 8% water content. The temperature of the drying air is kept low at < 43oC to avoid damage leading to kernel rancidity.

Production, Supply and Demand Data Statistics:

Walnuts, Inshell Basis India	2011/2012 Market Year Begin: Oct. 2011		2012/2013 Market Year Begin: Oct. 2012		2013/2014 Market Year Begin: Oct. 2013		
	USDA Official	New Post	USDA Official	New Post	USDA Official	New Post	
Area Planted	0	36,600	0	36,600		36,600	(HA)
Area Harvested	0	31,000	0	31,000		31,000	(HA)
Bearing Trees	0	1,400	0	1, 400		1,400	(1000 TREES)
Non-Bearing Trees	0	200	0	200		200	(1000 TREES)
Total Trees	0	1,600	0	1,600		1,600	(1000TREES)
Beginning Stocks	350	625	750	5,905		4,375	(MT)
Production	35,000	40,000	37,000	36,000		40,000	(MT)
Imports	0	0	0	0		1,000	(MT)
Total Supply	35,350	40,625	37,750	41,905		45,375	(MT)
Exports	12,800	12,720	15,000	12,530		13,000	(MT)
Domestic Consumption	21,800	22,000	22,000	25,000		29,000	(MT)
Ending Stocks	750	5,905	750	4,375		3,375	(MT)
Total Distribution	35,350	40,625	37,750	41,905		45,375	(MT)
TS=TD		0		0		0	

*: Unofficial figure; [ ]: Official data; F: FAO estimate; Im: FAO data based on imputation methodology

WALNUT KERNELS

The major quality characteristic of kernel is a high oil content (55 to 65% dry weight) that is free from bad flavors caused by oxidation of polyunsaturated fatty acids. The important criterion is maintaining kernel water content below 4%. It retards the progressions of events that leads to rancidity and also prevents mold growth and maintain the kernel's crispness.

The skin covering the kernel contains chemicals that protect fatty acids in the kernel from becoming rancid. Light colour kernels earn a higher price because the light colour indicates that the kernel still has a relatively long shelf life (Hendricks et al., 1998). Retention of light colour influenced by the integrity of the seal between the two halves of the shell, because the shell is an important barrier to O2 entry.

The walnut kernels are an ideal source of nutrition and add a rich taste to any dish. The inclusion of walnuts in the diet is recommended as a dietary source of polyunsaturated fatty acids and other nutrients, and to improve the lipid profile in hyperlipidemic individuals. Cardiac benefits of walnut consumption are described. Walnuts have also been studied in metabolic syndrome with limited benefit demonstrated.

GRADE, SIZES AND PACKAGING

In shell and shelled grades exist and are primarily determined by size, degree of kernel fill, colour and freedom from defects and foreign material. Freedom from off-flavors (rancidity) is important. Shelled kernels held for a long period are particularly susceptible. Packaging should be moisture proof. Shelled products should be packaged in airtight, moisture proof, opaque or foil packages to maximize shelf life (Mate et al., 1996).

STORAGE

Low water content and high fat content of the kernel make it relatively metabolically stable and able to tolerate low temperatures. The primary objectives of the storage are to maintain the low water content attained after preliminary drying (for enzyme activity suppression, retention of texture and reduction of microbial activity) and limit exposure to O2 to minimize rancidity. The optimum temperature range of storage is 0 to 10oC with the lower temperature being better. Within this temperature range, a 50 to 65% Relative Humidity will maintain walnuts at 4% moisture (Beuchat, 1978). The low water content of properly stored walnuts makes them relatively inert metabolically.

Walnuts are stored in gunny bags in a small ventilated room free from excess humidity. For export purpose, these are packed in double gunny bags. Walnuts are consumed in the winter season, so the problem of their shelf life is seldom felt. The quality of nut meat, however, deteriorates due to darkening and rancidity which are affected by air, moisture, heat and light.

MARKETING

Walnuts are marketed as nuts or kernels. These arrive into the market from September onwards and the kernels follow two to three weeks afterwards; the peak arrival season being from November to January. Walnuts produced in Himachal Pradesh and Uttarakhand are consumed almost locally, whereas in Jammu & Kashmir the produce is brought to the assembly market in Jammu, which is the biggest market for walnuts in India. Efforts have been made to assemble quality nuts in Shahia market of Chakrata hill (Dehradun) and send to Delhi market. The nuts in the market are roughly sorted out and empty, stony, highly blighted, shriveled, moldy and darkened nuts removed. Thin shelled nuts are packed in wooden boxes, while medium-shelled nuts are packed in gunny bags. The product then moves either to the commission agents or the exporters' godowns.

India: Commodity, Walnut, Price Table

Production, Supply and Demand Data Statistics:

Prices Table			
Country	**India**		
Commodity	**Walnuts, Inshell Basis**		
Prices in	**Rupees**	**Per uom**	**100 Kg**
Year	**2012**	**2013**	**% Change**
Jan	15,000	17,000	13
Feb	12,000	17,200	42
Mar	12,000	17,200	42
Apr	10,000	17,500	70
May	12,000	17,500	46
Jun	12,500	18,000	44
Jul	12,500	18,000	44
Aug	13,500	17,000	31
Sep	15,000		-100
Oct	15,000		-100
Nov	17,500		-100
Dec	18,000		-100
Exchange Rate	Rs. 65.96	Local Currency/US $	
Date of Quote	9/9/2013	MM/DD/YYYY	

Source: Trade and Industry sources (average week-end prices in the Delhi Wholesale Market); GAIN Report, India, Tree Nut Annual, 2013

India: Walnut Prices

PRICE	UNITS	2012/13	2011/12	2010/11
Wholesale Price of FAQ Walnut in Kashmir	**(Rs/Kg)**	**130-175**	**100-150**	**80-150**
Export Price (C& F Europe)				
Light Halves	US$/MT	8,000- 9,000	10,500 7,500-	4,000- 11,000
Light Broken/Amber Halves	US$/MT	6,500- 8,000	9,000 6,800-	6,800- 10,000
Amber Broken	US$/MT	4,000- 7,000	7,100 6,000-	4,500- 9,300

Source: Market Sources; GAIN Report, India, Tree Nut Annual, 2013

Exports

The country has exported 11800 MT of Walnuts to the world during the year 2012-13. The major importing countries of walnut from India are United Kingdom, Egypt Arab Republic, Netherlands, Germany, United States, China, Australia and Taiwan.

As far as the world trade in walnuts is concerned, it is traded in two forms, viz, shelled and in-shell. USA is a major exporter of both shelled and in-shell walnuts. In shelled walnut exports, USA is followed by Chile, Mexico, China, Republic of Moldova, India and others. Whereas in inshell walnut exports, USA is followed by France, Mexico, Chile, China, Ukrain, etc. In shelled walnut imports, Germany ranks first followed by Japan, Spain, Turkey, France and the UK. While for inshell walnuts, Italy is the major buyer followed by Spain, Mexico, Germany, Turkey and the Netherlands. As a whole, walnut exports from India have increased over the years. However, this is insufficient as normally 45-50 per cent of the production is consumed domestically.

India: Commodity, Walnut, Export Trade Matrix

Export Trade Matrix			
Country	**India**		
Commodity	**Walnuts, In Shell Basis**		
Time Period Exports for:	**April-March 2011**	**Units:**	**Metric Tons 2012**
United States	233	United States	730
'Others'		'Others'	
Spain	1,785	United Kingdom	2,278
Germany	1,658	Egypt	1,705
Netherland	1,438	China	1,178
Egypt	1,405	Germany	1,038
United Kingdom	1,355	Netherlands	1,013
France	1,078	France	708
Denmark	473	Australia	598
UAE	375	Taiwan	493
Kuwait	342	Spain	463
Australia	335	Hong Kong	418
Sweden	295	Cyprus	345
Greece	283	Denmark	305
Total for 'Others'	10,822		10,538
Others not Listed	1,665		1,262

Note: MY 2011 refers to Indian Fiscal Year (IFY) 2011/12 (April-March) as most exports happen during October through March

Source: MY 2011 – Trade sources and Global Trade Atlas; MY 2012 – Provisional Trade Estimates

Even though the domestic and external demand for walnut has increased over the years, in India walnut cultivation could not develop rapidly due to a number of constraints including insufficient scientific research, improper and random classification, long gestation period and low free density. Apart from these, there are several pre-harvest and post-harvest problems in this sector. Constraints in walnut trade include awareness of maturity indices, method of harvesting and non-scientific dehulling.

There is lack of orchard management facility, lack of grading practices, awareness about hygienic protocols and integrated handling system to manage the nuts. There is non-adoption of international standards on grades as well and lack of storage and drying, processing, storage facilities. There is increased competition from overseas suppliers i.e. California, Mexico, China and other countries which are competing with India especially in the EU market.

The domestic and external demand has been increasing over the years. As per the projected demand, we need to expand walnut production in the states like Uttarakhand, Himachal Pradesh and Arunanchal Pradesh which have suitable agro-climatic conditions for growing walnut. Other steps to be taken are:

1. Promotion of nurseries in private sector to fulfill the huge demand of grafted plants of walnut.
2. Introduction of new and improved and high yielding lateral bearing varieties having quality kernels for getting good economic returns to the farmers.
3. Linking of Institutions and Universities would be a great help support in this direction. The U C Davis is one of best University in the world working on walnut and other nuts, California Walnut Board, Walnut Club UK etc.
4. Promotion of drip irrigation system in the walnut orchards to increase the yield and improve the nut quality.
5. Dissemination of latest production technology among walnut growers through distribution of package and Practices
6. Training and skill up-gradation of nursery men on efficient methods and providing those facilities for vegetative propagation.
7. Rejuvenation of old and sick walnut orchards
8. Establishment of walnut processing units consisting of pre-cooling and storage facilities
9. Create technical awareness among farmers for plantation of walnut
10. Overcome the problem of pests and diseases

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Selection of Unique Walnut and its Cultivation

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ABSTRACT

Walnut (Juglans regia) is a nutritious crop and its kernel (the edible portion) is very rich in protein, fat, minerals and is a concentrated source of energy. Walnut oil is used for edible purposes as it contains Omega-3 fatty acid, antioxidants and vitamins. However, the cultivation of walnut is not very popular because of its late bearing characteristics. This problem has been overcome by the identification and evaluation of a unique walnut at the IARI Regional station, Shimla. This selection came into bearing in the second year of its grafting. The fruits on this walnut are borne in lateral as well as terminal position. Actually it has multiple bearing habit. The kernel is of good quality with the shelling per cent of 45-50. This unique walnut can increase the production in India which have very good quality for export potential also. There is a great demand for this walnut material to be fulfilled in near future.

INTRODUCTION

Nut trees are a promising food resource but this potential is not adequately utilized world-over. However, they are rich in protein and fat as well as in mineral and some vitamins. Nut trees also yield valuable timber when they are old. At present the productivity of the nuts is low or on a decreasing side as they come into bearing at a very late stage.

Although the walnut has been appreciated since ancient times, commercial walnut orchards only started to be planted at the end of the last century. Californian farmers are pioneers in modernizing and technifying this crop and now China is the main walnut producer in the world. During the last ten years an important change has been detected in walnut producing countries: the use of grafted plants with highly productive and well adapted cultivars in new orchards and the search for nut quality through an adequate orchard, harvest and post harvest managements.

A unique walnut plant is being evaluated at the IARI regional station, Shimla. It was collected from Chamba region of Himachal Pradesh which came into bearing in the second year of its grafting. The known varieties of walnut normally take 10 to 15 years to come into bearing. Sometimes it takes even more.The fruit appears to be borne in lateral position as well as terminally. This is a characteristics of newly evolved early, good quality and heavy bearing walnut cultivars. However, no such cultivar is reported in India so far. The leaf size and annual shoot increment is also much more than other walnut plants collected during the same survey. They are also not yet in bearing stage. The fruit weight with husk was 58.85gm; where as, without husk (nut) weight recorded 23.5gm.The length of the fruit with husk (nut) it was 43.85cm.The nut is thin shelled. Kernel colour of light yellow and good in taste

According to Ramos et al.(1984) selection of clones that produce pistillate flowers on lateral buds has resulted in Persian walnut, Juglans regia lateral bearing Persian walnut cultivars tend to be more precocious and are better suited to high yielding, high density plantings.

High development costs for establishing a walnut orchard demand the crops at an early age. Cultivars displaying lateral bud fruitfulness generally come into production well in advance of non-lateral bearing cultivars.

AREA AND PRODUCTION

The total area under walnut in India is 149.5 thousand hectares with an annual production of 284.4 thousand MT. The country has exported 58,41,556 MT of Walnuts to the world for the worth of Rs.231 crores during the year 2011-12.

