Selected Agricultural Technologies ... *A Compendium*

Indian Council of Agricultural Research

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH
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Foreword

DR. MANGALA RAI

Farming is gradually becoming technology intensive, which calls for planned efforts for enhancing agricultural productivity and also for increasing the farmers' income, so that there is not only sustainable food security but also income security. These challenges can be met only by having strong working linkages among the stakeholders engaged in technology generation, technology transfer and the end users with matching infrastructural support.

Since the technology generation is a continuous process, it was decided to compile at the first instance some of the technologies, with potential to bring revolutionary changes in Indian agriculture, in form of publication entitled "Selected Agricultural Technologies–A Compendium". The compendium provides information on several frontier areas like seed production, integrated pest management, grape cultivation for export, cultivation of medicinal plants, reclamation and land management of degraded soils, fresh water pearl culture, and low cost green house, etc. A chapter on 'Facilities and Services Provided by Centrally Sponsored Schemes in Agriculture' has also been included to provide information related to available services and support.

The publication would not have been possible without the contributions of ICAR Institutes/Project Directorates/All India Coordinated Research Projects as well as the Subject Matter Divisions at the ICAR headquarters. I appreciate the efforts of my colleagues in the Agricultural Extension Division in preparing this very informative compendium. I am sure this publication will prove to be very useful to the farmers and all those who are engaged in the tasks of agricultural development in the country.

(Mangala Rai)
Secretary, Department of Agricultural Research and
Education and Director General,
Indian Council of Agricultural Research

6 May 2004

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PACKAGE OF PRACTICES FOR CULTIVATION OF HYBRID RICE

The first two hybrid varieties of rice were released by the State Variety Release Committee of Andhra Pradesh in 1993. By the end of 2002, 17 hybrids (13 from public sector and four from private sector), have been released for commercial cultivation, the list of which is given below:

Hybrid	Crop duration (Days)	% Yield advantage over local check	States for which recommended for cultivation
APHR–1	130–135	35.4	Telangana, Rayalaseema and uplands of coastal Andhra Pradesh
DRRH–1	125–130	32.7	
APHR–2	120–125	44.2	
MGR-1	110–115	16.2	Tamil Nadu (for May-June and September–October) planting
CORH–2	120–125	20.2	Tamil Nadu (July-Sept.)
ADTRH-1	115–120	44.9	Tamil Nadu (April-July)
KRH-1	120–125	31.4	Irrigated areas of Karnataka
KRH–2	130–135	21.3	
CNRH–3	125–130	37.4	West Bengal (Boro season)
Pant Sankar Dhan–1	115–120	9.7	Plains of western Uttar Pradesh
Sahyadri	125–130	35.8	Konkan region of Maharashtra
Narendra Sankar Dhan–2	125–130	24.5	Eastern Uttar Pradesh
PHB–71	130–135	28.0	Tamil Nadu, Haryana, Maharashtra and Uttar Pradesh
PA 6201 (2000)	125–130	22.9	Eastern and some parts of Southern India
HRI–120 (2001)	135–140	24.4	Telangana region of Andhra Pradesh, Karnataka, Konkan region of Maharashtra, Plains of Uttaranchal, Eastern Uttar Pradesh, Orissa and Tripura
Pusa RH–10 (2001)	120–125	39.9	Haryana, Punjab, Western Uttar Pradesh, Delhi

High yielding hybrid rice variety KRH-2

High yielding hybrid rice variety PHB-71

On-farm multi-locational evaluation of hybrids released till 2000, showed that hybrid KRH–2 was the highest yielder and most adaptable one, followed by hybrids PHB–71, PA–6201, Sahyadri, Narendra Sankar Dhan–2 and DRRH–1.

PACKAGE OF PRACTICES

The Directorate of Rice Research (DRR), Hyderabad has developed package of practices for hybrid rice cultivation, which can be locally tailored depending upon the variation in soil, climate and other associated factors.

Sowing

Adjust sowing in a way that the crop is not exposed to extreme high or low temperatures particularly at panicle initiation and flowering stages.

Season	Sowing period*	Planting period*
Kharif	June 1st–3rd week	July 1st–3 rd week
Rabi	November 2nd–4th week	December 2nd–4th week

*Sowing and transplanting time may vary slightly depending on locations/seasons.

Seed Rate

15–20 kg/ha. Seed is to be procured afresh every season.

Nursery Management

Since the cost of hybrid seed is higher, proper nursery management is very important. Sparse sowing of hybrid seed @ 20–30 g/m^2 should be adopted to obtain strong, healthy and multi-tiller seedlings in 20–25 days for planting.

Prepare wet beds of 1 meter width and of convenient length with good drainage facility. Total nursery area required for sowing 15–20 kg of seed is 750 to 1,000 m^2. Apply 250 kgs of farmyard manure, 1 kg Nitrogen, 0.4 kg Phosphorus and 0.5 kg Potash per 100 m^2 nursery area. Before sowing soak the seeds for 12–15 hours. Treat the pre-soaked seeds with Carbendazim (50% WP) @ 4 g per kg of seed. Incubate the seeds in gunny bags for 1 to 2 days for better sprouting. Sow the sprouted seeds sparsely and uniformly on well prepared seed beds. Maintain thin film of water without allowing the beds to dry at anytime. Top dress the nursery beds after 15 days of sowing with 0.6–0.8 kg of Nitrogen per 100 m^2 area. Appropriate plant protection measures may be taken, if necessary.

Main Field Management

Transplanting

Prepare main fields thoroughly by repeated ploughing followed by puddling and apply the recommended dose of farmyard manure two weeks before transplanting. After thorough leveling of the fields, apply 50% of Nitrogen and 75% of Potash, and complete dose of Phosphorous, a day before transplanting. Transplant 25–30 days-old seedlings, 1 to 2 seedlings per hill at 2–3 cm depth. The spacing of 20 × 10 cm or 15 × 15 cm is essential to ensure a plant population of 45–50 hills/m^2 meter area.

Weed Management

Mix 2.5–3.0 kg of Butachlor in 50–70 kg of sand and apply in one hectare area after 5–6 days of transplanting of rice. Thereafter ensure uniform 2 cm of standing water in the field for 3–4 days. If needed, undertake hand weeding to ensure healthy crop.

Manures and Fertilizers

Balanced use of organic and inorganic fertilizers is also very important to realize full potential of these rice hybrids.

Recommended dose (per ha)		
Green manure or Farm Yard Manure (tonne)	10–15	
Chemical fertilizers* (kg)		
Nitrogen (N)	120–150	
Phosphorus (P)	40–60	
Potash (K)	40–60	
Zinc (Zn) need based	50–60	$ZnSO_4$ once in 3 years

*Fertilizer recommendations may vary slightly depending on location. Need based application of zinc and iron is also recommended for higher yields.

Apply 25% of the recommended dose of nitrogen in the form of Urea at 30–35 days after planting and the remaining 25% nitrogen and 25% of Potash at panicle initiation stage (70–75 days after transplanting).

Water Management

Maintain a thin film of water for initial 30 days and when the crop reaches maximum tillering stage, increase the water level to 4–5 cm.

Drain out water for 4 to 5 days after maximum tillering stage so that emergence of late tillers can be suppressed. Ten days before harvest drain out applied irrigation water completely from the field.

Disease and Insect Pest Management

Like other rice varieties, hybrids also are damaged by insect pests and diseases. Control measures for some of the common insect pests and diseases are given below. Plant Protection Experts from the concerned Agricultural University and/or State Department of Agriculture may be contacted for location specific requirements.

	Recommended control measures
Diseases	
Blast	• Tricyclozole 75 WP – Seed treatment (2 g/kg of seed) – Spraying (0.6 g/litre)
Sheath Blight	• Validamycin 3L spray (2.5 ml per litre) or • Hexaconazole 5 EC spray (2 ml per litre) or • Propiconazole 25 EC (1 ml per litre)
False smut	• Chlorothalonil 75 WP spray (2 g per litre) • Propiconazole 25 EC spray (1 ml per litre) • Mancozeb 75 WP spray (3 g per litre)
Sheath Rot	• Carbendazim 50 WP spray (1 g per litre) • Propiconazole 25 EC spray (1 ml per litre)
Insect Pests	
Stem borer	• Cartap spray 50 WP (0.3 kg a.i./ha) or • Monocrotophos spray 36 WSC (0.5 kg a.i./ ha) or • Chloropyriphos spray 20 EC (0.5 kg a.i./ha)
Brown plant hopper	• Imidachloprid spray 200 SL (25 g a.i./ha) or • Thimathoxan spray 25 WG (25 g a.i./ha) or • Ethofenprox spray 10 EC (75 g a.i./ha)
Leaf folder	• Cartap granules 4 g (0.6 kg a.i./ha) or • Cartap spray 50 SP (0.3 kg a.i./ha)
Gall midge	• Carbofuran or Phorate granules 3 g (1.00–1.25 kg a.i./ha or • Chloropyriphos granules 10 g (1.0 kg a.i./ha)

Harvesting and Threshing

- When grains in the lowest portion of the panicle are in the dough stage (about 20 days from 50% flowering), drain out water from fields.
- Allow the grains to harden.

- Harvest 30–35 days after flowering when stalks still remain green to avoid grain shedding. Moisture content of paddy should be 20 to 24% at harvest.
- Thresh as early as possible, preferably a day after harvest.
- Dry gradually under shade until the moisture content is brought down to 12–14%, to ensure better milling quality and storage. Under good management conditions the hybrids can give 1.0 to 1.5 tonnes/ha more than the best high yielding varieties.

GRAIN STORAGE

Depending upon the quantity of grain to be stored, a suitable storage structure (metallic/non-metallic) which is fairly air tight is needed. Disinfest the storage structure with malathion 50 EC (1: 100 dilution) @ 3 1itres of spray emulsion per 100 m^2. before filling in with grains. Store rice as unmilled paddy. Bring down the grain moisture level to 12–14% before storage by open drying.

If old gunny bags are to be reused, treat such bags with malathion or immerse in boiling water for 15 to 20 minutes and dry. Stack the bags in systematic way on proper planks either on wooden crates or on a foot high thick layer of husk or straw, away from the walls.

ECONOMICS

With complete adoption of the recommended practices along with good field management, it is possible to obtain 1.0–1.5 tonnes/ha higher yields from hybrids as compared to the recommended high yielding varieties under similar growing conditions. Hybrid seed cost is the only additional expenditure incurred in cultivation.

