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**

(FAO, 2011)

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

Walnut Varieties Released

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-1

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-2

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

CITH-W-3

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-4

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-5

CITH-W-6. Variety released in year 2012, by institute variety release committee**.** Nut**s** 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-6

CITH-W-7. Variety released in year 2012 by institute variety release committee**. N**uts 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-7

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-8

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-9

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 %.

CITH-W-10

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.

Suitable compatible pollinizer for elite varieties of CITH, Srinagar.

S. No.	Genotypes	Suitable Pollinizers
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,OpexCaulchery,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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