Table 1: Area and Production of walnut in India

STATES	2011-12		(estimated) for 2012-13	
	A	P	A	P
Jammu & Kashmir	120.5	260.8	128.94	254.02
Uttarakhand	19.6	21.8	19.64	21.81
Arunachal Pradesh	4.8	0.6	4.78	0.57
Himachal Pradesh	4.6	1.2	4.61	0.44

Source: NHB, 2013

MAJOR EXPORT DESTINATIONS (2011-12) :

The major importing countries of walnut from India are Spain, Egypt Arab Republic, Germany, Netherlands, United Kingdom, France, and Taiwan.

USES AND COMPOSITION:

Walnut kernel (the edible portion) is very rich in protein, fat and minerals and is a concentrated source of energy. The walnut kernels are used for dessert purposes in confectionery and for extraction of oil and as a dry fruit. Immature fruits are used for making pickles, chutneys, marmalades, juice and syrups. Walnut oil is used for edible purposes as it contains Omega 3 and 6 fatty acid, artist oil colours, varnishes and soap making. Walnut shell flour is used as ingredient in plastic pillers, battery cases, moulding resin forms, industrial tile and as insecticide spreader. Walnut timber is used for furniture, carving and making butts of guns. Composition of walnut is given in tile table 2.

Table 2: Composition of Walnut

Content	Amount/100g
Water	3.5 %
Protein	14.8 g
Fat	64.0 g
Carbohydrate	15.8 g
Fibre	2.1 g
Ash	1.9 g
Calcium	99 mg
Phosphorus	380 mg
Iron	3.1 mg
Sodium	2 mg
Potassium	450 mg
Magnesium	131 mg
Vitamin A	30 I.U
Thiamine	0.33 mg
Riboflavin	0.13 mg
Niacin	0.9 mg
Vitamin C	2 mg

Source: NHB, 2013

CONSTRAINTS FOR WALNUT CULTIVATION:

Since the entire walnut plantation is of seedling origin, there is considerable variation in nut crop production. The development of walnut cultivation has in addition faced a number of constraints, including:

- non-availability of plant material of known pedigree and characteristics produced by vegetative propagation
- an absence of proper classification of local varieties
- non-availability of good rootstock
- a long gestation period
- low tree density per hectare
- low productivity.

LEADING VARIETIES FOR CULTIVATION

Walnut (Juglans sp.) is the most important temperate nut fruit of the country. Walnut in India are found in different sizes and shapes. The Indian walnuts are categorized into 4 categories viz., paper-shelled, thin-shelled, medium-shelled and hard-shelled. Walnuts flourished at altitudes of 900 to 3000.

VARIETIES:

Walnut varieties grown in different states of India are:

Jammu and Kashmir	Lake English, Drainovsky and Opex Caulchry
Himachal Pradesh	Gobind, Eureka, Placentia, Wilson, Franquetfe, Kashmir Budded and Pusa Khor
Uttaranchal	Chakrata Selections

Source: APEDA, 2013

Table 3: Fruit Characteristics of the walnut selection (Pusa Khor)

With Husk			Without Husk			Dry Nuts		
On 04-09-12			On 04-09-12			On 22-09-12		
Weight (g)	Length (mm)	Width (mm)	Weight (g)	Length (mm)	Width (mm)	Weight (g)	Length (mm)	Width (mm)
59.97	61.48	44.35	23.59	43.78	32.87	12.19	43.20	34.65

Table 4: Vegetative and Kernel Characteristics (Pusa Khor)

Growth in Height (cm)	Growth in Tree Spread (cm)	New Growth (cm)	Shelling (%)	Oil (%)
427	**295-290**	**65**	**45-50**	**55**

The walnut is considered as one of the oldest tree species and is very valuable for food, economy and culture. Because of its importance, many researchers have tried to find the best method for improving the quality and quantity aspects.

ROOTSTOCKS IN INDIA

Paradox (Juglans hindsii x J. regia hybrid); Dwarfing and precocious rootstock, tolerant to drought

PROPAGATION

Walnut can be propagated either by seed or by vegetative methods. Both of these methods are described here.

A. Seed propagation

Healthy and disease free seeds should be selected for sowing. They may be sown in lines 50 cm apart and the seed to seed distance should be kept at 25 cm. Sowing is done during mid-November to mid-January depending on the altitude and temperature. The big nuts should be selected with bright brown colour having good cracking quality of the shell. Good taste and flavour of the kernel. Higher germination rates in walnut have been achieved by sowing seed in a vertical position at a depth of 7 cm. The beds should be covered with grasses after sowing and irrigation. While preparing the beds, proper drainage facilities should be provided. However, it is advisable to avoid propagation by seed because the plants which are grown by this method take a very long time (10 to 12 years) to begin fruiting and the plant characteristics may also not be true to type.

B. Vegetative propagation

Walnut can be propagated vegetatively by grafting, budding and stooling.

1. Grafting

Tongue or whip grafting, cleft and veneer grafting during February and early March have given good results. Epicotyl grafting has also given encouraging success in tile propagation of walnut. The best period for grafting is January -February. For propagating tile plants through veneer grafting, 5-6 month old scion wood of 15 cm is grafted on the rootstock of same thickness. The selected scion wood should be defoliated 15 days prior to its detachment from the scion cultivars. The optimum time for veneer grafting under mid -hill condition is July -August. One year old seedlings of hard shelled walnut or black walnut can be used as rootstock. Scion for tongue grafting should always be selected from the tree which has already started fruiting.

2. Budding

Patch budding is generally practiced to propagate walnut plants vegetatively. The best period for budding is May -June. Scion should always be selected from the tree which has already started fruiting.

3. Stooling

Stool layering is a suitable method of walnut propagation and is useful for the multiplication of true to type rooted plants from a rootstock bed. One year old seedlings of a known cultivar are planted in a nursery bed at I sq. m. distance and headed back from 6 .8 cm above the ground in March before bud swelling. All the cut ends are painted with Chaubatia paste. In April, buds start swelling and 3 -4 shoots come out from the stock. In July, 2 -5 cm bark is removed and the ringed portion is treated with IBA 6000 ppm in lanolin base. After a week the upper end of the ringed part swells and development of root primordia is initiated. The treated shoots are then earthed up, covering the shoot even beyond the ringed portion. Fortnightly irrigation is given to the stool bed to keep the moisture constant. During the second fortnight of February the shoots are unearthed. These shoots show rooting and are detached from the mother plant and planted in the main field in the month of March.

4. Top working

Top working is a very useful choice for walnut production in the hilly tracts of India since a large number of young seedling trees are found producing inferior quality of nuts. Top -working is usually carried out by modified cleft grafting or bark grafting late in the spring season or when new growth occurs. The dormant scion wood should be removed from the parent tree in advance and stored in refrigerator after proper packing. Bleeding is a problem in walnut top-grafting especially when it is done in early spring which can be avoided by heading back the stock two weeks before actual operations. After grafting, the open wounds must be covered by grafting wax and if required rewaxing may be done. White washing of the stem may be done to protect them from sunburn. As the rootstock is already well established, the scion makes rapid growth and bears earlier than the transplanted trees.

C. MASS MULTIPLICATION

The walnut micropropagation is one of the methods largely studied (Driver and Kuniyuki, 1984; Gruselle et al., 1987; Gruselle and Boxus, 1990; Marques Silva and Dias 1997; Navatel and Bourrain, 2001; Lopez, 2004; Britton et al., 2007; Vahdati et al., 2009). Driver and Kuniyuki (1984) demonstrated the feasibility of the tissue culture approach for mass propagation of Paradox (J. hindsii x J. regia) and to apply this process on a larger scale sufficient to satisfy commercial requirements. They obtained a good rate of shoot multiplication by using DKW medium with 1.0 mg/l benzyladenine (BA) and 0.001 mg/l indolilbutyric acid (IBA).

A properly proliferation rate of walnut shoot was obtained by using of MS modified medium with 1 mg/l BAP and 0.03 mg/l IBA (Gruselle et al., 1987; Gruselle and Boxus, 1990). Marques Silva et al. (1997) have obtained good results in shoots multiplication rate with DKWC medium and 1 mg/l BAP. Navatel and Bourrain (2001) have used DKW medium with BA (0.2 mg/l) and IBA (0.05 mg/l) for establishment of cultures. For shoot multiplication they have increased the concentration of BAP to 1 mg/l and have decreased the IBA concentration to 0.01 mg/l. Vahdati et al. (2009) studied the micropropagation of some dwarf and early mature walnut genotypes and for shoot multiplication was used DKW medium with 4.4 µM BAP and 0.05 µM IBA. In addition, acclimatization of in vitro grown shoots from mature walnut trees was realised (Vahdati et al., 2004).

PLANTING

Square system of planting is commonly adopted in walnut because it is easy to layout and convenient for cultural operations and tree thinning. Pits of 1.25 X 1.25 x 1.25 m size at a distance of 10 X 10 m should be dug during September. The pits should be filled up with orchard soil mixed with 50 kg well rotten FYM, 150 g Aldrin dust, 150 g urea, 500 g each of superphosphate and muriate of potash. The best season for walnut plantation is December to January. The plant should be well fixed in the soil and the adjoining portion of scion and stock union should be at least 15 cm above the ground surface. Watering should be done soon after plantation. To protect the plant from collar rot it should be treated with Dithane Z- 78 before planting.

MANURES AND FERTILIZERS

Walnut tree has a very extensive root system and vigorous growth, thus it requires heavy feeding. A balanced nutrition of nitrogen, potassium and phosphorus should be applied for the proper vegetative and reproductive growth. A one year old seedling requires 500 g urea and 750 g each of superphosphate and muriate of potash. The doses of fertilizer may be increased with the increase in the age of the tree. The full dose of superphosphate and muriate of potash and half dose of urea should be applied in October after picking the fruits and the remaining half dose in the month of February every year. These fertilizers should be well mixed with the soil and applied at least 30 cm away from the main stern of the plant. Every year in the month of October, 50 kg of well decomposed farmyard manure should be applied as a normal feed. Foliar application of all the micronutrients like zinc, copper, manganese, boron, iron and magnesium may be done in the month of March.

IRRIGATION

Watering is very essential for the establishment of grafts and young plants. The water requirement, however, decreases with the development of roots in adult trees. When the trees start bearing, irrigation should be given from the time of fruit set till its maturity to reduce the fruit drop and for better filling of nuts. When the trees are grown under rainfed conditions and when the rainfall is not sufficient and well distributed, irrigation is essential for walnut cultivation. The common irrigation systems followed are flood, furrow, sprinkler and drip irrigation.

TRAINING AND PRUNING

Walnut is both terminal and lateral bearer. It bears fruits on one year old wood which is produced either terminally or both terminally and laterally. Terminal bearing cultivars are thinned, but not headed back because vegetative growth keeps on increasing in absence of early fruiting. On the other hand, lateral bearing cultivars are both thinned and headed back in order to encourage shoot growth which gets suppressed due to early fruit production. Modified leader system of training is followed in walnut. After the first year's growth the plant is headed back above 2 m of its height. All lateral shoots on the leader are removed leaving one or two shoots at lower level on the trunk.

The primary objective of pruning of mature walnuts is to obtain regular and high production of quality nuts which is often

hampered by overcrowding of branches, insufficient production of new wood and inadequate availability of sunlight.. Selective thinning out of limbs in the top and sides of the tree should be done to avoid overcrowding. The pruning operations are carried out in the dormant season but early spring is preferable. Further delay causes excess bleeding. All the cut surfaces should be treated with a tree wound dressing.

FLOWERING AND FRUITING

Walnut is a monoeicous plant i.e. staminate (male) and pistillate (female) flowers are borne separately on the same tree. Staminate flowers are borne on the previous seasons growth and hang in catkins (elongated structures) and pistillate flowers appear in pairs in the form of nutlets in the current season's growth.

Walnut trees start flowering from April to May. Fruit bud formation is initiated during summer and the final development occurs shortly before anthesis in the following spring. The setting of fruits starts from the last week of May to June and maturing of fruits is over by September to October.

UNFAVOURABLE CLIMATE

Pollination in walnut is carried out by wind. It is self fertile but pollination is not satisfactory in certain varieties mostly because these varieties fail to mature their pollen at the time when the female flowers are receptive. Hot spring weather hastens the development of catkins and makes them shed their pollen quickly. It does not have great effect on the development of pistillate flowers. The pollination difficulty in the established orchards can be overcome temporarily by bringing catkins from the neighboring plantations and hanging them in the trees. It can be permanently overcome by top working certain limbs with the desirable varieties. The new plantations of walnuts should be located near the existing bearing trees. Snowfall or very cold weather at the time of flowering causes poor setting of the crop.