For more details contact:

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Hyderabad 500 030

PACKAGE OF PRACTICES FOR HYBRID RICE SEED PRODUCTION

The seed production technology for hybrid rice is quite different from that of high yielding varieties. The hybrid seed is not only required to be produced every year but it is necessary to maintain more than 99% genetic purity of the F_1 seeds to realize its maximum yield potential.

IDEAL CONDITIONS

Monitoring team visiting a seed production field of a farmer

Season	*Rabi* season is better for seed production than *kharif* season. The daily mean temperature of 24–30°C and clear sunny days during flowering are most ideal.
Site	Fertile land with good irrigation and drainage facilities are suitable for seed production. Preferably select a site where previous crop was not rice, to avoid the problem of voluntary plants.
Isolation	Provide space isolation of more than 100 m or a time isolation of 21 days. No other rice variety should be grown on all sides of the field within 100 meters. In case of time isolation, there should be a difference of at least 21 days between its flowering and other varieties grown in the vicinity.

Sowing

Since the parental lines differ in their duration, differential seeding should be adopted to synchronize the flowering of two parental lines for seed production. If the flowering male parent is ten days late as compared to that of the female parent, the male parent (R line) is sown first with two dates of seeding, with a gap of 4–5 days. Then the female line is sown only once, 10 days after the first seeding of R line.

Seed Rate	
	Seed
Female line seed	15 kg
Male line seed	8 kg

Day-1	Day–5	Day-1 0
Male line (R–1) (4 kg)	Male line (R–2) (4 kg)	Female line (15 kg)

Nursery Management

- Sow the seed of parental lines sparsely at the rate of 20–25 m^2 to obtain strong, healthy and multi-tiller seedlings in 20–25 days.
- Prepare wet beds of one meter width and of convenient length with good drainage facility. Total nursery area required for sowing 23 kg of seed is 1000 to 1200 m^2.
- Apply 250 kg of farmyard manure, 1 kg Nitrogen, 0.4 kg Phosphorus and 0.5 kg Potash per 100 m^2 nursery area.
- Soak the parental line seed for 12–15 hours. Treat the pre-soaked seeds with Carbendazim (50% WP) @ 4 g per kg of seed. Incubate the seeds in gunny bags for 1 to 2 days for better sprouting.
- Sow the sprouted seeds sparsely and uniformly on well prepared seed beds. Maintain a thin film of irrigation water without allowing the beds to dry at anytime.
- Topdress the nursery beds after 15 days of sowing with 0.6–0.8 kg of Nitrogen per 100 m^2 area.
- Adopt appropriate plant protection measures, if necessary.

Main Field Management

Field Preparation and Nursery Raising

Prepare the main field thoroughly by repeated ploughing followed by puddling and apply the recommended dose of farmyard manure, two weeks before transplanting. Apply 50% of recommended Nitrogen and 75% of Potash, and full dose of Phosphorous a day before transplanting, followed by thorough leveling.

Transplanting

When seedlings of the second sowing of male parent are 25 days old, uproot first and second sown seedlings of male parent and mix them properly and transplant in paired rows, leaving a space for 8 rows in between to plant female seedlings. Plant 3–4 seedlings of male parent per hill. Subsequently, pull out the seedlings of female parent and transplant 1–2 seedlings per hill in 8 rows between the rows of male parent.

Transplant male seedlings at a spacing of 30 × 15 cm, and female seedlings at a spacing of 15 × 15 cm in the row ratio of 2 male: 8 female. Keep 20 cm spacing between a row of male line and female line.

Weed Management

Mix 2.5–3.0 kg of Butachlor in 50–70 kg of sand and apply in one hectare area after 5–6 days of transplanting. Ensure uniform level of 2 cm of standing water in the field for 3–4 days. Need-based hand weeding may be undertaken to ensure healthy crop.

Nutrient Management

It is recommended to apply 150 kg Nitrogen, 60 kg Phosphorus, 80 kg Potash and 15 tonnes Farm Yard Manure/ha. In addition, 50 kg/ha Zinc Sulphate (once in three years) be also applied. Apply 25% of the recommended dose of Nitrogen in the form of Urea at 30–35 days after planting and the remaining 25% Nitrogen and 25% of Potash at 70–75 days after transplanting at panicle initiation stage. Full dose of Phosphorus and Zinc Sulphate should be applied as basal.

Water Management

Maintain a thin film of water for initial 30 days and later on increase the water level to 4–5 cm when the crop reaches maximum tillering stage. Drain out irrigation water for 4 to 5 days after maximum tillering stage, so that emergence of late tillers can be suppressed. Drain out water completely from the fields at least 10 days before harvest.

SPECIAL SEED PRODUCTION OPERATIONS

Roguing

Roguing is a process of removal of unwanted rice plants from the seed production plots. It is very important to maintain the purity of hybrid seed. Therefore, remove off-type plants at different stages starting from sowing to harvest. Though rouging is a continuous process throughout the crop season, it should specifically be carried out at three distinct stages viz., during vegetative phase at maximum tillering, before and during flowering, and just before harvesting. The important characters

based on which rouging should be done during the crop growth stages are given below.

Stage	Characters
Vegetative	Morphological characters such as plant height, plant type, leaf shape and colour, pigmentation of stem, leaf, leaf sheath etc.
Before and during flowering	Early and late types, panicle type, presence or absence of awns, panicle exertion, spikelet shape, anther colour etc.
Before harvesting	Extent of seed set on female parent (if the seed set on female parent is more than 70% such plants need to be checked thoroughly), grain type, grain shape, etc.

Prediction and Adjustment of Flowering

Perfect synchronization of male and female flowering is a pre-requisite for getting higher seed yield. For ideal synchronization, female parent should come to heading 2–3 days prior to heading of male parent. Synchronization can be predicted by observing the stages of young panicle development in female and male lines. There are eight stages in panicle development.

Stage No.	Developmental stage	Approximate days before flowering	Approximate panicle length (mm)
I	Panicle primordial	30	0.2
II	Primary branch primordial	27	0.4
III	Secondary branch primordial	24	1.5
IV	Stamen and pistil primordia	20	2.0
V	Pollen mother cells	17	10–25
VI	Meiotic division	12	80
VII	Mature pollen	6	190–250
VIII	Ripe stage of pollen	4	260

When female line is earlier than male line in growth duration (like in case of DRRH-I), the male line should be one stage earlier than female line during the first 3 stages of panicle development. Both female and male lines should be in the same stage during next three stages of panicle development. If the difference between male and female flowering is about 7–8 days, synchronization can be adjusted by two methods, viz., water management, and by spraying nutrient solution.

Water management is effective for adjusting flowering of male parent. To delay flowering of male parent, completely drain out the irrigation water for 4–5 days. For hastening flowering of male parent, maintain a water level of 4–5 centimeters. Application of nutrient solution can be adopted for adjustment of flowering in both parental lines. Application of 2% Urea as foliar spray will delay the flowering and the use of 1% Phosphatic fertilizer will enhance flowering. Depending upon the situation and severity of the problem, any one or both the methods can be used to attain proper synchronization. In rare cases, if the difference between male and female flowering is more than 10 days, synchronizing the flowering of early parent by removing the main panicles and by spraying 2% Urea or by applying Nitrogenous fertilizer at the rate of 30–40 kg/ha may be adopted.

Flag Leaf Clipping

Flag leaf clipping at a right stage helps in better pollen dispersal. At booting stage, cut the upper one-third to one-half of the flag leaf uniformly with a sharp sickle. Flag leaf clipping is not advisable when the field is infested with bacterial leaf blight, as this may spread the disease further.

Application of Gibberellic Acid (GA_3)

In all the CMS lines currently being used in commercial seed production, panicle exertion is not complete, as 20 to 25% of the panicle remains inside the flag leaf. Hence almost one-fourth of the spikelets are not available for out crossing. GA_3 application helps in improving panicle exertion, stigma exertion and overall seed set. Right stage for GA_3 application is at 5–10% initial heading (when 5 to 10 out of 100 tillers show initial heading). Dissolve recommended dose of GA_3 in a little quantity of 70% alcohol and use it for spraying as per the given schedule.

Spray schedule	Type of sprayer	
	Knapsack	ULV
GA_3 dose (g/ha)	50	25
First Spray (first day)	20 g in 500 litres of water	10 g in 20 litres of water
Second Spray (next day)	30 g in 500 litres of water	15 g in 20 litres of water

Spray GA_3 uniformly on both female and male lines during morning or evening hours on a sunny day by using either Knapsack or ULV sprayer as per convenience.

Supplementary Pollination

As rice is a self-pollinated crop, pollen dispersal and consequently extent of natural crossing is low. To increase out crossing and the seed set, supplementary pollination is adopted. Move in between male rows and shake the plants with the help of two long (2 to 3 m) bamboo sticks during peak anthesis period. Depending on weather conditions, the time of peak anthesis varies, the plants reach peak anthesis after half an hour after the opening of first few spikelets in a panicle. Carry out supplementary pollination 3 to 4 times in a day starting from 9.00 to 11.30 AM at peak anthesis period depending on weather conditions and locations.

Disease and Insect Pest Management

Like other rice varieties, hybrids are also damaged by insect pests and diseases. Control measures for some of the common insect pests and diseases have been given under Package of Practices for Cultivation of Hybrid Rice.

Harvesting and Threshing

- Drain out irrigation water from the field when the grains in the lower portion of the panicle in male parent are in dough stage (approximately 20 days after 50% flowering). Allow the grains to harden. Initiate harvesting 30–35 days after flowering when stalks are not completely dried to avoid shattering of grains.
- Harvest the male rows first. Dry after threshing and remove the produce from threshing floor and store separately. Critically examine the field for any of the panicles of male parent falling on the ground or on the plants of female lines.

- Take up the final rouging in the female lines, specifically looking for seed set higher than 70%. All the panicles having seed set more than 70%, should be removed, as these may be selfs or off types.
- Harvest and thresh the female rows separately, after cleaning the thresher thoroughly. The seed borne on female parent is the hybrid seed.
- Dry the harvested seed for 1–2 days, to ensure that moisture percentage is reduced to 12–14. Clean and bag the seed in well aerated gunny bags. If old gunny bags are used, these should be properly cleaned before using for bagging.

YIELD

With good planning and ideal management, average seed yields of 1.5 to 2.0 tonne/ha can be obtained.

ECONOMICS

By adoption of the above recommended package of practices, average seed yields obtained in large scale seed production areas are 2.0–2.5 t/ha. At the average procurement price of Rs 30–40 per kg, the gross returns are Rs 60,000 to 80,000 per hectare. The cost of cultivation is around Rs 25,000–30,000 per hectare. Hence the net profit by undertaking hybrid rice seed production works out to be Rs 35,000 to 50,000 per hectare.

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WHEAT SEED PRODUCTION TECHNOLOGY FOR FARMERS

Wheat being a self-pollinated crop, the varietal deterioration takes at a slow rate and seed needs replacement after five to six years, provided a separate seed plot is maintained following a systematic seed production programme. Farmers can multiply quality seed for their own use from the source seed of any class-breeders, foundation, certified, or truthfully labeled, procured from a reliable source by adopting the guidelines developed by the Directorate of Wheat Research (DWR), Karnal as described below:

Bumper wheat crop for seed production

LAND REQUIREMENTS

A well levelled separate piece of fertile land with assured irrigation, free from surface drainage problems should be demarcated for seed production. In the hilly areas, since the emergence of volunteer wheat plants is a serious problem, therefore, the fields with the previous wheat crop should be avoided.

METHOD OF SOWING

Seed rate of 80 kg/ha for timely sowing and 100 kg/ha for late sown crop should be used. Adopt normal recommended nutrient management practices for the area. Seed production plots should be sown using a seed drill by adopting the following steps:

- The seed drill's pipes, seed cups and bin should be thoroughly cleaned as any left back seed will contaminate the seed production plot.
- Ensure that there is no physical mixture due to negligence at sowing time.
- Every eighth and ninth row should be left unsown in order to walk through the plots for easy cultural operations, monitoring and effective rouging.

ISOLATION

Maintain minimum isolation distance of three meters of seed plot of a variety with other varieties to avoid possible out-crossing and admixture. Also, ensure that no loose smut infected wheat; triticale or rye field is nearby seed plot (within 150 meters) to ward off infection from seed borne diseases.

ROUGING

Off-type plants can be identified in seed plot based on the variation noticed in features of the variety like:

- Auricle pigmentation
- Days of flowering
- Plant height
- Waxy bloom
- Ear color
- Ear shape
- Ear density, etc.

It is recommended to perform at least three rougings i.e. one each at early vegetative growth, 75% ear emergence, and maturity. The rouged plants, particularly those having physiological seed maturity, should be removed from the field and disposed-off from seed plot to avoid any chance of its mixing with the seed bulk.

HARVESTING AND POST-HARVEST HANDLING OF BREEDER SEED

Extra care is needed to avoid mechanical mixing likely to occur during harvesting, threshing, seed treatment, packing and processing. The threshers, combine harvesters, trailers, processing machinery etc. to be used for seed production should be thoroughly cleaned.

SEED TREATMENT AND STORAGE

Treat the seed through seed dresser using Vitavax 75 WP @ 2.5 g/kg or Raxil 2 DS @ 1.25 g/kg seed to control loose smut and other seed borne diseases such as hill bunt. If seed production is undertaken in the hills, seed treatment is strongly recommended to control hill bunt.

Generally, at harvesting time the seed moisture is around 14 to 15% and at such a moisture level the seeds should not be sent to the warehouse. The seed should be dried in shade or with a seed drier to bring the seed moisture to 9–10%. This will besides increasing seed viability also minimizes the chances of damage due to storage pests and fungi. Proper record of seed bags and storage should also be maintained.

During storage in ware house/silo, samples must be drawn at periodic intervals to measure grain moisture, and also inspect for pest/fungi damage. As the situation may demand, action must be taken either to reduce seed moisture levels or fumigate seed to suppress insect-pest incidence. Occasionally, rodent control may also be necessary.

SEED PURITY STANDARDS

A series of tests should be undertaken to assess the quality of seed. Generally such tests are conducted in designated Seed Testing Laboratories. Every State has at least one Seed Testing Laboratory to conduct such tests.

Minimum certification requirements for field standards

Field standards						Specific requirements				Limits	
Field selection	Number of field inspections needed	Isolation distance (metres)				Off type plants (%)		Inseparable other crop plants (%)		Seed born disease infested plants	
		Crop		Disease							
		F	C	F	C	F	C	F	C	F	C
Free of volunteer plants	Two	3	3	150	150	0.05	0.2	0.01	0.05	0.1	0.5

F- Foundation Seed, C-Certified Seed

Minimum certification requirements for seed standards

Parameters	Standard	
	Foundation	Certified
Pure seed (minimum, %)	98	98
Inert material (maximum, %)	2	2
Other crop seed (maximum per kg)	10	20
Other distinguishable varieties (maximum per kg)	10	20
Total weed seed (maximum per kg)	10	20
Objectionable weed seed (maximum per kg)	2	5
Germination (minimum, %)	85	85
Moisture (maximum, %)	12	12
Moisture for vapour-proof containers (maximum, %)	8	8

For more details contact:

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PLANT PROTECTION

INTEGRATED PEST MANAGEMENT (IPM) FOR SELECTED CROPS

The intensive agriculture practiced during the last fifty years or so contributed to significant increase in production. However, the injudicious use of chemical pesticides as one of the intensive inputs, affected non-target and beneficial organisms. Over the period the residues grew as environmental threats and non-tariff barriers to export of agricultural commodities. The biggest challenge today is to sustain crop production along with conservation of natural resources like soil and water, and to conserve and maximize the abundance as well as the effectiveness of beneficial insects and microorganisms by adopting a systems approach with a holistic view. One of the conservative estimates is that around 18% loss in yield in different field crops is due to disease and insect infestation amounting to Rs. Forty five thousand crores. In order to keep the economic losses to the minimum, Integrated Pest Management (IPM) has been introduced since 1985.

The IPM approach includes all the components such as soil preparation, treatment of seed, optimum sowing time, maintenance of desirable plant population, balanced use of fertilizers, irrigation water, monitoring of insect pests, need based use of pesticides, and use of bio agents for sustainable and healthy crop production. Estimates show that in our country, approximately half of the total pesticide use is in cotton, 17% in rice, and 12% in vegetables and the remaining in other crops. The National Centre for Integrated Pest Management (NCIPM), New Delhi in association with several other institutions like State Agricultural Universities, State Departments of Agriculture and Horticulture, Non Governmental Organizations, and private industrial institutions has developed IPM modules for several important crops. These modules are environmentally sound, economically viable and socially accepted and have been validated in farmer's participatory mode at several locations. The IPM modules being location and crop specific require appropriate refinement as per location needs. Early warning system for aphids and bollworms has also been developed for rational decision making by the farmers.

COTTON

Cotton is an important commercial crop in India occupying about 8 million ha. and supports 60 million people. Cotton under irrigated conditions is grown in Punjab, Haryana and Rajasthan while it is cultivated in Maharashtra, Karnataka, Andhra Pradesh, Gujarat, Madhya Pradesh and Tamil Nadu mainly under rainfed conditions. This crop is affected by several insect pests, and diseases from sowing to its harvesting. Though this crop occupies only 5% of the total cultivated area of the country, yet over 50% of the total pesticide use is in this crop and it accounts for 40% of the total production cost in cotton. Due to indiscriminate use of pesticides, there have been deleterious effects on environment as well as development of resistance in insect-pests. Therefore, IPM approach in cotton assumes great significance.

Whitefly adults

Irrigated Cotton

Key Pests and Diseases

Cotton jassid (*Amrasca biguttula*), whitefly (*Bemisia tabaci*), spotted bollworm (*Earias insulana* and *E. vittella*), pink bollworm (*Pectinophora gossypiella*), American bollworm (*Helicoverpa armigera*), Tobacco caterpillar (*Spodopotera litura*) and Cotton Leaf Curl Virus.

IPM Approach

- Adopt sucking pest tolerant and early maturing varieties.
- Treat 1 kg seed with 8g Imidacloprid, thereafter treat this seed with 10 ml Chloropyriphos.
- Maintain plant to plant distance of 30 cm and row to row distance of 75 cm.
- After sowing, put 4-5 Pheromone Traps per hectare, to monitor bollworms and undertake weekly scouting for other pests.
- Along with cotton, sowing of cover crops – one border row of maize/ bajra promotes the entomophagous population.
- To control American bollworm, bioagent *Trichogramma chilonis* @ 1.5 lakh / ha should be released in the fields. Also spray Nuclear Polyhedrosis Virus (*Ha*NPV) @ 250 ml/ha (2×10^9 POB/ml) at the flowering and boll formation stages.
- Undertake need based spray of systemic insecticides i.e., Dimethoate (Rogor) or Oxydemeton methyl (Metasystox) @ 750-900 milliliter or Imidacloprid (Confidor) @ 100 milliliter/ha (1-2 sprays during July).

Jassid nymph

Rainfed Conditions

Key Pests and Diseases

Cotton jassid (*Amrasca biguttula*), whitefly (*Bemisia tabaci*), thrips (*Thrips tabaci*), spotted bollworm (*Earias insulana* and *E. vittella*), pink bollworm (*Pectinophora gossypiella*), American bollworm (*Helicoverpa armigera*), and tobacco caterpillar (*Spodopotera litura*).

IPM Approach

- Treat seed with Imidacloprid and use Bt cotton (MECH - 184) as a resistant cultivar for the management of Bollworms.
- Plant border row of maize + cowpea as a cover crop and one row of setaria as a source of food and perch for birds in between each 10th and 11th row of cotton.
- Release *Trichogramma chilonis* @ 1.5 lakhs/ ha when American bollworm eggs are seen and spray *Ha*NPV @ 250 ml/ ha (2 x 10^9 POB/ml), when the small larvae of American bollworm are seen.
- Spray 5% Neem Seed Kernel Extract for the management of sucking pests and bollworms and repeat *Ha*NPV spray @ 250 ml/ha (2 x 10^9 POB/ml), if required. Also spray Endosulfan 35 EC, if required.

For more details contact:
Director
National Research Centre for Integrated Pest Management (ICAR), Lal Bahudur Shastri Bhawan, IARI Campus, Pusa, New Delhi-110 012

RICE (BASMATI)

Basmati rice is high value crop with great potential of export. Thus the farmers often use excessive fertilizers and chemical pesticides. The development of IPM practices not only help to sustain soil fertility but also in crop quality improvement.

Key Pests and Diseases

Yellow stem borer, leaf folder, brown plant hopper, Gandhi bug, blast or bacterial diseases.