HARVESTING AND YIELD

Harvesting at proper maturity is of prime importance in the production of quality nuts. Any delay in picking after maturity of kernels deteriorates the quality and increases the incidence of mould and pests. Two indices for maturity are commonly used. A thick hull covering the nut splits on maturity causing the fall of the nut on the ground. Sometimes kernel matures earlier than hull splitting. In such cases proper maturity is assessed by observing the packing tissue between and around the kernel halves which turns brown on maturity.

Walnuts are ready for harvesting in September and October. Some nuts fall on the ground after splitting of the hull while others are forced to drop down by beating with long poles. The harvesting is repeated 2 to 3 times at intervals to collect the whole crop. The nuts are collected from the ground, cleaned, washed and dried in the sun by spreading them on a canvas sheet or floor. The dried nuts are graded according to the cultivar, size and colour, Sometimes in order to improve the appearance of nuts. These are bleached either with acid or alkali solution.

Yield of walnut varies depending on the age, size and variety of trees. A 40-year old large tree can produce as much as 175 kg nuts while an average yield is around 40 kg/tree. Full commercial bearing starts after 18 -20 years in seedling trees and 8 -10 years in grafted trees.

WEED CONTROL

The herbicides such as Simazine and Diuron have been successfully used to control weeds in young and established walnut grooves. Simazine and Diuron @ 2-4 lb/acre have effectively controlled annual weeds throughout tile season.

DISEASE CONTROL

There are a number of diseases found attacking walnut tree. Description of these diseases along with their control measures is given below.

1. Walnut blight

This is a common bacterial disease found all over tile world wherever walnut is grown. The bacterium enters all the tissues of leaves, catkins and nuts. Brown to black spots With yellowish green perimeter develop on the leaves. Florets die in the infected catkins. Early infection causes nut drop, while late infection results in nut shriveling and discolouring.

Control

This disease can be controlled by spraying copper containing' chemicals and Bordeaux mixture. The first spray is done on the opening of the female flower followed by subsequent sprays at 7 to 14 days interval depending on the weather conditions. Metallic copper is sprayed at the rate of 4.5 kg/hectare.

2. Anthracnose

This fungal disease is found in tile Kashmir valley. The fungi attacks leaves, young shoots and fruits. Small, circular light brown spots develop into large blotches which further affect the whole lamina.

Control

a. Fallen leaves should be collected and burnt.

b. Spray Zineb or Captan fungicides (0.01 %) on leafing followed by another two or three sprays at an interval of a fortnight.

3. Downy leafspot

It is a serious fungal disease found in Kashmir. White patches of the mould appear on the ventral side of the leaves which coalesce into large irregular shapes.

Control

It can be controlled by spraying twice systemic fungicide Bavistin 50 WP (0.03%) in June at an interval of 15 days.

4. Walnut canker or die back

The canker is found affecting walnut in Jammu and Kashmir and Uttar Pradesh hills. The swollen or sunken areas of various sizes rupture the bark of branches and trunk.

Control

a. Scrap the affected tissues and apply a paste of 50% copper oxychloride (WP) on tile diseased portion.

b. A foliar spray of copper oxychloride (0.2%) is also effective,

5. Phytophthora root and crown rot

This is also a fungal disease. The common symptoms are small chlorotic leaves, premature defoliation, decreased yield, die back .of terminal shoots and finally death of tile tree. Crown rot girdles the tree causing its death. Root rot infects the small and large roots which later destroy the entire root system.

Control

a. Use resistant rootstock such as Paradox.

b. Avoid tree injury contamination during cultural operations.

c. Provide better drainage facilities.

d. Grafled union should be kept high while planting.

PEST CONTROL

Important insect pests of walnut along with suitable control measures are described here.

1. Codling moth (Cydia ponwnella)

This is a serious pest of apple which also attacks the early blooming walnuts. The larva of the moth enters the growing fruit

through the blossom end and damages immature fruit which falls down from the tree. The larvae also enter the nuts through the side of the husk and make them unmarketable.

Control

a. Spray Diazinon or Carbaryl (0.2%) to control the pest.

b. Synthetic pheromone traps can be put in the month of May.

2. Nav~1 orange worm (Paramyelois transitella)

Several larvae are found attacking the nut. They attack damaged and mummified (dead and mumified) nuts during spring" and summer and cause serious damage to nuts on splitting of husks.

Control

a. Remove dead and shriveled nuts.

b. Control codling moth and walnut blight as they become breeding sites.

c. Harvest the nuts after husk splits.

3. Walnut husk fly (Rhagoletis cingulata)

Generally mid and late season cultivars are damaged by husk fly which feeds on the fleshy tissues of the husk and the nut shell gets stained making the nut in the shell unfit for sale. The infested nuts do not split. making harvest a problem. An early infestation of husk fly damage the kernel which shrivels and turns brown.

Control

The fly can be controlled by timely spray of insecticides.

4. Walnut weevil (Atcidodes porrectirostris)

The female insect lays eggs on the fruits which on hatching bore deeper and feed on kernels causing premature fruit drop. The adult weevils emerge from fruits and feed on petioles and tender shoots.

Control

The pest can be controlled by spraying Carbaryl (0.2%) twice, at an interval of seven days from the first attack.

5. Indian gypsy moth (Lymantria obfuscata)

The caterpillars of this moth are very destructive. They feed on buds and leaves. The moth over winters in egg stage. They are nocturnal in habit and attack the foliage after sunset resulting in complete defoliation.

Control

Application of Endosulfan (0.05%) and Fenvalarate (0.03%) can effectively reduce the pest population.

6. Walnut aphid (Chromaphis juglandicola)

Aphids are found in abundant number on the underside of leaves and tender shoots where they suck the sap. On severe infestation, leaves fall, kernels shrivel and sooty mould develops on honeydew.

Control

a. Mix Disulfotall (5%) granules thoroughly in thje soil around the tree trunk.

b. Spray insecticides such as Phosphomidon (0.03%) or Dimethoate (0.03%) to control the pest.

c. Biological control can be achieved by the parasitic wasp (Trioxys pallidus)

7. Long horned beetle (Batocera horsfield)

The bark boring beetle is an important pest in India. The grub eats the inner side of the bark making zig-zag tunnels reaching the centre of the heartwood. The infested tree becomes unfit for timber purpose.

Control

The grubs and adults can be hand picked and destroyed by treating the holes with carbon disulphide or chloroform creosote.

SUMMARY

The establishment cost of walnut orchard is so high that the fruiting at an early stage is very much required. Lateral bearing cultivars generally come into production well in advance of non-lateral bearing cultivars. Shell thickness and structure are the most important determinant of percent kernel and nut crack-ability. The highest quality walnuts have a medium-thin outer shell with no internal convolutions protruding into the nut meat. The nuts of the tree collected from Chamba District of Himachal Pradesh appear to meet this standard. This selection (Pusa Khor) can meet the increasing demand for an early bearing, high yielding of good quality which could be suited to high density walnut orchard in India.

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Present Status and Future Strategies for Walnut Production in India

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Walnut (Juglans regia) is one of the important nut crop of India being exported to more than 42 countries with earnings of more than Rs. 300 crores annually. The area under walnut in India is about 1,49,502 ha with production and productivity of 2,84,409 tones, 1.90 t/ha respectively. It is grown mainly in Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. However Jammu & Kashmir is the major walnut producing state contributing 80.58% of total area and 91.16% total production of the country. The most important walnut growing districts in Kashmir are Anantnag, Pulwama, Kupwara, Budgam, Baramulla and Srinagar while in Jammu region Doda,Kistwar, Poonch, Udhampur are important with minor quantity in Rajouri and Kathua. In Himachal Pradesh Kullu, Mandi, Shimla, Kinnaur, Sirmour, Chamba are important with a productivity of 2.70t/ha. While in Uttarakhand Nanital, Dehradun, Pauri, Tehri, Chamoali, Almora and Pithoragarh are major growing areas with productivity of 1.10t/ha (Table 1).The major importing countries of walnut from India are Spain, Egypt Arab Republic, Germany, Netherlands, United Kingdom, France, and Taiwan (APEDA-2011-12).

The worldwide production of walnut has been increasing rapidly in recent years, with most increase coming from Asia. World production of walnut is 3.42 million tonnes from 9.65 lakh ha. China is the world's leader in area (4.0 lakh ha) with a total harvest of 1.65 million metric tonnes the other major producers are United States, Iran, Turkey, Ukraine, Mexico, France, India and Romania. Though India is sixth and eighth in area and production in the world but in productivity it ranked 34th among walnut producing countries. Romania have highest productivity (24.44 t/ha) followed by Pakistan (8.6 t/ha), Ukraine (8.13), Egypt, Iran and Czechoslovakia. (Table 2)

Table 1: Area production and productivity of walnut in India.

States	Area (Ha)	Production (MT)	Productivity (t/ha)	% share in Area	% share in Production
Arunachal Pradesh	4780	573	0.12	3.19	0.20
Himachal Pradesh	4607	12420	2.70	3.07	4.30
Jammu & Kashmir	120471	260782	2.16	80.58	91.16
Uttarakhand	19644	21812	1.11	13.18	4.63
Total	149502	284409	1.90	100	100

(Source-NHB-2012)

Table 2: Top ten walnut producing countries of the world

Area	Production	Productivity						
Rank	Country	Area (lakh ha.)	Rank	Country	Production (Lakh Tones)	Rank	Country	productivity (t/ha)
1	China	4.00	1	China	16.55	1	Romania	24.44
2	USA	0.99	2	USA	4.18	2	Pakistan	8.71
3	Turkey	0.95	3	Iran	4.18	3	Ukraine	8.10
4	Mexico	0.68	4	Turkey	1.83	4	Egypt	7.33
5	Iran	0.64	5	Ukraine	1.12	5	Iran	6.53
6	India	0.30 (1.49)	6	Mexico	0.96	6	Czech Republic	6.33
7	Poland	0.27	7	France	0.38	7	Afghanistan	6.00
8	France	0.19	8	India	0.36 (2.84)	8	Uzbekistan	4.54
9	Chile	0.16	9	Romania	0.35	9	Kyrgyzstan	4.33
10	Ukraine	0.14	10	Chile	0.35	10	USA	4.22
	World	**9.655**		**World**	**34.18**		**World**	**3.54**

(Source-NHB-2012)

Productivity of walnut is much less in India. Lack of systemic orcharding with high yielding cultivars and dwarfing root stock, non responsiveness to the pruning, non availablity of easy clonal propagation techniques and production technologies which makes it difficult to improve the yield and quality of walnut. To improve production and productivity of walnut in India research institutions and developmental departments have initiated work on development of varieties, propagation techniques and production technologies and are able to make some progress.

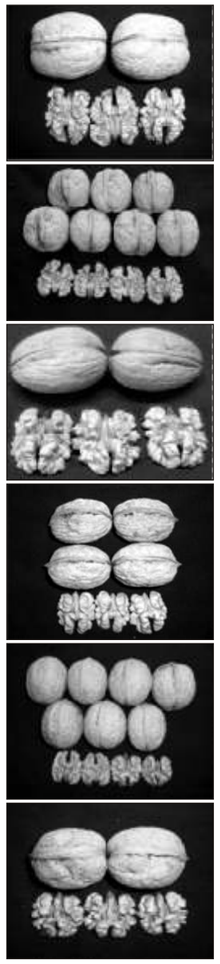
1. Varietal Development

More than 95 percent of walnut plantations in India are of seedling origin and are being grown since ancient time. Being a cross pollinated crop each growing plant in walnut is a different genotype. Likewise most of the varieties even in other countries of the world are of seedling selection except few in USA, which are developed through hybridization. The varieties grown in India are mostly selected from indigenous material or introduced from abroad like Lake English, Colby Blackmore, Franquette, Opex Caulchery, Turtle 16, Turtle 31, Nielson etc. Few seedlings with high shelling percentage, better kernel quality and soft shell have been identified and released for cultivation such as Gobind, Eureka, KS-1, Sarawari, K-2, SH-23 and SR-11, Roopa, Ratna, Pratap in HP; Chakrata No-2, 4, 6, 13 and 14, in Uttarakhand; Sulaiman, Hamdan, CITH-W-1,2,3,4,5,6,7,8,9 and 10. Lake English, Opex Caulchery, Drainovsky, Franquette in J & K are very promising. In countries like USA, France, Spain etc a quite number of commercial cultivars of walnut are commonly grown having good qualitative traits. Out of which only few of exotic cultivars like Opex Culchery, Tutle, Nugget, Franquette and Chenovo have been introduced and planted in the field gene bank of CITH, Srinagar to see their comparative performance with more than 400 indigenously selected genotypes. More than 50 selections were found superior than top world leading varieties like Chandler and Opex Caulchry, out of which ten have been released by Institute Variety Release Committee which now are being multiplied and supplied in large quantity for growing in entire temperate region.