IPM Approach

- Treat seed with *Trichoderma* @ 4 g/kg and Carbendazim/ Bavistin @ 5 g/kg seed.
- Monitor for appearance of eggs of stem borer on the leaf from the very beginning. Use Trichocards (fix small pieces of Trichocards at several places in the fields).
- Fix five pheromone traps/ha.

- To control leaf folder, spray neem based pesticides like Neegark/ Nimbesidin or use Monocrotophos or Phosphomidon (mix 500 ml in water sufficient for spray in one hectare).
- In case of attack of false smut, use Dithane-M-45 (0.25%) or Copper oxychloride (2 g/ lit)

For more details contact:

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National Research Centre for Integrated Pest Management (ICAR), Lal Bahudur Shastri Bhawan, IARI Campus, Pusa, New Delhi-110 012

CHICKPEA

Pulses are suitable crops for crop diversification and are a major source of protein. Gram pod borer, pod fly, sterility mosaic virus, phytophthora blight are biotic stresses in chickpea pea and lower the yield significantly. Fusarium wilt, yellow mosaic virus and pod borers also cause around 15-20% losses in chickpea and other pulses.

Key Pests and Disease

Fusarium wilt (*Fusarium oxysporum* f sp. *ciceris*), dry root rot (*Rhizoctonia solani*),
botrytis grey mold (*Botrytis cinerea*), cutworm (*Agrotis ipsilon*) and gram caterpillar
(*Helicoverpa armigera*).

IPM Module

- Use tolerant variety like RSG-44.
- Treat seed with *Rhizobium* culture @ 600 g/ha and also seed treatment with *Trichoderma harzianum/ Trichoderma viride* @ 4 g plus Vitavax @ 2 g/kg seed for the control of collar rot.
- Adopt seed rate of 80 kg/ ha and increase plant to plant distance of 30 cm instead of 22.5 cm usually recommended.
- Apply pre-emergence spray of Alachlor @ 2 kg/ha for the management of weeds.
- Monitor presence of *Helicoverpa* through pheromone trap @ 3-4/ha starting from 30 Days After Sowing.
- Install T-shaped perches for birds @ 25-30 /ha, 20-30 cm above crop height for natural control of insects.
- Spray *Ha*NPV @ 250 ml/ha (2 x 10^9 POB/ml) + 0.01% fabric whitener + 0.5% gur, when the small larvae of American bollworm are seen. After next seven days, spray Neem Seed Kernel Extract @ 5% or 1500 ppm as Azadirachtin solvent base.

Pheromone traps and perches installed in Chickpea field

For more details contact:

Director
National Research Centre for Integrated Pest Management (ICAR), Lal Bahudur Shastri Bhawan, IARI Campus, Pusa, New Delhi-110 012

- Repeat the spray of *Ha*NPV @ 250 ml/ha (2 x 10^9 POB/ml) + 0.01% fabric whitener + 0.5% gur after a gap of one week.
- If there are 1-2 *Helicoverpa* in a row of one meter, spray Endosulfan 35 EC @ 750-800 ml/ha.
- Near to grain ripening, ensure removal of bird perches.

PIGEON PEA

Key Pests and Diseases

Ridge Sowing of Pigeonpea for the management of Phytopthora blight

Tur pod fly (*Melanagromyza obtusa*), pod borer (*Helicoverpa armigera*), plume moth (*Exelastis atomosa*), *Euchrysops cnejus*, legume pod borer (*Maruca vitrata*), green stink bug (*Nezara viridula*), pod sucking bug (*Clavigralla gibbosa*), phytopthora blight, etc.

IPM Module

- Undertake deep summer ploughing to destroy immature stages and pathogen propagules.
- To control pigeon pea wilt, prior to sowing, undertake soil application of *Trichoderma harzianum* @ 10 g in 1 kg of FYM.
- Grow high yielding varieties with pest/disease tolerance like Asha (ICPL-87119) -wilt and pigeon pea sterility mosaic tolerant for Andhra Pradesh and Karnataka, and Bahar for Varanasi area of UP.
- Sow crop on ridges for suppression of *Phytophthora* disease at Varanasi (Uttar Pradesh).
- During September, install in the fields pheromone traps @ 10/ha.
- Erect bird perches @ 25/ha for facilitating predation of *Helicoverpa* larvae.
- Undertake one spray of neem oil (2%).
- Apply Neem Seed Kernel Extract (5%) each in September and October.
- When small larvae are noticed, spray *Ha*NPV @ 500 ml/ ha (2 x 10^9 POB/ml) in September and October.

For more details contact:

Director
National Research Centre for Integrated Pest Management (ICAR), Lal Bahudur Shastri Bhawan, IARI Campus, Pusa, New Delhi-110 012

- Shake plants for 4-5 times a day starting from October.
- Undertake need based spray of Endosulfan @ 2 litre/ha in areas around Varanasi, UP.

RAPESEED -MUSTARD (*RAYA SARSON*)

The oilseeds crops and primarily rapeseed and mustard are the major source of edible oils in the Indogangetic plains. The major pest problems like aphids and white rust are mainly managed by advancing date of sowing. Sowing of crop in second and third week of October provides aphid free growing period and can enable the farmers to grow it under pesticide free umbrella.

Key Pests and Diseases

The mustard aphid (*Lipaphis erysimi*) is the key pest of this crop. Hence the IPM strategy is primarily based on the control of this pest.

IPM Approach

- Undertake early sowing of crop (between 15-25 October).
- Grow tolerant varieties like T 59, RLM 198, RL 1359 to save the crop from mustard aphid infestation and grow Vaibhav, Vardan varieties to the save the crop from attack of white rust.
- Monitor the crop after every 10-15 days to find out the extent of damage, if any by aphids. Remove twigs heavily infested by aphids without disturbing the whole plant so as to check its proliferation.
- Mechanically remove, preferably on community basis, twigs and leaves harbouring Hairy Caterpillar.
- To control white rust caused by *Albugo candida*, carry out three sprays of Dithane-M-45 or Ridomil @ 0.2% solution after a gap of 15 days each, when the crop is 50 to 60 days old.

For more details contact:

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National Research Centre for Integrated Pest Management (ICAR), Lal Bahudur Shastri Bhawan, IARI Campus, Pusa, New Delhi-110 012

CABBAGE

Cabbage is mainly infested by Diamond Black Moth and Black rot. Use of Neem seed kernel extract and Pongamia soap solution, use of healthy seedlings, light trap augmentation of *Colesia mutellae* are some of the approaches to reduce chemical pesticides use.

Key Pests and Diseases

Diamond Back Moth (*Plutella xylostella*), leaf webber (*Crocidolomia binotalis*), stem borer (*Hellula undalis*), black rot (*Xanthomonas compestris*), aphids (*Brevicoryne brassicae*) and soft rot.

IPM Approach

Nursery

- About two to three weeks before sowing, undertake soil solarization of nursery beds with polythene sheets (60-100 gauge).
- Add 50 g of *Trichoderma harzianum* to FYM and mix in 1 m^2 of nursery beds to prevent infection from soil and seed borne fungal diseases.
- Soak 1 kg seed in 100 ppm Streptocycline sulphate solution for 15 minutes before sowing to prevent the black rot infection.
- Use nylon nets in nursery beds to avoid entry of white fly, aphids etc.

Main field

- If Diamond Back Moth (DBM) population is observed at early stage after transplanting, spray *Bacillus thuringiensis* @ 500g/ha and repeat it after every fortnight.
- Starting from 30 days of transplanting, take up inundative releases of *Trichogramma bactrae* @ 0.5-0.75 lakh/ha at weekly interval. Four to five releases will be required.
- Periodically remove Alternaria affected bottom leaves.
- Spray Chlorothalonil @ 0.2% incase the *Alternaria* disease is severe.
- Periodically remove black rot affected heads. If the disease is severe, then spray Blitox 0.2%+100ppm Streptocycline sulphate/ ha.
- Spray of Neem seed kernel extract (5%) or Pongamia soap solution for the management of Diamond Black Moth.

For more details contact:

Director
National Research Centre for Integrated Pest Management (ICAR), Lal Bahudur Shastri Bhawan, IARI Campus, Pusa, New Delhi-110 012

TOMATO

Tomato is highly susceptible to diseases and pests. The most prevalent among those are fruit borer, whitefly, tomato leaf curl virus, Alternaria blight, collar rot, and bacterial leaf spot. A comprehensive pest and disease management module has been developed by the Indian Institute

of Vegetable Research (IIVR), Varanasi with least use of chemical pesticides. Beside use of bioagents in management of pest and disease, this IPM approach can reduce the pesticide residue to a tolerance level.

Soil solarizations of nursery beds

IPM TECHNOLOGY

Nursery

- Undertake soil solarization of nursery bed as well as main crop field.
- Use disease/bacteria free seeds collected from healthy plants.
- Treat seeds with *Trichoderma harzianum* @ 4 g/kg of seeds and also with Imidacloprid @ 3 g/kg of seeds.
- Cover the nursery bed with nylon net (of 200 gauge) or muslin cloth for 25–30 days.

Main field

- Plant one row of marigold for every 16 rows of tomato.
- After 45 days of transplanting apply 2–3 sprays of NSKE (4%) at 10 days interval.
- Monitor fruit borer (*Helicoverpa*) adults through pheromone traps @ 4 traps/ha and release *Trichogramma pretiosum* @ 50,000 adults/ ha per release (3–4 times) at weekly interval when adults are noticed in the trap.
- Spray NPV 250 LE (1.5×10^{12} POB)/ha 2–3 times at 6–7 days interval in the evening.
- In case of collar rot, uproot disease infected plants along with infested soil and burn it.
- Give two sprays of Streptocycline @ 150 ppm followed by foliar spray of Blitox–50 @ 0.3% to control Alternaria blight, collar rot and bacterial diseases.

ECONOMICS

By adopting the above IPM technology,the cost benefit ratio is around 1: 2.09. The produce obtained by the IPM is much safer in terms of pesticide residue as well.

For more details contact:

Director
Indian Institute of Vegetable Research (ICAR)
1, Gandhinagar (Naria)
P.O. Box No. 5002,
Post Office BHU
Varnasi 221 005

AVAILABILITY OF TRICHODERMA

Trichoderma is available with several ICAR Institutes, State Agricultural Universities and Plant Protection Department of States and the Central Government.

It is also available with several private firms like Pest Control (India) Limited, No. 36/2, Sriramnahalli Rajankunte (P.O.) P.O. Box No. 6426, Yelahanka, Bangalore; Biotech International, New Delhi; Excel Industries; Anu Biotech International etc. with different brand names.

BRINJAL

Infestation of brinjal shoot borer

Brinjal shoot and fruit borer (*Leucinodes orbonalis*) are the most important insects in cultivation of brinjal as these may cause more that 80% damage if left unprotected. Farmers often resort to frequent insecticide application and spending approximately Rs 12,000 to 15,000 per season on insecticides. This increases the insecticide resistant level without much satisfactory control of the pest. The Indian Institute of Vegetable Research (IIVR), Varanasi has developed Sex Pheromone based Integrated Pest Management (IPM) Technique in which there is least use of insecticides and thus reduces the chances of health hazards caused by insecticides residues. Besides, the cost of plant protection is also less compared to chemical insecticides. The natural enemies are more abundant causing higher parasitization of the pest.

Sex pheromone baited traps in brinjal field

PACKAGE OF PRACTICES

- Keep seedlings free from pest infestation by raising the nursery under nylon net cover.
- Treat the seedlings by putting the root zone in Imidacloprid solution (1 ml/lit) for 3 hours.
- Starting from 25 days after transplanting, remove and destroy the borer infested shoots at weekly interval along with the insect larvae.
- Install sex pheromone baited pheromone traps @ 100/ha at 10 m distance from each other and 5 m away from the crop border. Plastic funnel trap may be used for trapping the moths. The traps should be installed at such height that the pheromone septa remains just above the plant canopy. Increase the height periodically to retain the relative height of the traps as the plants grow taller. The septa should be

changed at 50–60 days interval. The trapped moths should be killed at weekly interval.

- Remove the dry leaves at weekly interval and keep the crop clean.
- During each harvesting, the early infested fruits should be plucked and the larvae inside the fruits should be killed.

ECONOMICS

In comparison to farmer's practice of applying insecticide mixtures atleast 5–6 times per month, by adopting sex pheromone based IPM technique, the damage can be reduced by 20–25%.

AVAILABILITY OF SEX PHEROMONE AND PHEROMONE TRAP

Sex pheromone septa and pheromone trap of brinjal shoot and fruit borer may be had from Bio Control Research Laboratories, Pest Control (India) Limited, 36/2, Sriramnahalli, Rajankunte (P.O.) P.O. Box No. 6426 Yelahanka, Bangalore 560 064.

For more details contact:

Director
Indian Institute of Vegetable Research (ICAR)
1 Gandhinagar (Naria)
Post Box No. 5002
P.O. BHU
Varanasi 221 005

COCONUT

The coconut crop is attacked by several pests. The Central Plantation Crops Research Institute (CPCRI), Kasaragod has developed an integrated pest management (IPM) technology.

RHINOCEROS BEETLE (*Oryctes rhinoceros*)

This is one of the major insect pests of coconut palm. The adult beetle damages the palm by boring through the unopened spindle, inflorescences and petiole. The damage of spindle on unfolding presents the typical 'V' shaped geometric cut pattern. The IPM package includes:

- By using a beetle hook, extract adult beetles, during the peak period of pest abundance (June-Sept.) from crown of all the palms. Holes should be filled with Dithane M–45, 3 g mixed in 1 kg fine sand.
- Treat all possible breeding sites of the insect (Farm Yard Manure dump, fallen coconut logs, etc.) with 0.01% Carbaryl (50% WP) on w/w basis.
- Dispose of all breeding grounds of beetle.

Adults of Rhinoceros beetle

Characteristics 'V' shaped cut caused by Rhinoceros beetle

- As a biological suppression of the pest, release 10–15 beetles inoculated with *Oryctes* virus in one ha of garden. During monsoon period, apply 5×10^{11} spores of *Metarhizium anisopliae* fungus/cubic meter area of the breeding site of the pest.
- Carry out leaf axil fillings with 12 g naphthalene balls/palm covered with sand at 45 days interval.
- Set up breeding traps using decaying organic debris treated with *0.1%* Carbaryl 3–4 times a year.

RED PALM WEEVIL (*Rhynchophorus ferrugineus*)

Red palm weevil is a serious tissue borer pest of the coconut, capable of causing damage to the crown and bole regions of the palm. Infestation, if undetected, kills the palm outright by toppling the crown. All the stages of the insect are completely hidden inside the palm. The apodous grubs are the damage inflicting stage. *IPM* package includes:

- Clean palm crown periodically to avoid decaying of organic debris by cutting and splitting. Burn red palm weevil infested palms.
- Treat the wounds on the palm with Coal tar + 1% Carbaryl or *0.1%* Endosulfan.
- Treat bud rot and leaf rot diseases with recommended fungicides and insecticides. While cutting the leaves, leave 120 cm long petiole.

Prophylactic leaf axil filling with 20 g Phorate (10 g in 200 g of fine sand) or with 250 g marotti oil cake + 200 g of fine sand in leaf axils around spindle during May, September and December.

- Adopt curative treatment of infested palms with 0.1% Endosulfan/ Dichlorvos or 1% Carbaryl. Introduce the chemical into the palm by a funnel inserted into a hole drilled slantingly downward on the stem at about 15 cm above the infested portion. After the chemical application a 45 days waiting period must be given for harvest.
- Trap floating population of the weevil by using coconut logs treated with fermented toddy (@ 10 traps/ha) or with mud pots containing sugarcane molasses 2.5 kg or toddy 2.5 lit + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/logs of green petiole at the rate of 75 numbers/ha. The traps should be kept in the evening. Trapped weevils must be killed next day morning.
- Set up pheromone traps. Use Five litre plastic bucket and make four windows (2.5 × 5.0 cm) equidistantly just below the upper rim of the bucket. Stick jute cloth (gunny) on the outside of the bucket to provide better grip for the attracted weevils to get into the bucket.

  Hang the pheromone lure on the inner side of the lid using a metal wire. Provide a food bait of pineapple 100 g or 100 ml of toddy, yeast 2 g or jaggery and carbaryl 5 g mixed in 1 liter of water in the bucket. Hung the traps at about 1.0 to 1.5 m above the ground. Undertake once in a week, servicing of the traps and replacing it with fresh food bait. One trap per hectare is recommended, and the trap should be shifted from place to place. Placement of the traps on young palms (less than 10 year old) should be avoided.

LEAF EATING CATERPILLAR (*Opisina arenosella*)

In certain areas, leaf eating caterpillar is a major endemic pest. The larvae of this insect feed on the undersurface of the leaflets within silken galleries resulting in considerable reduction of photosynthetic area. This leaf-eating caterpillar can be managed by biological control methods. In an epidemic outbreak, IPM method as recommended below should be followed.

- Cut and burn badly infested outer leaves/leaflets.
- Spray less toxic insecticide like 0.02% Dichlorvos, when the pest is in active larval stage.

- Release larval parasitoids *Goniozus nephantidis* @ 20.5%, pre-pupal parasitoids like *Elasmus nephantidis* @ 49.4% and *Brachymeria nosatoi* @ 31.9% respectively at fortnightly intervals depending on the larvae, pre-pupal and pupal population of *Opisina*.

ERIOPHYID MITE (*Aceria guerreronis*)

The mites are very small (about 250 microns in size) and harbour on the tender meristematic regions of the nuts underneath the perianth. The mites suck the sap from the tender nuts resulting in appearance of elongated triangular white patch below the perianth, which first becomes pale yellow and with the advancement of the mite infestation to brown. Severe infestation leads to poor development of the nuts with reduced kernel weight and poor quality fiber. The following measures should be adopted:

Chemical Pesticide

Spray micronised Wettable Sulphur at 0.4% concentration or 0.2% Triazophos or 0.1% of Endosulfan or Dicofol or 0.05% Carbosulfan.

Botanical pesticides

Spray 2% Neem oil, Garlic and soap mixture or 0.004% Azadirachtin. Prepare Neem oil, Garlic and soap mixture (Neem oil–20 ml, cleaned garlic pearls–20 g, washing soap–5 g, water–1 liter). Dissolve the soap in 500 ml of water, add neem oil to this solution and mix it well until emulsification occurs. In another 500 ml water, mix the well ground garlic and add this to the soap-neem oil by sieving through a cloth. Stir the whole contents well. Spray it on the same day.

The mite colonies are harboured on the inner soft tissues of the developing nuts covered by the perianth. Therefore, pesticide spray should be focused on the perianth regions from the top to provide the maximum possible accessibility to the perianth lobes through capillary action. The droplet of spray should be fine and about 250–500 ml/palm of spray solution is sufficient. Nuts of 2–7 months alone need to be sprayed during April-May, Oct.-Nov. and Dec.-Jan., in such a way that all mite infested palms in an area are covered at the shortest possible interval. Mature bunches should be harvested before the pesticide application. Unpollinated bunches should not be sprayed.

For more details contact:

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MANGO

Mango orchards are attacked by several pests leading to poor quality of fruits and low returns to the orchardists. The Central Institute for Subtropical Horticulture (CISH), Lucknow has developed a calendar of operations for integrated pest management. The recommended month wise operations are listed below to facilitate easy comprehension and adoption.

Spraying on mango plants

January

- Clean at regular intervals the alkathene bands already fastened on tree trunk to manage mango mealy bug.
- To control inflorescence midge, spray Fenitrothion (0.05%) or Dimethoate (0.045%) or Monocrotophos (0.04%) at the bud burst stage.
- If necessary, carry out second spray with above insecticides after a fortnight.

February

- For control of hoppers, carry out first spray with carbaryl (0.2%) or monocrotophos (0.04%) or chlorpyriphos (0.04%) or dimethoate (0.06%). Undertake pruning and destruction of inflorescence infested with inflorescence midge.
- Clean polythene bands at regular intervals.

March

- If necessary, carry out second spray with any of the insecticides above for control of mango hoppers.

April

- To look after the grafted seedings, if necessary, spray Carbaryl (0.2%) or Monocrotophos (0.04%) to control leaf cutting weevils.
- Hang methyl eugenol bottle traps (methyl eugenol 0.1% + malathion 0.1% solution) for monitoring of fruit fly and its control.

May

- Change bottle trap solution at weekly intervals.

June

- Change solution in methyl eugenol traps at weekly intervals.

- Undertake early harvesting of mature fruits to avoid fruit fly infestation.
- Collect and destroy fruit fly infested fruits.