Promising selections released by different institutions.

Varieties	Year of release	Source
Hamdan	2001	SKUAST (K), Srinagar
Sulaiman	2001	SKUAST (K), Srinagar
Sarwari	2007	Dr. YSPUHF , Solan
K-12	2007	Dr. YSPUHF , Solan
KN-5	2007	Dr. YSPUHF , Solan
SH-23	2007	Dr. YSPUHF , Solan
SR-11	2007	Dr. YSPUHF, Solan
CITH-W-1,2,3,4 and 5	2009	CITH, Srinagar
CITH-W-6, 7,8,9 and 10	2012	CITH, Srinagar

Varieties identified /released from CITH, Srinagar



CITH-W-1. Variety released in 2009 by institute variety release committee. It is suitable for export as well as domestic market, having light kernel colour, bold nut (28g), and large kernel size (14.21g), good kernel recovery (50.75%), light shell colour, intermediate shell seal, intermediate shell strength, long trapezoidal in shape and very easy to remove kernel halves.

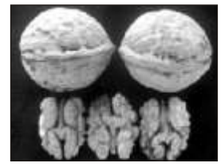
CITH-W-2. Variety was identified in 2009 by institute variety release committee. Nuts are large, ovate, medium shell texture, medium shell colour, strong shell seal, intermediate shell strength, complete shell integrity, satisfactory kernel flavor, well filled kernel, plumy, easy to remove kernel halves and light kernel colour. It has average nut weight 16 g and average kernel weight 8 g.

CITH-W-3. Variety was released in 2009 by institute variety release committee. Nuts are attractive, large, long trapezoidal in shape, rough shell texture, medium shell colour, strong shell seal, strong shell strength, complete shell integrity, satisfactory kernel flavor, well filled kernel, plumy, difficult to remove kernel halves and light kernel colour. It gives nut weight (19.3 g) and kernel weight (9.8 g).

CITH-W-4. Variety released in year 2009 by institute variety release committee. Nuts are large, ovate, rough shell texture, light shell colour, strong shell seal, intermediate shell strength, complete shell integrity, thin, satisfactory kernel flavor, well filled kernel, moderately plumy, very easy to remove kernel halves and light kernel colour. It givesaverage nut weight 19.08g and kernel weight 10.09 g

CITH-W-5. Variety released in 2009 by institute variety release committee. It is a high yielder, having extra light kernel colour, suitable for export market, bigger nut (19.5) and kernel (10.16 g), good kernel recovery (48.9%), and light shell colour, ovate in shape, moderate to remove the full kernel halves.

CITH-W-6. Variety released in year 2012, by institute variety release committee. Nuts are medium in size, ovate in shape ,light shell colour , intermediate shell seal, and shell strength, satisfactory kernel flavor, well filled kernel, moderate plumy and easy to remove kernel halves. It has average nut weight 24 g and kernel weight 12.2 g with kernel recovery 50.8 %.



CITH-W-7. Variety released in year 2012 by institute variety release committee. Nuts are large, elliptic, rough shell texture, medium shell colour, strong shell seal with good shell strength, complete shell integrity, satisfactory kernel flavor, well filled kernel, plumy, easy to remove kernel halves and light kernel colour. It has average nut weight 24.7 g and kernel weight 12.4 g with kernel recovery 50.2%.

CITH-W-8. Variety released in 2012 by institute variety release committee. Nuts having light kernel colour with average weight 20.4g, and kernel weight 11.01g, with shelling percentage of 54%, light shell colour, long trapezoidal in shape, very easy to remove kernel halves, rough shell texture, strong shell seal and strong shell strength

CITH-W-9. Variety released in 2012 by institute variety release committee. Nuts are large in size, ovate in shape, rough shell texture, light colored shell, strong shell seal, intermediate shell strength, satisfactory kernel flavor, well filled kernel, plumy, easy removal of kernel halves. It gives in shell nut weight 21.2 g, kernel weight 10.7g with 50.5 % kernel recovery.

CITH-W-10. Variety released in 2012 by institute variety release committee. Nuts are medium in size, round in shape, light in colour, strong shell seal, intermediate shell strength, well filled kernel, plumy, moderate to remove the kernel halves. It has average nut weight 24.5 g and kernel weight 12.5 g with kernel recovery 51 %.

Most of the released varieties have internationally acceptable quality, standard nut size, shell softness, kernel color and flavor. Lateral bearers have smaller nut size but suitable for hedge row planting system. The CITH has started hybridization programme for developing the hybrids having lateral bearing with larger size nut for hedge row planting to enhance the productivity.

2. Pollination management

Walnut is monoecious in nature where male and female appear on same tree at different locations. Walnut is self and cross fruitful the pollen of Juglance regia variety is capable to fertilize the eggs of same variety or any variety of other species. The walnut flowers are anemophilous representing all characteristics of wind pollination.(Chauhan and Julka,1997). Dichogammy is major problem in walnut pollination where many cultivars shed pollen before the stigma becomes receptive (protandry) and in others stigma maturity precedes the pollen dehiscence (protogyny) coupled with short period of pollen viability and stigma receptivity. CITH has rigorously screened the Pollinizer for elite varieties to maximize the pollination and fruit set. Late blooming genotypes have also been identified for frost prone areas.

Promising selections released by different institutions.

1	CITH-W-1	CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W- 6 CITH-W-7. CITH-W-8 CITH-W-9, CITH-W10, Hamdan, Sulaiman.
2	CITH-W-2	CITH-W-3, CITH-W-4, CITH-W-5, CITH-W-6 CITH-W-7. CITH-W-8, CITH-W-9, CITH-W-10
3	CITH-W-3	CITH-W-2 CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 CITH-W-7. CITH-W-7 Hamdan, Sulaiman, Opex Caulchery
.4	CITH-W-4	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 ,Hamdan, Sulaiman,
5	CITH-W-5	CITH-W-3, CITH-W-4, CITH-W-7, CITH-W-8, CITH-W10, Hamdan, Sulaiman, Opex Caulchery, Nugget Franquette
6	CITH-W-6	CITH-W-1,CITH-W-2,CITH-W-3,CITH-W-4,CITH-W-6,CITH-W-7, Hamdan, Sulaiman, OpexCaulchery, Nugget Franquette
7	CITH-W-7	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 ,CITH-W-6,CITH-W-7.CITH-W-8, Hamdan, Sulaiman Cheinova, Tutle
8	CITH-W-8	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 ,CITH-W-6, Hamdan,Sulaiman
9	CITH-W-9	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 CITH-W-7, Hamdan, Sulaiman
10	CITH-W-10	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 CITH-W-7. Opex Caulchery, Nugget Cheinova, Tutle

3. CLONAL PROPAGATION

In walnut, vegetative propagation is more difficult compared to other fruits therefore the work on new reliable propagation technologies are being tried world-wide including micropropagation for production of quality planting material. The propagation methods of budding and grafting such as patch budding, chip budding, bench grafting, whip, tongue and cleft are highly successful under specific environmental conditions along with new techniques of Hot Cable Callusing and hypocotyls grafting as walnut graft union requires specific temperature (26 +_ 2 0C) and humidity (80 -90%) for 4-6 weeks for graft success. Hot cable callusing method evaluated under Kashmir conditions gave 60-65 % graft success as compared to open environmental conditions (25-30%). To improve grafting success a major work on propagation of walnut was initiated at CITH, Srinagar and standardized different factors responsible for maximum graft success. Among the grafting techniques, wedge grafting and among types of scion wood middle portion recorded maximum graft success in all environmental conditions (open, poly house and poly trench). Among the interaction effects wedge grafting with middle portion of graft wood under low cost poly house conditions recorded highest graft success (90.00%) and plant growth (201.33 cm) grafted on 15th of March (Ahmed et al., 2012). Varieties, rootstock and scion girth also showed significant variations for maximum graft success under poly house conditions. Wedge grafting performed in mid of March on CITH-Walnut-1 recorded highest grafting success (86.7%) and plant growth as compared to other varieties. Among three root stock girths (25-30 mm, 20-25 mm and 15- 20 mm) and three scion girths (15-20 mm, 10-15 mm, 5-10 mm.) evaluated under poly house conditions the highest graft success(93.30%) was recorded with 25-30mm root stock girth and 15-20 mm scion girth. Due to scarcity of scion material budding is preferred over the grafting as budding have capacity to produce three to four time more plant than grafting from same scion material. The experiment on standardization of different budding methods, timings and environmental conditions indicated that among three budding methods (Patch, Annular and Chip budding), two environmental conditions (open field and net house) and four time of budding (mid May, mid June, mid July and mid August), the patch budding gave better success than annular or chip budding. Mid July was best time for maximum bud success. Patch budding under net house conditions performed in mid July recorded maximum budding success of 51.17%.

4. PLANTING DENSITY

Low planting density is another factor for lower productivity. Long juvenile period seedling planting material, vigorous growing habit of terminal bearing varieties are major cause of lower density. Lateral bearing varieties which are shy in vigour and more responsive to pruning can enhance the planting density and productivity of walnut. Because of slower growth walnut takes several years to cover allotted area. In initial years, planting density can be increased to get maximum yield /unit area. Later on limb thinning or tree thinning can be practised whenever required.

5. PRUNING

Pruning in walnut trees is not practised in our country resulting in unmanageable tree size and shading in lower branches which becomes unfruitful in long run. The pruning of walnut trees is done by thinning out in case of terminal cultivars and by heading back and thinning out in lateral bearing cultivars. It is done for maximum sun light penetration to the lower branches which improves the bearing capacity of the tree. CITH has started the work on pruning and thinning of walnut to standardize the quantum of removal of braches to get maximum fruiting.

6. NUTRITION

In India, generally no fertilizer is added and no work has been done on nutrition because of non existence of systematic walnut plantations. Deficiency of major and micronutrients may be responsible for poor growth, flowering, fruit set and poor yield. There is need to initiate work on standardization of nutrient dose for walnut on the basis of nutrient removal and plant age.

7. IRRIGATION

Walnut is grown as rain fed crop in our country. During summers, plants suffer from drought. Inadequate soil moisture results in poor plant growth and yield coupled with low nut quality. A water stress during the beginning of fruit growing period results in production of small size nuts poor kernel fill and ultimately low yield. Yield of Fraquette walnut on Juglance regia root stock was found double under sprinkler irrigation as compared with un-irrigated one (Charlot,1990). Nut size and nut weight increased with irrigation in Serr cultivar from 7.6g to 9.6 g (Ramos et al, 1978) . The work on water requirement is very much essential and is being carried out at CITH on newly released varieties.

8. PLANT PROTECTION

Walnut industry in India suffers due to walnut weevil, leaf roller, defoliating beetle and bacterial blight due to unmanageable large tree size and smaller holding, which calls upon cost effective eco-friendly control strategies.

9. FUTURE STRATEGIES

It is clear from fore going discussion, a very little work has been done on walnut in India and as such its production potential is yet to be harnessed. Productivity of walnut is much less than other fruit crops due to lack of lateral bearing cultivars and intensive production technologies. There is a need to develop high yielding lateral bearing varieties with better kernel characters with matching production and protection technologies involving dwarfing rootstocks and hedge row orcharding or HDP to improve the productivity. Clonal propagation techniques especially budding need to be standardized for easier multiplication of elite varieties. Introduction of lateral bearing germplasm from China, USA and Russia may be helpful in strengthening the breeding programme. Post harvest handling for shelled walnut packaging and export needs to be standardized for better economic returns of the farming community.

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Prospects of Walnut Growing in Himalayan Region of India and Future Plan of Action

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Walnut (Juglans regia) commonly known as Akhrot in India, is a native of North-western Himalayas and is grown in all parts of the Himalayan region between the elevation of 1,200 to 2,150 m above mean sea level. It belongs to the family Juglandaceae. This Persian walnut is the most important temperate nut fruit crop grown in our country. It is mainly grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. Total area under walnut is 30,800 ha and annual production is over 36,000 M.T. (2011). Jammu and Kashmir is the major walnut growing state contributing more than 85 per cent of total production. Most of the plantations are of seedlings origin and are in scattered form which produce nuts of variable qualities. At present no regular orchards of walnut exist in the Himalayan region. The productivity of walnut in our country is about 1.2 MT per ha which is very low as compared to other countries like USA, China, Iran, Turkey, France, Mexico etc. where it ranges from 3 to 5 MT per ha.