July

- Change solution in methyl eugenol bottle traps at weekly intervals.
- Collect and destroy fruit fly infested fruits.
- Carry out deep ploughing of orchard immediately after harvest to expose eggs and pupae of mealy bug and inflorescence midge.
- If required, spray Monocrotophos (0.04%) or Dimethoate (0.06%) to control scale insects in the second week. This will take care of infestation of leaf eating weevil and shoot borer.
- Prune and destroy shoots infested by shoot borer.

August

- Remove webs (made by leaf Webber) by 'leaf web' removing device and burn them.
- Prune overcrowded and overlapping branches to control leaf Webber.
- Spray Carbaryl (0.2%) or Monocrotophos (0.04%) or Quinalphos (0.05%) in case of heavy infestation of leaf Webber. These insecticides will also control infestation of shoot gall psylla.

September

- If necessary, undertake second spray of one of the insecticides mentioned above (in August) for control of shoot gall psylla and leaf Webber.

October and November

- Flood orchards to destroy eggs of mealy bug, dia-pausing pupae of midge and fruit fly.
- Prune shoots and branches infested with leaf Webber and shoot gall psylla, if required.
- Carry out deep ploughing of the orchards to expose eggs and pupae of insects and to remove weeds which harbour pests and diseases.

December

- Fast 25 cm. wide alkathene sheet of 400 gauge thickness around the base of tree to control mealy bug.

- Rake soil around the tree trunk and mix neem cake for management of mealy bug nymph or apply Chlorpyriphos dust (1.5%) @ 250 g per tree.

PRECAUTIONS IN ORCHARD MANAGEMENT

In order to carry out efficiently the operations listed month-wise, it is necessary to adopt several precautions as well. These are:

- Planting at proper distance.
- Training and pruning.
- Clean cultivation.
- Intercultural operations at regular intervals.
- Avoiding spray at full bloom.
- Avoiding use of pesticides which damage the pollinating agents.
- Avoiding use of synthetic pyrethroids.
- Preferable use of neem based pesticides, predators and parasites in orchards.

Availability of Bio control Agents

1. Director, National Centre for Integrated Pest management (ICAR), Lal Bahadur Shastri Bhawan, IARI Campus, Pusa, New Delhi 110012.
2. Project Director, Project Directorate of Biological Control, PB No. 2491, Hebbal, Bangalore – 560024.
3. Director, Central Rice Research Institute, Cuttack -753 006 (Orissa).
4. Director, Directorate of Oilseeds Research, Rajendra Nagar, Hyderabad-500 030.
5. Director, Indian Institute of Horticultural Research, Hassaraghatta Lake Post, Bangalore-560 089.
6. All State Agricultural Universities.
7. Biotech International Ltd., 'VIPPS Centre', 2-Local Shopping Centre, Block-EPGH, Masjid Moth, GK-2, New Delhi-110 042.
8. Excel Crop Life India Ltd., 705-707, Navrang House, 21-Kasturba Gandhi Marg, New Delhi.
9. Pest Control India Pvt. Ltd., 36- Yusuf Building, MG Road, PB No. 1510, Mumbai

For more details contact:

Director
Central Institute for
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Lucknow 227 107

INTEGRATED MANAGEMENT OF IMPORTANT DISEASES AND PESTS OF POTATO

Potato is affected by a large number of fungi, bacteria and viral pathogens depending upon the region. Late blight is the most important disease followed by mosaic/leaf roll viruses and bacterial wilt. The Central Potato Research Institute (CPRI), Shimla has developed technology of integrated management of important pests and diseases.

VIRAL DISEASES

Depending upon the type and extent of viral diseases, yield losses vary from 10 to 80%. The viruses show a wide range of overlapping symptoms individually and/or in various combinations, such as super-mild, transient, typical green or yellow, mild/severe mosaics mottle and to generate chlorosis of plants, coupled with various types of foliage discolouration/distortion. Due to differences in the nature of spread and growth of viruses, a number of indirect and direct measures need to be adopted. The indirect measures can help in maintaining better health of the crop for a longer period by selecting the seeds with the following measures:

- Aphid free location
- Use of certified healthy seed
- Tissue cultured virus eliminated tubers

Late blight attack on potato

FUNGAL DISEASES

Among the fungal diseases, late blight, early blight and phoma leaf spots are important. Late blight (*Phytophthora infestans*) is one of the most devastating diseases of potato, the losses may go as high as 85% in hilly regions, if crop remains unprotected. Late blight affects all plant parts -leaves, stems and tubers. The early blight (*Alternaria solani*) infects leaves and tubers. The symptoms include brown, circular to irregular depressed lesions. The symptoms of leaf spots (*Phoma exigua*) are alternate

light and dark concentric zones of 1 to 2.5 cm in diameter and those with (*Phoma sorghina*) numerous pinhead size spots appear.

To control late blight, the following measures should be adopted:

- In late blight endemic areas of plains, grow resistant varieties like Kufri Badshah, Kufri Jyoti, Kufri Sutlej, Kufri Jawahar, Kufri Anand, Kufri Chipsona-I, Kufri Chipsona-II and Kufri Pukhraj. For hills, Kufri Megha (Khasi hills), Kufri Giriraj (HP hills), Kufri Swarna, Kufri Thanamalai (Nilgiri hills) and Kufri Kanchan (Darjeeling and Sikkim hills) are recommended.
- Use disease free seed and follow proper earthing up.
- Spray the crop with Mancozeb (0.2%) 2–3 times during the crop season.
- In hills, two additional sprays of Ridomil (0.25%) + Sticker (0.1%) may also be given.
- Stop irrigation under cloudy conditions.
- Remove the haulms and bury them in pits at 75% disease severity.

In case of other leaf spot diseases, apply balanced dose of fertilizers, especially Nitrogen. Spray 1% Urea at 45 days and give subsequent sprays after 8–10 days. Discourage collateral solanaceous hosts near potato fields to reduce disease inoculums.

To control tuber born diseases, use healthy seed, adopt crop rotation with cereals, millets and non-solanaceous crops. Follow hot weather cultivation or soil solarization in plains and plateau, and cold weather cultivation in hills. Harvest crop before soil temperature rises above 28°C, thereafter, cure tubers for 8–10 days at 10–15°C and store them in cool, ventilated places.

BACTERIAL DISEASES

The bacterial wilt (*Ralstonia solanacearum*) is characterized by wilting of the plant, vascular rot and pitted lesions in tubers occurring in patches in the field causing losses upto 30–70%. The disease is present in Northeastern hills, Eastern plains, Northwest mid hills (upto 2,000 m), Deccan plateau and the Nilgiri hills. Though bacterial wilt is difficult to control, yet, it is recommended to adopt the following measures:

- Grow disease free seed in disease free areas.
- Include in the crop rotation non-solanaceous crops like, cereals onion, garlic, cabbage, knolkhol, horse gram, etc.
- Drench the infested areas with stable bleaching powder @ 12 kg/ha.

- Undertake blind earthing up.
- Cold weather/hot weather cultivation also reduces disease incidence.

INSECT–PESTS

In each region, there are certain key pests that must be specifically targeted for control.

Aphids (*Myzus persicae*) can injure potato plant directly by sap feeding and are capable of transmitting several important potato viruses. The primary concern with aphids is usually their role as vectors in transmitting viruses. This aphid has different summer and winter hosts (peach). The eggs are laid on the winter hosts in the autumn and in the spring; the young aphids fly from these plants to their diverse summer hosts, one of which is the potato. They may be winged or wingless and under favourable conditions, aphids can propagate very rapidly. Dimethoate and Metasystox @ 0.03% are recommended as remedial control measures.

White flies

These insects act as a vector mainly for potato gemini viruses in plains. To prevent population build up of this pest, give prophylactic sprays of Dimethoate, Methyldemeton or Imidacloprid.

Potato tuber moth

The caterpillars of potato tuber moth can cause damage to potato, in particular to the tubers, in warm areas, both before harvest and during storage. The caterpillars first make mines in the leaves, leaf veins and stems. This pest can cause 100% damage to the stored tubers. Most damage in the field occurs just prior to harvest, especially when vines dying naturally are left over the rows. To prevent tuber injury, the following measures should be adopted:

- Ensure adequate hilling without cracks in the soil.
- Spray crop with synthetic Pyrethriods or Monocrotophos to kill the moths and caterpillars.
- Spray storage areas, too, if potatoes are to be stored at temperature above 10°C.
- Remove infested tubers before storage.

- Protect stored potatoes from egg laying females by wire mesh screens placed over any potential entry point into storage facilities.
- In stores, save tubers by covering them with dry leaves of *Ageratum, Eucalyptus* or *Lantana*.

White grubs

These are polyphagous pests both in grub and adult stages and inflict heavy damage on various fruit/forest trees, their nurseries, vegetables, potato, lawns and field crops in hilly areas. The preventive measures are as follows

- Collection of beetles on flight trees on community basis during May-June.
- As soon as attack is noticed, spray @ 0.05% Methyl parathion or Carbaryl 0.1% or Monocrotophos 0.05% on flight trees.
- In growing crop, white grub damage can be minimized by applying Phorate or Chlorpyriphos at the time of earthing up during mid June.

Cutworms

It damages potato during dry seasons in hills (by *Agrotis ipsilon*) and in plains (by *A. segetum*). The larvae are active at night and rest in the soil during the day close to the stem of plants. The stems are injured underground or just above the soil line. Treat the soil with Chlorpyriphos 20 EC (2.5 liters/ha) when there is likelihood of damage.

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INTEGRATED DISEASE MANAGEMENT IN MANGO

Mango orchards are attacked by several diseases, leading to poor quality of fruits and low returns to the orchardists. The Central Institute for Subtropical Horticulture (CISH), Lucknow has developed a calendar of operations for integrated disease management.

January

- Protect plants from frost injury by irrigating the fields. Young plants should be protected by thatching the plants. Care should be taken that the east side of the thatch is kept open so that the sun light enters in the thatch at least for some time in the morning. To control mango malformation new flower buds or new growing panicles should be de-blossomed.

February

- Powdery mildew affected leaves and malformed panicles should be removed and burnt. Undertake first spray for control of powdery mildew with Wetable Sulphur @ 2 g/liter. Liquid soap is mixed with the solution so that the fungicide sticks well and makes it more effective. Generally 10–20 liters of solution is required for one plant, depending upon its age.