The production and productivity of walnut in our country are on a decreasing side and seedling trees also come into bearing at very late stage. The present production of walnut in our country is unable to meet the domestic demand and export potential. Thus, there is a need to introduce new varieties/cultivars of walnut which produce pistillate flowers on lateral buds, tends to be more precocious and are better suited to high density plantings and give more yield per unit area

However, breeders of our country over the year have exploited various strains amongst these seedling trees to select superior genotypes with desirable traits and some cultivars/varieties have been selected/evolved and recommended for growing in J&K, H.P. and Uttarakhand. Besides some cultivars were also introduced from other countries and after evaluation some recommendations have also been made. The varietal status of walnut growing states in our country is as under:

J&K: Lake English, Drainovsky, Opex Caulchry, Sulaimaan and Hamdan, CITH Walnut Selections 1 to 10.

Himachal Pradesh: Gobind, Wilson Wonder, Franquette, Kashmir budded, Pratap, Solding Selection, Kotkhai Selection-I and Kainthal Selection

Uttarakhand: Chakrata Selections.

On the whole, walnut has remained low priority crop in otherwise apple dominated region. Walnut growing suffers from lack of suitable methods for vegetative propagation of plants, lack of standard rootstocks/cultivars, problems in re-establishing of the nursery plants in the orchard, specific climatic requirements, pollination behaviour and lack of suitable pollinizer, long juvenility period and difficulty in harvesting of huge trees.

So, there is a need to take some initiatives for over coming above mentioned problems by adopting new technologies developed both in India and abroad for growing this valuable crop in the hilly regions of the country. This will raise the socio-economic conditions of the farmers living in Himalayan region. The initiatives required to be taken are:-

1. Introduction of high yielding new cultivars from USA, France and other countries like UK, Italy, Spain, Bulgaria, Romania, Iran and China for the establishment of bud wood bank and for mass propagation. The walnut varieties which are high yielding and some of them bear fruits laterally are:

USA:

Chandler (L), Howard (L), Tulare (L),Cisco (P), Hartley (T)

New varieties under patent are Sexton,Gillet and Forde which are precocious and high yielder at young stage.

France:

Franquette (T),Lara (L),Fernor (L),Meylannaise (P),Fernette (P),Ronde de montignac

(P)

Italy: Walnuts of Sorrento (T)

Bulgaria: Izvor-10 (T)

Romania: Germisara, Orastie and Sarmis

British Columbia : Broad view

Holland: Buccaneer

L = Lateral bearing

T = Terminal bearing cultivars

Most of these cultivars require 700-800 chilling hours below 7o c during winter months.

Top ten walnut producing countries (2011) are:

Promising selections released by different institutions.

Production (Tonnes)		
1.	China	1,655,508
2.	Iran	4,85,000
3.	United State	4,18,212
4.	Turkey	1,83,240
5.	Ukraine	1,12,600
6.	Mexico	96,476
7.	France	38,314
8.	India	36,000
9.	Romania	35,073
10.	Chile	35,000

World's Walnut annual production is 3,259,550 (MT)

Two most common species of walnut which are grown for their seeds/ nuts are :- the Persian walnut or English walnut (J. regia) originated in Persia, and the Black walnut (J. nigra) is a native to eastern North America. The black walnut is of high flavour, but due to its hard shall and poor hulling characteristics, it is not grown commercially for the production of nuts. The commercially produced walnut varieties are nearly all hybrids of the English walnut. Our country exported 5.292 thousand MT of walnuts to the world worth of about 200 crores rupees during 2012-13. The major export destination are UK Arab, Republics, Netherlands, Germany, USA, Australia and Taiwan. Other species include J. californica, the California black walnut (often used as a roostock for commercial breeding of J. regia, J cinerea (butter nuts) and J. major, Arizona walnut.

The average world wide walnut seed yield was about 3 M.T. per hectare in 2010. Among the major producers, eastern European, countries have the highest yield. According to FAO the most productive walnut seed farms in 2010 were in Romania with yields above 23 metric tones per hectare. The United State is the world largest exporter of walnut seeds. The Sacromento and San joaquin valleys of California produce 99 per cent of USA commercial English walnut seeds.

Nutritive value of walnut:

The walnut is a rich source of fat, protein, carbohydrates and minerals. The storage life of these nuts is longer than that of other temperate fruits because nut fruits are dry and light. It is a high value low volume crop. The nuts stands transportation better, hence cultivation walnuts can be taken in remote and in accessible areas of hills. The walnut nuts are in great demand in our country as well as in abroad and thus has a high potential of earning foreign exchange. The walnut also provide high quality timber wood for furniture.

Freshly harvested raw walnut seeds with water content between 2 to 8 per cent offer the best colour, flavour and nutrient density. Walnuts are high nutrient density food. 100 g of walnut contains 15.2 g of protein, 65.2 g fat and 6.7 g dietary fibre. The protein in walnuts contains essential amino acids. The walnut contains the highest total level anti-oxidants including both free anti-oxidants and anti-oxidants bound to fibre. It is a rich source of heart healthy more unsaturated fats and excellent source of omega-3-fatty acids.

1. Expansion of area under walnut cultivation with elite varieties:

The agro climatic conditions of J&K, H.P., Uttarakhand, Arunachal Pradesh and some parts of Sikkim are suitable for growing walnut. It requires climate which is free from frost in spring and from extreme heat in summer. It is highly sensitive to extremes of winter and summer temperature. The temperature should not go below 2 to 3oC in winter and above 35oC in summer. Annual rainfall of about 80 cm is considered sufficient for cultivation of walnut which can be supplemented with irrigation in drier regions, particularly for young plants. It requires soil pH of neutral range having good organic matter and proper water drainage.

There is need to expand walnut plantations in the states like Himachal Pradesh, Uttarakhand, Arunchal Pradesh, J&K and some part of Sikkim having suitable agro-climatic conditions. Small and marginal farmers have to be motivated to adopt new technologies of walnut cultivation which will not only improve the socio-economic conditions of the farmers but will be helpful in conserving the environment of the areas. At the initial stages emphasis is required to be given on the establishment of mother blocks of international varieties, developing good nurseries and training and skill up-gradation of a farmers and capacity building of other stakeholders. The selection of farmers/entrepreneurs should be on the basis of his interest and past experience having suitable land with irrigation facilities and keenness to grow walnut plants with a mandate of raising grafted and budded nursery plants.

3 Vegetative Propagation

Walnut is difficult to propagate species and does not responds to vegetative propagation as favourably as other temperate fruits. The success rate of different budding and grafting methods varies not only from year to year but also from one location to another depending upon the agroclimatic conditions. Commercially, Side veneering grafting, tongue grafting, wedge grafting and annular budding are employed, however patch and chip budding can also be used to propagate the walnut trees under open conditions.

i) Rootstocks

Majority of the walnuts growing in the country are of seedling origin however walnut varieties should be propagated on rootstocks by vegetative methods to maintain their distinctive characteristics and to maintain desirable traits such as uniform, vigour, disease resistance and quality nuts and kernel. The following rootstocks can be used under different conditions.

J. regia: Persian walnut is most common rootstock because of its availability, besides being fully compatible, resistant to crown rot and tolerant to black line disease.

J. hindsii: It is resistant to root oak fungus, root rot nematode, but susceptible to phytophthora, root lesion nematode and black line disease. Plants on this rootstock donot perform well due to low absorbing capacity of Phosphorus and Zinc and poor performance under water logged soils.

J. nigra: more tolerant to crown gall, phytopthora, oak, root fungus, and induce precocity. Also control the tree size to some extent. It is susceptible to black line disease and has low yielding capacity.

Paradox: (J. hindsii x J. regia) cross, it is tolerant to both nematode and phytophthora species. Makes more growth than J. hindsii under poor soil conditions. Susceptible to black line disease.

J. microcarpa: The rootstock is suitable for soil having high chloride, pH and boron where it perform better than J. regia and J. nigra rootstocks.

ii) Selection of Scion/Budwood

The scion wood should be selected from vigorous growing branches/trees in the month of December and January. The scion wood should have minimum of three and maximum of five to seven active buds. If the selected scion wood has male flower buds, they should be removed on the spot. Preference should be given to scion wood in which male flower buds are absent. The scion wood should be 2.5 to 3.0 cm in thickness. After selection and collection of the scion wood should be buried in the soil to avoid dryness until they are used for grafting and chip budding purposes in spring. Alternately the scion wood can also be stored in cold storage at 2-3oC having 80-85 per cent humidity. For patch and annular budding during July and August fresh scion wood should be used for achieving better success. Only vegetative buds, which are round, plump and well developed, should be used. It is better to irrigate both roostock seedlings and budwood trees 3-5 days before budding so that bark slips easily. In grafting, the efficient and suitable methods are wedge and whip grafting which are performed in the last week of February to mid March.

iii) Propagation Environment

a). Hot Cable Callusing system

In this system an insulated cable which is covered by adhesive strips increase the temperature around the graft union. To maintain the desired temperature around the union, wrapped graft is covered with almunium foil. The thermostat is connected with the sensor which is inserted between the cables. When the temperature in the cable rises above the fixed (26+2oC) the thermostat get off. This system maintain only temperature however, the maintenance of desired humidity (80 to 90 %) is not possible. This system (HCC) is power dependent thus, method is in practised in countries like Italy and Spain.

b). Zero energy polyhouse system

Under this indigenous system, higher success has been recorded. Construction is also cheaper. The wooden structure is covered with UV protected polythene. The temperature in this system rise automatically during February-March and humidity can be maintained by water sprays under polyhouse without any involvement of electric energy. During May-June onwards when temperature rises, polythene can be removed. The multiplication cost per plants is lower than HCC system.

Top working

Young seedling trees producing inferior quality nuts should be top worked with better scion cultivar for the production of better quality nuts. Top working is usually carried out by cleft and bark grafting in spring season and chip budding in summer season. The dormant scion wood for spring grafting should be cut from the parent tree quite in advance and be stored in refrigerator/cold storage after proper packing. Bleeding is a problem in walnut top working which can be avoided by heading back the stock before two weeks of actual operation. In top working of grown up trees, the frame working or grafting of branches is desirable for quicker healing of wounds and to obtain large yield early. The open wounds should be covered with grafting wax and the stem portion needs white washing for protecting from sun.

iv) Selection of Varieties/Cultivars

The selection of walnut variety (cultivar) is one of the most important decisions a walnut grower must make. The varieties which are highly fruitful on laterals and are very productive require intensive management and best of growing conditions. A grower must evaluate a climate, soil, availability of suitable irrigation water and management ability. One must have the knowledge of available varieties, their characteristics and needs.

The climate of area in general and micro-climate in particular at the site are important consideration. Pollen shedding and pistillate flower receptivity must coincide with pistillate bloom is the first step toward adequate pollination. Most of varieties do not shed pollen at proper time for pollination of pistillate flower, therefore, second variety needs to be planted for pollination, the flowering of which coincides with main variety there should be pollinizer and is planted at 5 per cent level.

a) Leaf bud fruitfulness

The varieties with high (80-90%) lateral bud fruitfulness bear more heavily during early years than varieties with a low (0-10%) lateral bearing habit. Variety with 90 per cent lateral bud fruitfulness is not always more precocious than one with 70 per cent lateral bud fruitfulness. The number of lateral buds that actually grow and produce nuts and number of nuts per shoots are important factors in determining the yield. Lateral bearing habit has little effect upon yielding ability of a mature orchard where cultural practices are effective.

b) Pollination

Walnut is a monoecious plant i.e. male & female flowers are borne separately on the same tree. Though walnut plant is self fertile, yet pollination is not satisfactory in certain varieties mostly because their pollens do not mature at the time when the female flowers are receptive. Two or three varieties are therefore, required to be planted for adequate pollination at 5 per cent level.

c) Nut quality

Characteristics of nut are important consideration when choosing a variety. Light coloured kernels have traditionally command a high price in the market. It is of prime importance in a new variety. The market favours a large nut with large well developed kernel. Kernel should be easily removable from the shell and it should yield a high percentage of large halves. Shell strength and shell integrity are also important to avoid insect damage. A weak shell seal can be a problem in harvesting, hulling and processing.

d) Harvesting: Budded/grafted walnut trees should be sprayed with 1000 ppm ethepon 3 weeks before normal harvest time. Nuts can also be dipped in 1500 ppm ethepon for 10-15 minutes after harvesting 15 to 20 days before normal picking date. This facilitates easy and early hull dehiscence, superior shell and kernel colour with good taste.

The strength of Himalyan Region for growing elite varieties of walnut is:-

i) The states of HP, Uttarakhand , Jammu and Kashmir, Arunachal Pradesh and some parts Sikkim have suitable agroclimatic condition where high quality walnut can be grown.

ii) The new varieties having desirable traits and characteristics like dwarf stature, shorter juvenile period, earliness, better nut kernel ratio and lateral bearing are available which can be used as planting material instead seedling which lack such desirable traits.

iii) Walnut is less perishable commodity and thus has good storability it can be transported easily to distant places and it is a good commodity for export.

iv) Now, the package of practices for growing walnut has been standardized and made available to the farmers by various State Agricultural Universities and institutes in India.

v) Walnut has both ailmentary and industrial uses. The kernel is rich in fat, protein and minerals and is concentrated source of energy. Walnut is a high energy food, rich in oil (including the preferred omege3 fatty acids), Vitamins and minerals. The tree produces high quality timber wood.

FUTURE PLAN OF ACTION

1. Import of planting material from abroad

   Identification of high yielding varieties which can be planted as high density orchards and import of their planting material is required ot be done in a phased manner. These cultivars are Chandler, Howard, Tulare, Cisco (P) from USA and Franquetle, Lara, Fernor Firjean, Fernette (P), Meylanaise (P) and Ronde de Montignue (P) from France, Izvor-10 from Bulgaria, Sorrento walnuts from Italy, Broad view, Buccaneer from Germisara,Orastice and Sormis from Romania. Some of these varieties mentioned above are lateral bearer and some of them are terminal bearers but are good yielder having excellent quality.

2. Identification of sites/location and farmers for the establishment of mother plant orchards and nurseries of walnut in Himachal Pradesh, Uttarakhand and Arunachal Pradesh etc for mass propagation of planting material.

3. Survey to find out the availability of then shelled good quality walnuts in all the Himalayan States for direct use as scion wood for grafts and their utilization in breeding work to select, develop and evolve new varieties with lateral bearing habit.

4. Study the problems and prospectus of new exotic in proved cultivars in our agroclimatic for their commercial exploitation.
5. Standardization of production technologies for growing organic walnuts in collaboration with State Agricultural Universities and ICAR institutes.
6. Sharing of knowledge and information on growing of walnuts and its post harvest management with premier nurseries, Institutes and Universities in India and abroad.

The productivity of walnut in our country is around 1.2 metric tonne which is very low in comparison to 3-5 MT/ha in advance countries. During 2011, in our country total area under walnut was 30800 ha with a production of 3600 MT having the productivity of 1.16 MT per ha. Whereas, world's production was 34,23,447 MT from 9,68,596 ha land having the productivity of 3.53 MT/ha. The low production in our country is due to the non-availability good quality grafted plants of international varieties with efficient methods and facilities for vegetative propagation are lacking. The productivity can increased if regular orchards are planted with grafted plants of high yielding lateral bearing varieties with a 5 per cent provision of pollinizer varieties and good cultural practices. Domestic and external demand is increasing over the years and is expected to increase 75,000 by 2020 so there is a need bring addition area under walnut growing in Himalayan states of the country which at present is 30800 ha with a production level at 36000 MT.

The walnut is known for its nutritious and healthy food, the regular consumption of which prevents from many ailments. The tree produces a high quality valuable timber and its nuts have multiple usage which are in great demand therefore, the cultivation walnut in Himalayan region is required to be encouraged and given priorities for the benefits of farmers of hilly states.

Pest Management in Walnut

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Walnut (Juglans sp.) is an important temperate nut fruit of India. The major growing area is Jammu and Kashmir, Uttarakhand, Himachal Pradesh and Arunachal Pradesh, with Jammu & Kashmir occupying the largest share in total area and production. The total area under walnut in India is 149.5 thousand hectares with an annual production of 284.4 thousand MT in 2011-12.(Source:http://www.apeda.gov.in/apedawebsite/SubHead_Products/Walnuts.htm).Walnut is grown in North America, Iran, France, Italy, China, India, Turkey, Romania, and Yugoslavia.

Walnut is highly sensitive to the extremes of winter and summer temperatures as well as to its duration. It requires frost-free spring and free from extreme heat in summer. A well drained soil rich in organic matter is the most suitable for walnut cultivation.

Walnut tree requires heavy feeding. A balanced nutrition of nitrogen, potassium and phosphorus should be applied for the proper vegetative and reproductive growth. A one year old seedling requires 500 g urea and 750 g each of superphosphate and muriate of potash. The doses of fertilizer may be increased with the increase in the age of the tree. The full dose of superphosphate and muriate of potash and half dose of urea should be applied in October after picking the fruits and the remaining half dose in the month of February every year. Every year in the month of October, 50 kg of well decomposed farmyard manure should be applied as a normal feed. Foliar application of all the micronutrients like zinc, copper, manganese, boron, iron and magnesium may be done in the month of March. (Walnut Booklet No. 189 Nuts Production: NPS- 6 www.inseda.org/.../56-Nuts%20Production%20(NPS)/Walnut-189.doc•).

Walnut trees grow very fast. It takes 10 years for most trees to produce mature fruit. Walnuts should be stored in cool and dark environments for better shelf life.

There are a number of diseases and insect-pests associated with walnut tree.

Walnut blight: This is a common bacterial disease. Brown to black spots with yellowish green perimeter develop on the leaves. Early infection causes nut drop, while late infection results in nut shriveling and discoloring. The disease can be managed by spraying Copper oxychloride (COC) and Bordeaux mixture. The first spray is done on the opening of the female flower followed by subsequent sprays at 7 to 14 days interval.

Anthracnose: The fungus attacks leaves, young shoots and fruits. Small, circular light brown spots develop into large blotches which further affect the whole lamina. The disease can be managed by collecting and burning fallen leaves and spraying plant with Zineb or Captan fungicides (0.01 %) two or three sprays at an interval of a fortnight.

Downy leafspot: White patches of the mould appear on the ventral side of the leaves which coalesce into large irregular shapes. The disease can be managed by spraying Bavistin 50 WP (0.03%) in June at an interval of 15 days.

Die back: The swollen or sunken areas of various sizes rupture the bark. Scrap the affected tissues and apply a paste of 50% copper oxychloride (WP) followed by foliar spray of copper oxychloride (0.2%).

Phytophthora root and crown rot: Symptoms include small chlorotic leaves, premature leaf fall, die back of terminal shoots and finally death of the tree. Crown rot girdles the tree causing its death. Root rot infects the small and large roots which later destroy the entire root system. Use resistant rootstock. Avoid tree injury contamination during cultural operations. Do not use farm implements to clean the area around tree. Go for chemical mowing (use Excel Mera 71). Provide better drainage facilities. Grafted union should be kept high while planting.

Codling moth (Cydia ponwnella): Attacks the early blooming walnuts. The larva enters the growing fruit through the blossom end and damages immature fruit which falls down. The larvae also enter the nuts through the side of the husk. Spraying plant with Profenophos or Trizophos (2 ml/L) will manage the pest.

Orange worm (Paramyelois transitella): Larvae attack the damaged and mummified nuts during spring and summer and cause

serious damage to nuts on splitting of husks. Remove dead and shriveled nuts. Manage codling moth and walnut blight as they encourage this pest. Harvest the nuts after husk splits.

Walnut husk fly (Rhagoletis cingulata): Feeds on the fleshy tissues of the husk and the nut shell gets stained. The infested nuts do not split. An early infestation of husk fly damage the kernel which shrivels and turns brown. Inesectides mentioned for codling moth take care of this pest.

Walnut weevil (Atcidodes porrectirostris): Eggs are laid on the fruits which on hatching bore and feed on kernels causing premature fruit drop. The adult weevils emerge from fruits and feed on petioles and tender shoots. Use Trizophos (2ml/L) twice, at an interval of seven days from the first attack.

Indian gypsy moth (Lymantria obfuscata): The caterpillars feed on buds and leaves. The moth is nocturnal. Attack is noticed on the foliage after sunset resulting in complete defoliation. Spraying foliage with Profenophos (2ml/L) will manage the pest.

Walnut aphid (Chromaphis juglandicola): Aphids suck sap on the underside of leaves and tender shoots. Severe infestation leads to leaf fall, kernels shrivel and sooty mould on honeydew. Pest can be managed by spraying Imidacloprid (200 ml/500 L water).

Long horned beetle (Batocera horsfield): The grub eats the inner side of the bark making zig-zag tunnels reaching the centre of the heartwood.The grubs and adults can be handpicked and destroyed by treating the holes with Chlorpyriphos.

Mite: Feed on cell contents and scrap the plant tissue. Mites reproduce very fast. Females lay up to 80 eggs in a month. Adult's life span is about one month with several generations in a year. Hot, dusty conditions encourage a rapid population build up. Spray on walnut foliage with a force of water. It will wash off mites and dust. If the mite is confined on few branches, prune and destroy infested portions. Spraying Fenpyroximate (Pyromite) with 0.75 ml/L water will control this pest.

- Walnuts require a deep, fertile soil with a near-neutral or slightly acidic pH. Plant the tree in deep, well-drained soil enriched with well decomposed manure using “Madhyam” and “Tricho-XP”. New plants should be protected from Termite and Whitegrub therefore, soil should be drenched with termiticide like Chlorpyriphos (Tricel).
- Water, Walnut trees regularly. Young plants need more water than old one. Drip is the best alternative for economic utilization of water.
- Clean-up around the Walnut tree with a suitable herbicide, safe to environment like Excel Mera 71. Weeds compete for nutrients, water and sunlight with the main crop. They also harbor pathogens and insect-pests.
- Plant spacing is very important for trees to receive proper sunlight and aeration. Trees should be placed at least 50 feet apart from one another.
- Harvesting of nuts is critical, especially if you don't want to deal with having to pick-up fallen nuts.

Organic Walnut Cultivation

Sh. S.P. Ghulati
Former Secretary, Govt. of India

Introduction

Walnut (Jug/ansregili L.) is one of the important nut fruits of India being exported to more than 23 countries with earnings of more than Rs 120 crore of foreign exchange annually. It is mainly grown in Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. However Jammu & Kashmir is the major walnut producing' state contributing more than 85% of total production of the country.In this state walnut is grown on more than 81393 hectares which accounts for 22% of the total area under fruits with production of about 1.15 lakh MT. It is the principle walnut growing state having monopoly in the production of export quality nuts. However the current level of production does not meet the requirements of domestic and export markets. The productivity per unit area is very low in comparison to other walnut growing countries of the world.

The two most common major species of walnuts are grown for their seeds — the Persian or English Walnut and the Black Walnut. The English Walnut (J. regia) originated in Persia, and the Black Walnut (J. nigra) is native to eastern North America. The Black walnut is of high flavor, but due to its hard shell and poor hulling characteristics it is not grown commercially for nut production. The commercially produced walnut varieties are nearly all hybrids of the English walnut.

Other species include J. californica, the California Black Walnut (often used as a root stock for commercial breeding of J. regia), J. cinerea (butternuts), and J. major, the Arizona Walnut.

To grow walnuts organically one has to start with the digging of the pits for planting the stock of walnut plants.Plants obtained from a reliable source should be planted in the previously dug 1x 1x1m size pits in a square system of layout at 6-8 m distance. The bottom of the pit up to 10 inches should be filled with stinging nettle (Biccho Grass). Top 25cm soil should be placed over the biccho grass while refilling it. This soil should be mixed with 20% vermi compost/well rotten FYM.Rest of the soil should be mixed with well rotten FYM in the ratio of 50% of the soil.

After planting the plant should be headed back 40 to 50 cm above the graft union by leaving at least four to six active buds. This will help in establishing the balance of the top of the tree with root system. After planting, irrigate the plants. The plants may take 4-7 years to fully mature , before production of nuts. During this period the field can be kept weed free by growing crops/vegetables organically in it.

Organic farming of crops/vegetables etc.:

Organic farming is a system of crop and livestock production which is not merely stopping the use of synthetic chemicals, genetically modified organisms, antibiotics, and growth hormones in agriculture, but emphasizes on converting the soil into a living entity by optimizing conditions for biological activity within the soil and maintaining biological diversity within the system. Organic Farming aims at protecting the environment, minimizing soil degradation and erosion, reducing pollution, providing attentive care that promotes the health and meets the behavioral needs of livestock.

On the one hand there is an increasing consciousness about conservation of environment as well as health hazards associated with excessive use of pesticides, fertilizers and other chemicals being used in the agriculture production system and consumers' preference to safe and hazard-free food on the other, are the major factors leading to the growing interest in alternate forms of agriculture in the world. A major eco-friendly community subscribes to the philosophy that a successful organic system begins with the soil - a healthy soil produces healthy plants and, in turn, healthy livestock and people. They regard soil as a living organism of inter-dependent processes and life forms. Organic farming promotes the use of crop rotations, cover crops, and encourages balanced host/predator relationships.