March

- Undertake second spray for the control of powdery mildew with Tridemorph (Calixin @ 0.1% i.e. 1 ml/liter). Care should be taken that the second spray is done before the opening of the flowers. In the third or fourth week of the month, Dinocap or Tridemefon (Karathane or Bayleton) @ 0.1% (1 ml or 1 g/liter) is sprayed. Third spray should be done when fruit set has already taken place. During this month, infestation of mango hopper also takes place. Joint control of powdery mildew and hopper can be taken.

April

- If blossom blight or anthracnose is visible on the panicles, Carbendazim (Bavistin) @ 0.1% (1 g/1iter) should be sprayed. Side by side, affected leaves and twigs should also be removed and burnt, so that the inoculums load is kept under control.

May

- Two to three sprays of Borax @ 1% are desirable for control of Black tip or Internal necrosis during this period. As the Borax is not easily dissolved in ordinary cold water, it should first be dissolved in small quantity of warm water and then the volume should be increased to

the desired quantity. For the control of latent infections on fruit, 1–2 sprays of Thiophanate methyle or Carbendazim (Topsin M or Bavistin) @ 0.1% (1 g/liter) may be done, to protect mango fruits from post harvest diseases. For the control of sooty mould, spray of a mixture of Wettable Sulphur + Monocrotophos + Gum acacia (0.2, 0.05 and 0.3% respectively) may be done. Indian Oil formulation (Tree

spray oil) with 3% concentration is also effective for control of sooty mould. If there is chance of bacterial canker disease on fruit, Streptocycline 200 ppm should be sprayed. Field sanitation and pruning of infected twigs should also be done during this month.

June

- Second spray of Streptocycline 200 ppm may be done for the control of bacterial canker disease.

July

- Spray of Copper-oxychloride @ 0.3% (3 g/liter) may be done in the third or fourth week to control anthracnose and red rust. Sterilize the nursery soil by treating soil with Formaldehyde and then cover with polythene sheet. Later on, polythene sheet should be removed and soil opened so that the leftover Formaldehyde gets evaporated from the soil. The mango stones should also be treated with Thiram or Captan @ 0.3%.

August

- Undertake second and third sprays at 15–20 days interval with Copper oxychloride @ 0.3% to protect the crop from anthracnose and red rust. Field soil treatment with Captan @ 0.3% to control seedling rots be also carried out. Provide for appropriate drainage of water in the nursery to reduce the chance of infection by root rot fungi. Undertake weeding to remove the collateral hosts of the *Sclerotium* or *Rhizoctonia*.

September

- One spray of Copper-oxychloride can be repeated, if there is more incidence of anthracnose or red rust. Undertake field cleaning and ploughing to control collateral hosts of several pathogens.

October

- For the control of die-back, infected and dried branches should be pruned in such a way that these are removed 5 to 8 cm below the dried portion. After pruning, apply Copper-oxychloride paste to the cut ends in nursery plants, while in case of grown up plants, spray Copper-oxychloride @ 0.3%. This spray also takes care of phoma blight and gummosis. For control of gummosis, 200–400 g of Copper sulphate can be applied depending upon the age of the plants. During

this month, apply recommended quantity of fertilizers to develop plant vigor and to protect from different diseases. For the control of mango malformation, spray 200 ppm of Naphthalene acetic acid in the first week of October.

November

- Undertake second and third sprays of Copper-oxychloride @ 0.3% to control die back disease. This spray also takes care of phoma blight.

December

- Protect crop from frost injury as per the operations indicated for January. For the control of mango malformation, carry out de-blossoming of new flower buds.

All these operations may or may not be necessary to be adopted by every orchardist. These operations are need based and depend upon severity of disease in different mango growing areas.

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GRAPE CULTIVATION FOR EXPORT

Grape is one of the most exotic fruits for centuries the world over. India has been exporting Grapes to Europe and Gulf countries, as well as to neighboring countries like Sri Lanka and Bangladesh. Newer markets for export are emerging in South-East countries through Singapore and Hong Kong centers. The Indian grape growers have been continuously adopting stringent quality control demands of the importers, by implementing new and advanced techniques in grape cultivation and post harvest management. The National Research Centre for Grapes (NRCG), Pune has developed package of practices for grape cultivation for export.

QUALITY STANDARDS FOR EXPORT

Export quality bunch of grapes

Table grapes meant for export need to look good and tempting. Therefore, the bunch should be well filled with berries of uniform colour and size. The characteristics of a good bunch generally preferred in export markets are:

- Loose bunches of uniform colour, size and shape, weighing between 400 to 600 grams.
- Fresh stalk, green, turgid and disease free.
- Damage free from scars or damage due to sun, diseases or pests.
- Berries of 16 to 18 mm diameter and firm to touch.
- Fresh and green pedicel.
- Total Soluble Solids (TSS) of 17–18°Brix
- Brix: acid ratio of 25 to 30 and no pesticide residues.

PACKAGE OF PRACTICES

Canopy development and quality improvement after foundation pruning (April)

- The vines should be given rest for about a month after harvest and thereafter all the canes are pruned by retaining only one basal node.

- Immediately after pruning, spray 1% Bordeaux mixture to kill the inoculums of pathogens. Thereafter, the buds are swabbed with Hydrogen cyanamide at the rate of 30 milliliters per liter to ensure early and uniform bud break.
- Keep 5–6 well-developed canes for each square meter area of canopy space. For this purpose only one shoot is retained on each node. This helps in avoiding competition for space, nutrients and sunlight while ensuring proper growth and maturity of the retained shoot and easier disease management.

Quality improvement after fruit pruning (October)

- Five to seven days earlier to pruning, all the leaves may be removed and the canes twisted to activate the dormant auxiliary buds.
- Vines are then pruned just above the fruitful bud. The short internodal length generally indicates the location of the fruitful buds that can be confirmed by bud testing under the microscope.
- After pruning, 1% Bordeaux mixture is sprayed and Hydrogen cyanamide is applied to the top 2 to 3 buds to induce uniform sprouting.
- At 3-leaf stage, if excessive shoot growth is observed, spray 250 to 500 ppm CCC spray.

The production of loose bunches is essential for export, which can be achieved by elongation of the rachis as well as by berry and bunch thinning. Rachis elongation can be induced before bloom by Gibberellic Acid (GA_3) application. The first spray of 10 ppm is applied at the parrot green stage of the cluster, followed by a spray of 15 or 20 ppm GA_3 after 4 to 5 days. Use about 400 to 600 liter solution per hectare for each spray. Subsequently the cluster should be dipped in 40 ppm GA_3 solution. To avoid short berries formation, care must be taken not to dip the clusters in GA_3 solution at full bloom or from full bloom to shatter stage, i.e. till the berries are 3 to 4 mm.

The rachii of the cluster need to be thinned out manually, immediately after berry set, retaining the top three branches and thereafter every alternate branch. Then, to increase the size of the berries, bio-regulator treatments should be given. The first treatment is given after the berry shatter stage, that is when the berries are about 3 to 4 mm in size and then after 7 days. The use of hormones generally depends upon the leaf area available per bunch. In case of adequate leaf area of about 15 leaves, the first dip should be with 2 ppm N–(2-chloro–4-pyridyl) –'N'-phenyl urea (CPPU) and 40 ppm GA_3. The second dip should be of 1 ppm CPPU and 30

Well raised vineyard before harvest

ppm GA_3. To harvest optimum yield of 15 kg of good quality fruits from a vine, the excess load is recommended to be removed.

Water management

Most of the new vineyards are coming on rootstock. In areas having the problems of salinity and water stress, rootstocks offer a better option for the survival and better economic returns from the vineyard in the long run. Since the growth stage influences the water requirement of the vines, an appropriate irrigation schedule based upon pan evaporation as given in the following table must be adopted.

Stage	Growth stage	Quantity of water (liter/ha) per mm of evaporation
	Foundation pruning	
I	Shoot growth (1–40 days)	4200
II	Fruit bud differentiation (41–60 days)	1400
III	Shoot maturity (61–120 days)	1400
IV	Fruit bud development (121 days to pruning)	1400
	Forward pruning	
V	Shoot growth (1–40 days)	4200
VI	Bloom to shatter (41–55 days)	1400
VII	Berry growth (56–105 days)	4200
VIII	Ripening (106 days to harvest)	4200
IX	Rest period (harvest to back pruning)	-

Nutrient management

Apply every year 660 Kg Nitrogen, 880 Kg Phosphorus (P_2O_5), and 660 Kg Potassium (K_2O) per hectare. However, by fertigation, the nutrient

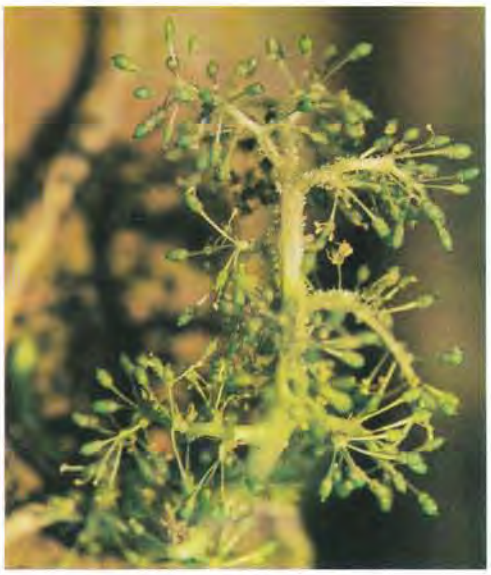
Growth stage	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
April pruning (Back pruning)			
Pre-bud differentiation (1–30 days)	80	–	–
Bud differentiation (31–60 days)	–	213	–
Post-bud differentiation (61–120 days)	–	–	80
October pruning (Forward pruning)			
Pre-bloom (1–40 days)	80	–	–
Bloom set and shatter (41–70 days)	–	107	–
Berry growth up to veraison (71–105 days)	80	–	80
Veraison to harvest (106 days to harvest)	–	–	80
After harvest (Rest period of nearly 20 days)	27	35	27
Total	267	355	267

requirement can be substantially reduced. The growth stage wise fertigation schedule given below need to be followed.