India has emerged as one of the largest potential markets for organic food consumption globally, owing to the fact that organic food or products are healthy, contain no chemical or preservatives and are completely natural.

Climate change has become a great concern and attracted the attention of all nations in the world. Under erratic rainfall and

extreme events like floods, drought, cyclone, higher temperature higher land productivity can only be obtained by crop diversification including alternate land uses. For sustaining the subsistence agriculture, a holistic multifarious self reliant farming system knitted to land productivity is the present day need. Terrestrial carbon sequestration is an effective mitigation option because it combines mitigation with positive effects on environmental conservation and soil fertility.

Recent studies have highlighted the substantial contribution of organic agriculture to climate change mitigation and adaptation.

ORGANIC FARMING

The FAO's Codex Alimentariaus Commission (June 1999) states:

“Organic Agriculture is a holistic production management system which promotes and enhances agro ecosystem health, including biodiversity, biological cycles and soil biological activity”.

The founder of Cuba's Organic Farming Association has beautifully described Organic Farming.”Many people think that farming is a simple and mundane act, but they are wrong. It is the soul of any great culture, because it requires not only a great deal of accumulated knowledge but also putting this knowledge to use every single day. Knowledge of the weather, the soil, plants, animals, the cycles of nature: all of this is used every day by a farmer to make decisions that have to be made in order to produce the food that we eat. To us it may seem like food comes from a factory, but in reality it comes from a culture that, generations has created to produce that food”.

TRADITIONAL SYSTEM:

Organic Farming is based on the traditional system of Indian Agriculture. This is the system which has sustained and fed us for centuries. Hundreds of manuscripts since ancient times have been written on or contain chapters on Organic Farming.

To illustrate:

RIG VEDA(7000 BC);ARTHSHASTRA(after 326 BC);BIRHAT SAMHITA(6 century);VRIKASH AUYURVEDA(6 century)SARNGADHARA PADDHATI(13 century);BAHARNAMA(15 century); JAHANGIR'S MEMOIRS(16 century); DARA SHIKOH'S Book on Agriculture (17 century).

These manuscript cover the entire gamut of Agriculture including prediction and measurement of rainfall; soil improvement; Non chemical fertilizers and pest control, seeds preservation, growth promotion of plants, better farming implements etc.

Very few of these ancient manuscripts have been translated into modern Indian languages. The tradition has been passed on through generations by word of mouth. Women and Balladeers formed a major force in this.

Even today in our villages many farmers follow this system.

ORGANIC FARMING AND ENVIRONMENT:

Organic Farming is basically Farming without the use of chemicals. In India- after Power- Agriculture (19%) is the second highest emitter of Green house gases.

Organic Farming is totally environmental friendly

Organic Farming reduces carbon emission by 40 to 60 percent compared to farming with chemical fertilizers and pesticides

As Organic Farming does not pollute the environment with chemicals it preserves biodiversity of animal, plant, insects and micro-organism species

Conserves water and enhances moisture retention in fields.

Organic Farming ensures sustainable soil health and reduces soil erosion.

Organic Farming reduces use of non-renewable energy :-

ORGANIC FARMING HEALTHIER AND CHEAPER OPTION

ADDITIONAL BENEFITS TO FARMERS WITH ORGANIC FARMING:

A. Organic Farming produce has a longer shelf life.

B. Organic farming also empowers women as they form the main labour force in their fields and carry forward the knowledge through generations.

C. To manufacture one kg of Urea over 13 KW of electricity are required along with a large quantity of water. This non-renewable energy and water will also be saved. Of course, there is reduction of carbon emission to the extent of 40 to 60 percent.

D. The Supreme Court has, in a recent judgment ordered that for every 2 kg of urea sold; the seller has to sell 1 kg of Organic Manure. This order, if implemented rigorously-as it should be- ensure further mitigation of carbon emission.

E. Over 60 percent of our farmland is rain-fed and over 8 crore of our farmers are small and marginal farmers. In both these cases use of chemical fertilizers is not possible Chemical fertilized fields require water fixed periodicity, which is a dicey proposition in rain-fed

F. For the small and marginal farmers the cost of urea and chemical pesticides is also very high whereas organic farming can be developed at nil or minimal cost. It also requires much lesser water.

SCIENCE AND TECHNOLOGY INPUTS:

In SANCHAR, we have evolved organic farming protocols and best cultural practices for each phase of agricultural production. The Protocols have been evolved with three main objectives:-

1. Achieving a minimum of 25 to 50 % increase in production of agricultural produce.

2. This to be achieved at 'No cost basis' to the farmers by using in-farm organic inputs.

3. The Protocols evolved should be applicable to all aspects of agriculture production including crops, vegetables, medicinal plants, floriculture and fruits etc.

The protocols evolved are on:-

Soil preparation

Seed preparation

Growth promotion

Pest control

Enhanced flowering

Protection of Seeds and produce from pests

Improved cultural practices.

A. Soil Preparation :-

These include using:

a. Green manuring with crops and leaf manure

b. Mulching

c. Amrit Pani serves the dual purpose of increasing microbial activity and moisture retention-both vital for increased production in rain-fed areas. It is a 24 hours fermented preparation of animal dung,butter-milk, milk, ghee and honey. This is sprayed on the soil.

d. Preparation and use of compost – Animal dung compost, NADEEP, Vermi-Compost, Gobar Gas plant slurry compost, etc.

e. Cow horn bio-dynamic inoculums for increasing microbial activity and moisture retention. This is bio-dynamic preparation of cow dung put in cow horns and buried underground for about 6 months. The inoculums are sprayed on the soil.

f. Cow urine collected overnight from stables for use in fields.

g. Bio-Fertilizers

h. Biomass plantation on bunds

B. Seed Preparation :-

This ensures enhanced sprouting of seeds, pest control and cent per cent transplantation of seedlings. It involves:

a. Seeds Selection. Poor seeds, which float on water, are rejected.

b. Bio-fertilizer

c. Bio-gas slurry

d. Amrit Pani

e. Butter Milk

f. Neem Leaf and other plant materials.

g. Seed treatment with bio-agents

The seeds are dipped in a mixture of Amrit Pani, Neem leaves or Persian Lilac leaves extract, butter milk and cow urine. They are dried in shade and then planted.

C. Growth Promotion :-

This involves weekly spraying of organic foliar sprays:

a) Manure Tea is a filtered extract of compost soaked overnight in water. This is sprayed on the plants.

b) Vermi spray is earth-worm water extract sprayed on plants.

c) Bio-gas slurry spray

d) Panchgavya Liquid Manure Spray is prepared with organic inputs like cow dung, dry leaves, green leaves, leaves of Persian Lilac or Neem, Bichuu grass , Mulberry leaves, Papaya leaves, Custard Apple leaves, Peach leaves ,Walnut leaves, Milk, butter milk, Gur etc. It is fermented for 15 days. The filtrate diluted with water is sprayed once a week on the plants.

D. Pest Control :-

1. Preventive Pest Control :-

a) Panchgavya Liquid Manure Spray acts as a growth promoter as well as a preventive pesticide.

b) Natural pest control methods includes attracting birds with yellow coloured rice balls. Greased yellow plates to attract white flies, these get attracted and stuck on the plates. Perches for dragon flies in rice fields, etc.

c) Use of Phonemes

d) Bio control methods

e) Crop Rotation

f) Rodent Control methods.

g) Spray of cow urine fortified with neem leaf

2. General Pesticides :-

1. Panchgavya re-inforced with additives like cow urine, turmeric powder, hing and extracts of green chillies, neem leaves and garlic pods along with khadi soap powder. This mixture is diluted with water and sprayed on the plants

E. Enhanced Flowering :-

Butter Milk Spray

Enhanced Flowering is achieved with the help of once week butter milks Sprays re-enforced with Botanical inputs sprayed on the plants.

Once the walnut plants grow up it would not be possible to grow any crops etc in the field. However by this time the field will be rich with organic micro organisms conducive toward optimal walnut production.

IRRIGATION:

Nuts grow most rapidly during the 5 or 6 weeks after the blossoming. Moisture shortage during this period may result in larqe proportion of small sized nuts Walnut shells of most of the varieties begin to harden from mid June .. Mid summer or late irrigation will not increase nut size after the shells harden. Moisture stress during summer results in poor nut quality due to lack of plumpness of the kernels and the yield is reduced considerably .

Rain water Harvesting should be done by digging shallow pits round the plants. It should be noted that as the drip line of rainfall increase with the growth of the plant fresh series of pit should also be dug along the dripp line so that the roots ca easily absorb moisture.

MANURING:

For achieving higher yields of quality crop, manuring is very important. Two weeks before expected bloom each plants should be given 40 kgs of vermi compost. Another 10 kgs should be applied three weeks after fruit set and another 10 kgs during early July. Fully grown plants (10 years onward) should be given an additional dose of 50% at each stage.

Pest Control:

The Panchgavya spray will normally control all pests of walnuts. Once a week sprays 4-6 times with the last spray ending just after setting up fruit will ensure pest control.

Propagation and Quality Nursery Production of Walnut (juglans Regia L.)

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INTRODUCTION

Walnut (Juglans regia L.) is one of the important nut fruit of the world, cultivated mostly in semi-cold regions. It is grown extensively in USA, China, France, Italy, Turkey, Poland, Yugoslavia, Rumania and Iran. In India, walnut is mainly grown in the state of Jammu and Kashmir and to a limited scale in Himachal Pradesh and Uttarakhand. It occupies an area of 137000 ha. with a production of 233400 MT (Anonymous, 2010). Although there is tremendous scope for its cultivation in entire Himalayan region between elevation of 1200 to 2500 m a.m.s.l., yet its commercial has remained in a state of neglect particularly in Himachal Pradesh and Uttarkhand. At present, the walnut is grown as scattered trees and not in the form of well laid out regular plantation or orchard. The majority of trees are of seedling origin, which has a long gestation period and are highly variable producing nuts of inferior quality with low shelling. The development of walnut industry in north western Himalayas has been constrained due to:

- The non-availability of vegetatively propagated plant material of known pedigree with desirable nut attributes
- Low transplanting survival in the orchard due to strong tap root system
- Non availability of lateral bearing and high yielding superior cultivars
- Long gestation period, low productivity and low planting density etc.

Some efforts have been made on the standardization of propagation techniques in the state of Himachal Pradesh and Jammu and Kashmir with a bud take success of 40-50 per cent in tongue grafting to as high as 70-80 per cent with hot callusing cable and 90 per cent in chip budding . These improved methods/techniques should be adopted on commercial scale for mass multiplication of nursery plants of walnut to cater the need of farmers. The advances / techniques made in walnut propagation by the University of Horticulture and Forestry, Solan is as under.

ROOTSTOCK AND PROPAGATION:-

In India, seeds of hard shell walnut known as katha walnut are generally used to raise seedlings rootstocks. Although, walnut germinates without stratification under some conditions, yet proper stratification is desirable for good seed germination and growth of seedlings. The seeds are stratified for 90-110 days in alternate layers of moist sand during December to February. Soaking of seeds in 750- 1000 ppm GA3 or 1000 ppm etherel solution for 24 hours after stratification is very effective in stimulating seed germination and growth of seedlings. The stratified seeds are sown in nursery beds in line 30 cm apart at a distance of 15-20 cm and at a depth of 5-6 cm in March. The rootstock attain graftable or budable size in a year, which are grafted or budded in next year, thus takes two or three years to produce grafted or budded nursery plants. However, a technique has been developed by sowing stratified seeds either in polybags or in nursery beds under polyhouse conditions in the month of Mid February and these seedlings attain budable size in July.

ESTABLISHMENT AND MANAGEMENT OF BUD-WOOD BANK

For the production of quality nursery plants, bud wood bank or mother tree orchard of improved high yielding varieties should be established near the nursery for the supply of scion wood in bulk for further grafting and budding. Mother trees are planted at close spacing of 3m x 3m and proper record of variety is made by making maps in the nursery register. Trees are hard pruned every year to develop hedges for the production of scion-wood in bulk. Trees are frequently irrigated and higher doses of nitrogen fertilizers is applied to make more vegetative growth. Rigorous plant protection measures are followed for the control of insect-pests and diseases. Separate tools like secature, pruning saw, knife and pick axe etc are kept to use in mother tree orchard, which are also sterilized before their use.

PROPAGATION OF SCION

Walnut is propagated through grafting and budding techniques.

GRAFTING:

In grafting, generally tongue, cleft and side veneer methods are used. Tongue and cleft methods are performed during the month of February and March and graft success in these methods depend upon the climatic conditions particularly the temperature at the time of grafting and subsequent healing of graft union. A good bud-take success is obtained in tongue and cleft methods of grafting if the temperature remain around 24- 25oC during grafting time. However, poor success is obtained if the temperature remain less than 20oC at the time of healing of graft union. The average graft success in these methods generally ranged from 40 to 55 per cent. In Jammu and Kashmir, some refinement has been made with the use of hot callusing cables at graft union by which the temperature is maintained around 25oC at graft union. They obtained about 77 per cent graft take success by using this technique. Better success with these grafting methods are obtained when grafting is done in green house having 25-28oC temperature and 80-90 % relative humidity. The best time for veneer grating under mid hill conditions has been found in August with a success rate of about 60-65 per cent.

SUMMER BUDDING METHODS (CHIP, PATCH AND ANNULAR):

A significant achievement in the propagation of walnut has been made with the summer budding methods particularly chip budding by the University of Horticulture and Forestry, Solan (HP). The studies were conducted on the standardization of time and methods of summer budding viz. chip, patch, annular and shield at 10 days intervals from Mid of May to last week of August at Solan in Himachal Pradesh for four years. Among these methods, chip method was found superior and gave as high as 87 - 92 per cent bud take success during last week of May to first week of June. The best time for Patch and Annular budding methods was found Mid of June to Mid of July under mid hill conditions. However, time of budding should to standardized in different agro-climatic conditions as the best time for chip budding at higher elevation of Himachal Pradesh was found in Mid of June.

PRODUCTION OF BUDDED PLANTS IN A YEAR UNDER PROTECTIVE CONDITIONS:

Generally it takes 2 to 3 years to produce grafted and budded plants, however, an agro-technique has been standardized to produce budded plants in a year. The seeds are put for stratification in alternate layers of moist sand in first week of December and stratified seeds are sown in well prepared nursery beds in polyhouse during mid February. The seedling rootstocks attain budable size in July and budded with chip and patch methods from mid July to first week of August with a bud-take success of 80-87 per cent. The budded plants become saleable by December.

TOP-WORKING TECHNIQUE:

Large number of young seedling trees producing inferior quality nuts are abundant in the hills of north-west Himalayas, which can be top-worked by scion of some superior varieties using budding methods. Top-working technique with dehorning has been standardized for higher bud-take success. In this technique, the seedling trees are dehorned by heading back main branches in dormant season (December-January). New branches will emerge from dehorned branches in spring season and these new branches are budded with chip method in second week of May and annular method in first week of July. Chip method gave 85 per cent bud-take success in second week of May and annular budding also registered more than 80 per cent bud-take success. This technique can be adopted for changing the seedling trees with some superior cultivars.

Chip budding

Bud-take success in chip budding(92%)

Dehorned walnut seedling tree with summer budding on current season's forced shoots

At the time of Bud Sprouting

At the end of season

Top worked walnut tree with chip budding

उत्तराखण्ड राज्य में बागवानी मिशन के अन्तर्गत कृषकों एवं व्यवसाईयों को विभिन्न घटकों में 50 से 75 प्रतिशत तक राज सहायता प्रदान की जाती है, जिसका विवरण निम्नानुसार हैः–

मिनी मिशन–II

क्र0 सं0	घटक का नाम	कार्य का विवरण	राज सहायता का विवरण	अधिकतम सीमा प्रति लाभार्थी
1.	**नये उद्यानों की स्थापना**			
अ	फल क्षेत्रफल विस्तार	विभिन्न प्रजाति के फलों के नवीन उद्यानों की स्थापना	75 प्रतिशत प्रति है0 (3 वर्षो में देय) 1. सामान्य दूरी पर – ₹30,000/– 2. सघन रोपण पर– ₹60,000/–	4 है0
ब	सब्जी क्षेत्रफल विस्तार	सामान्य एवं सघन सब्जी की खेती	क्रमशः ₹22,500/ एवं ₹33,750/प्रति है0	2 है0
स	मसाला क्षेत्र विस्तार	बीज एवं कन्द वाली मसाला की खेती	₹18,750/– प्रति है0	2 है0
द	पुष्प क्षेत्र विस्तार	खुले डंडीयुक्त एवं बल्बयुक्त पुष्पों की खेती	क्रमशः ₹18,000/–, ₹52,500/– एवं ₹67500/– प्रति है0	4 है0
य	कम्पोस्ट इकाई	मशरूम उत्पादन हेतु कम्पोस्ट का उत्पादन	₹25.00 लाख प्रति इकाई	
र	मशरूम स्पान इकाई	मशरूम उत्पादन हेतु स्पान का उत्पादन	₹7.50 लाख प्रति इकाई	
2.	**जीर्णोद्वार**	पुराने उद्यानों का जीर्णोद्वार	50 प्रतिशत अथवा ₹15,000/– प्रति इकाई	2 है0
3.	जल प्रबन्धन व्यवस्था			
अ	ट्यूबवेल स्थापना/ पौण्ड निर्माण	1. नये ट्यूबवैल की स्थापना। 2. 20X20X3 मी0 आकार के पौण्ड	75 प्रतिशत अथवा ₹1,03,000/– प्रति इकाई	
ब	कम्यूनिटी टैंक/ऑन फार्म पौण्ड	सामुदायिक रूप से 10 है0 नियन्त्रित क्षेत्र की सिंचाई के लिये 100mX100mX3m आकार के टैंक/पौण्ड निर्माण	लागत का शत प्रतिशत या अधिकतम ₹17.25 लाख प्रति इकाई	
4.	**संरक्षित खेती**			
अ	ग्रीन हाउस निर्माण (नेचुरलीवेन्टीलेटेड)	विभिन्न फूलों एवं सब्जियों की संरक्षित खेती करने हेतु ग्रीन हाउस (पालीहाउस)	₹468/– प्रति वर्ग मीटर	4000 वर्ग मीटर
	ग्रीन हाउस निर्माण (फैन–पैड सहित)	–तदैव–	₹732.50/– प्रति वर्ग मीटर	4000 वर्ग मीटर
ब	शैड नेट हाउस	ट्यूबलर बनावट, प्रकाष्ठ संरचना	लागत का 50 प्रतिशत अधिकतम ₹300 /– की दर से	4000 वर्ग मीटर
स	प्लास्टिक मल्चिंग	नमी को रोकने एवं प्रकाश संश्लेषण को बढावा देना	₹10,000/– प्रति है0 प्रति वर्ष	
द	एन्टी हेल नेट	फलों एवं सब्जी फसलों की ओलों की सुरक्षा	50 प्रतिशत या अधिकतक ₹10/– प्रति वर्ग मीटर	5000 वर्ग मीटर
य	ग्रीनहाउस में रोपण सामग्री की व्यवस्था	सब्जी पौध व पुष्प सामग्री का उत्पादन	लागत 50 प्रतिशत अथवा कमश ₹52.50/ एवं ₹250/ प्रति वर्ग मीटर	4000 वर्ग मीटर
5.	**जैविक खेती**			
अ	जैविक खेती अपनाना	विभिन्न फसलों की जैविक खेती को बढावा देने हेतु	₹ 10000/– प्रति है0 प्रति तीन वर्षो में	4 है0
ब	वर्मी कम्पोस्ट यूनिट का निर्माण	30X8X2.5 फीट आकार के वर्मी कम्पोस्ट यूनिट की स्थापना	₹30,000/– प्रति यूनिट	1 यूनिट
6.	**पॉवर आपरेटेड मशीन**	सामान्य, 20 बी0एच0पी0 एवं 20 बी0एच0पी0 से अधिक पॉवर आपरेटेड मशीन/सेट	50 प्रतिशत अथवा क्रमशः ₹ 17,500/–, ₹ 60,000/– एवं ₹ 1,50,000/– प्रति सेट	
7.	आई0 पी0 एम0	आई0 पी0 एम0 के अन्तर्गत पौध रक्षा कार्य	50 प्रतिशत या अधिकतमत ₹ 1,000 प्रति है0	4 है0
8.	मौनपालन	कृषकों को मौनवंश, छत्ते (चार फ्रेम) एवं मौनपालन उपकरण	50 प्रतिशत अथवा अधिकतमत कमशः ₹ 700/, ₹ 800/ एवं ₹ 7000/ प्रति इकाई	50 कालोनी प्रति लाभार्थी
9.	पौधशाला की स्थापना	छोटी पौधशाला (01 है0 क्षेत्रफल) एवं बड़ी पौधशाला (2 से 4 है0 क्षेत्रफल) जिनका उत्पादन 50,000 पौध प्रति है0 प्रतिवर्ष	प्रति है0 पौधशाला हेतु ₹ 3.125 लाख अधिकतम ₹ 12.50 लाख 04 है0 हेतु	

मिनी मिशन–III

क्र0 स0	घटक का नाम	राज सहायता का विवरण
1.	पैक हाउस का निर्माण (9 मी0 x 6 मी0)	₹3.00 लाख प्रति यूनिट का 50 प्रतिशत प्रति लाभार्थी
2.	प्रसंस्करण इकाई की स्थापना (कम लागत वाली)	₹2.00 लाख प्रति यूनिट का 50 प्रतिशत प्रति लाभार्थी
3.	स्थिर/चालित ठेला (शीत चैम्बर सहित)	₹30,000/ प्रति यूनिट का 50 प्रतिशत प्रति लाभार्थी
4.	कम लागत की प्याज भण्डारण संरचना 25 मै0टन	₹1.00 लाख प्रति यूनिट का 50 प्रतिशत प्रति लाभार्थी
5.	पूषा जीरो इनर्जी कूल चैम्बर 100 किग्रा0	₹4000 प्रति यूनिट का 50 प्रतिशत प्रति लाभार्थी
6.	अपनी मण्डी/रूरल मार्केट की स्थापना	अधिकतम ₹20.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
7.	रिटेल मार्केट/आउट लेट (वातावरण से नियन्त्रित)	₹10.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
8.	उत्पाद के संग्रह, छटाई, पैकिंग हेतु फक्शनल अवस्थापना संरचना	₹15.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
9.	मोबाईल/मिनिमल प्रोसेगिंग यूनिट	₹24.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
10.	मोबाइल प्री कूलिंग यूनिट (5 मै0टन क्षमता)	₹24.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
11.	प्री कूलिंग यूनिट (6 मै0टन क्षमता)	₹15.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
12.	रेफरवेन/कन्टेनर (6 मै0टन क्षमता)	₹24.00 लाख प्रति यूनिट का 55 प्रतिशत प्रति लाभार्थी (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
13.	कोल्ड स्टोरेज यूनिट (निर्माण/विस्तार/आधुनिकीकरण)	₹6000 प्रति मै0टन– 5000 मै0टन क्षमता हेतु /लागत का 55 प्रतिशत (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
14.	सी0ए0 स्टोरेज यूनिट	₹32,000/ प्रति मै0टन– 5000 मै0टन क्षमता हेतु / लागत का 55 प्रतिशत (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
15.	परिपक्व चैम्बर	₹1.00 लाख/ प्रति मै0टन– 300 मै0टन क्षमता हेतु / लागत का 55 प्रतिशत (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
16.	होलसेल मार्केट	₹100.00 लाख प्रति यूनिट का 33.33 प्रतिशत (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)

मिनी मिशन–IV

क्र0 स0	घटक का नाम	राज सहायता का विवरण
1.	नये खाद्य प्रसंस्करण इकाईयों की स्थापना	इकाई की अधिकतम कैपिटल लागत ₹800.00 लाख प्रति यूनिट का 50 प्रतिशत अर्थात ₹400.00 लाख प्रति इकाई (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)
2.	पुरानी इकाईयों का आधुनिकीकरण एवं तकनीकी उच्चीकरण	इकाई की अधिकतम कैपिटल लागत ₹400.00 लाख प्रति यूनिट का 50 प्रतिशत अर्थात ₹200.00 लाख प्रति इकाई (क्रेडिट लिक्ड बैक इन्डेड सब्सिडी)

सम्मानित कृशकों एवं व्यवसाईयों से अनुरोध है कि बागवानी मिशन योजना का लाभ लेने के लिये सम्बन्धित जनपद के जिला उद्यान अधिकारी अथवा निदेशक, राज्य बागवानी मिशन, राजकीय उद्यान, सर्किट हाउस, देहरादून से दूरभाश संख्या 0135–2759799 व मोबाईल संख्या 9411569444 पर सम्पर्क कर सकते हैं।

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