Disease management

Three major diseases in grapes are Downy Mildew, Powdery Mildew and Anthracnose. Under rain or high humidity conditions, Downy mildew can be very devastating from the 3rd leaf stage till fruit set. To control downy mildew, the following measures should be adopted:

- At the 3 to 5 and 7 leaf stages of the shoot growth, systemic fungicide sprays be undertaken.
- Give prophylactic sprays of non-systemic fungicides at 5 to 7 days' intervals from berry set till the berries develop to about 13 millimeter in diameter.
- Do not spray dithiocarbamate fungicides such as Mancozeb or Ziram after 75 days of pruning as it leads to residue of Ethyl thiourea which is a carcinogenic compound in berries.



Downy mildew affected bunch of grapes

Powdery mildew occurs both on the leaves and on bunches. For the crop to be exported, appropriate disease control measures must be undertaken, as due to blemishes on the surface of berries, its market value gets reduced. As soon as the symptoms of powdery mildew are noticed, spray systemic fungicides during the active vegetative growth. When the shoot growth stops after berry set, sprays of non-systemic fungicides should be preferred. To avoid development of resistance, do not spray more than 2 to 3 sprays of systemic fungicides per season.

A bunch of grapes affected by powdery mildew

Anthracnose occurs only on tender shoots, young leaves, flowers and young berries. If wet conditions prevail during the active growth stage, new shoots should be protected by systemic fungicides, followed by a spray of any copper fungicide. The infected canes are pruned before the fungicide sprays. Copper fungicides are preferentially sprayed as they can control downy mildew, anthracnose and bacterial canker which occur in wet weather.

Pest management

Mealy bug is a serious problem in grapes for export, as they grow on the mature bunches and make them unfit for export. Therefore, integrated management of mealy bug is essential. Adopt the following measures for its control:

- Undertake the manual removal of the dead bark during September and paste sticky substance in a ring on the trunk and the angle irons.

Anthracnose disease of grapes

Mealy bug on a grape bunch

- Sprays of insecticides during active growth of bunch, bio-control by cryptolaemus beetles near veraison and spray of the fungal mycoparasite *Verticillium lecani* after veraison.
- On the fourth day of fruit pruning, undertake spray of Carbaryl at the rate of 0.15% for control of flea beetle.
- At 50% bloom, a spray of any systemic insecticide can be given to control jassid and leafhopper.

POST-HARVEST MANAGEMENT

To prevent the rotting of grapes during storage, these should be packed with in-package Sulphur di-oxide generators, commonly known as 'grape guard', which are Sodium metabisulphite impregnated craft paper/polythene sheets. Pre-harvest spray of the bio-control fungus *Trichoderma harzianum*, 20 and 5 days before harvest or immediately after pre-harvest rains also gives good control of post-harvest rot and increases the shelf life of grapes.

In order to obtain phyto-sanitary certificate required for export of grapes, report on pesticide residue analysis has become mandatory. Some strategies which can be adopted to minimize pesticide residues are:

- Use only the approved pesticides.
- Do not spray banned as well as non-recommended chemicals.
- Strictly adhere to the recommended dose of application.
- Do not spray pesticides blindly as per pre-decided spray schedules. Decide on the spraying based on prevailing weather conditions and growth stage of vines.
- Strictly maintain recommended Pre-Harvest Interval or Safe Waiting Periods.
- Adopt bio-control measures during last 30 days before harvest.

HARVESTING

The grapes should be harvested in clean plastic crates, lined with bubble sheets or other soft material for cushioning. While harvesting, the bunch is held by the stalk and not by the berries and cut above the knot present on the stalk, which ensures a longer shelf life. Harvesting is stopped before the temperature rises above 20°C.

QUALITY CONTROL AND PACKAGING

In the pack house, grapes should be unloaded and tested for quality. Strict hygiene is maintained in the pack-house. The bunches are first graded by size, then the undersized, deformed or damaged berries as well as the water berries are removed. The compact bunches are made loose and the general look of the bunch is improved by selective removal of berries. Bunches are then graded, based on more objective parameters like berry diameter and the uniformity in colour of the bunch. The graded bunches are packed in four and a half, five or in nine kilogram lots as per the requirement of the export and the domestic market.

View of a pack house

Use the boxes made of 4 to 5 ply cardboard which can be interlocked while stacking. The process of cleaning, grading, packing and sending the grapes for pre-cooling should be finished within 6 hours of harvesting. After packing, the boxes are labeled and pre-cooled to 4°C, within 6 to 8 hours and then cold stored at 0± 0.5°C and with 95% Relative Humidity. Before shipment, the boxes are stacked to form pallets containing 850 kg of grapes. Once fully loaded and sealed, the container carrier leaves for the nearest port to reload the container on to a ship, where it is taken to its intended destination.

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LOW COST INPUT TECHNOLOGY FOR POTATO PRODUCTION

Large scale potato production–
Farmers' sorting potatoes

Potato is one of the most input intensive crops. At the optimum level of adoption of inputs and cultural operations, about 35–40% of the cost is for seed, nearly 40% for labour, 14% fertilizers and manure, and 7% for irrigation. Therefore, the Central Potato Research Institute (CPRI), Shimla has developed low cost input technology. By its proper adoption savings can be on labour, seed, tillage, fertilizer and irrigation inputs in potato *per se* as well as in the potato based cropping system.

TILLAGE

- Practice minimum tillage. Go in for green manuring during *kharif* season, and then one harrowing followed by one planking for land preparation to sow potatoes. Make ridges right at planting to save cost on second earthing up.
- Saving in land preparation could also be affected in wheat following potato since the soil tilth is greatly improved at the time of harvesting of potato. Use low cost implements being developed by CPRI like peg type intercultivator, rotary peg type intercultivator, rotating blade type inter cultivator, and cup type potato planter.

SEED

- Use small size seeds with an adjustment in the planting geometry to reduce the seed requirement by about 50%. The large size tubers can also be effectively planted by increasing the plant spacing.

FERTILIZERS

- Grow high yielding varieties requiring low fertilizer input. Apart from using nutrient efficient varieties, make judicious choice of source of nutrient and method of application.

- Application of urea a day before planting mitigates the injurious effect. Apply half of the recommended dose of Phosphorous (P) at planting and the other half through foliar spray to enhance its efficiency and reduce the dose. Considerable saving in P fertilizers can be achieved by soaking seed tubers for 4 hours in 1.5% Single Super Phosphate + 0.5% Urea along with a suitable fungicide.
- In wheat following potato, apply only half of the recommended Nitrogen and no Phosphorous and Potash as their requirement is met out of the residues left by potato crop.

WATER MANAGEMENT

- Apply irrigation in a judicious manner. In medium textured soils, irrigate at critical soil moisture deficit of 25 mm,which reduces the water requirement by 100 mm. Adopt alternate furrow irrigation by which 25–35% water saving can be achieved, but there could be about 10% decrease in yield.
- If labour is easily available and cheap, practice paddy straw mulching which can save 1–2 irrigations.

WEED MANAGEMENT

Many of the cultural operations are complimentary to each other. Weed control is one such operation, which is benefited by many other cultural operations. Hot weather cultivation, recommended for control of soil borne pathogens also mitigates the problem of weeds. Similarly, mulching for water economy reduces the weeds.

PESTS AND DISEASE MANAGEMENT

Late blight is the most serious disease affecting the crop in the northern Gangetic plains. Adopt high yielding resistant varieties. Use healthy seed and go in for hot weather cultivation along with adoption of appropriate crop sequences to minimize the problem of pest and diseases.

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PACKAGE OF PRACTICES FOR CULTIVATION OF SAFED MUSLI

Safed musli

Recent years have seen a major spurt in the demand of medicinal plants not only with in the country but also for its export. More and more number of farmers are entering into this most potential sector. The National Research Centre for Medicinal and Aromatic Plants (NRCMAP), Anand has developed package of practices for cultivation of Safed musli.

Safed musli (*Chlorophytum borivilianum*) is an important medicinal plant. The stem is a condensed disc from which a whirl of long and sessile leaves originate. Roots are fleshy and fasciculated and are medicinally important as it contains saponins, used for preparation of many Ayurvedic tonics. The roots fetch an attractive market price (presently Rs 600–1,000 per kg of dry peeled fleshy roots).

CLIMATE

It can be cultivated in areas having 500 to 1000 mm rainfall. Moderate atmospheric humidity is also desirable for its foliar growth and development. The plant is very susceptible to water logging.

SOIL

The crop requires sandy loam soil with better drainage condition. It can also be cultivated in black cotton soil, under proper drainage conditions. Sloppy land is good for its cultivation, provided frequent irrigation facility is available.

LAND PREPARATION

It should be grown in well pulverised soils. The field should be ploughed twice or thrice, harrowed once or twice and well levelled. The whole field should be subdivided in plots of suitable size, considering the slope to facilitate drainage of excess water.

PLANTING MATERIAL

It is recommended to plant about 2.22 lakh plants per hectare, which could be from about 600–1000 kg of sprouted plants. Quantity of planting material varies because of size of roots and sprouting percentage. Two to three roots with sprouted stem disc should be used for planting.

PLANTING TIME AND METHOD

Best planting time is just after onset of first rain in the season. Normally planting should be done between mid May to mid June, depending upon the onset of first rain. Undertake planting on ridges 30 cm apart and plant to plant distance of 15 cm.

VARIETIES

So far there is no released variety available for cultivation. However, some good selections are available in the private sector. The AICRP on Medicinal and Aromatic Plants, Anand has developed a few very promising selections.

MANURING

Apply 10–15 tonnes of FYM or farm compost per hectare to improve soil productivity and water holding capacity for good root development. Green manuring may also be undertaken to add organic matter and to improve soil structure.

INTERCULTURAL OPERATIONS

Frequent weeding (3–4 times) is recommended in the first two months after sowing/planting. Hoeing and earthing -up should be done after every weeding. Provide appropriate drainage to cope with heavy rainfall.

IRRIGATION

If rainfall is well distributed, there is no need of supplemental irrigation. However, in general about 6–8 irrigations are needed. No heavy irrigation is needed and water should not be allowed to stagnate in the field.

HARVESTING AND PROCESSING

Plants start withering after four to four and a half months from planting. However, harvesting should be done during November-December. Give time gap for maturation of roots. Apply light irrigation before digging of roots and its harvesting in December to January, if the material is to be used as a planting material. Yield varies from 2,000 to 6,000 kg per hectare depending upon the soil type, its fertility, moisture holding capacity, and management etc.

For sale as a raw material for drugs, the peeling of skin should be done immediately after harvest by mechanically scraping with a knife. Thereafter, it is dried in the sun. For use as planting material, store in sand in a cool place or in the soil under trees.

ECONOMICS

The approximate cost of cultivation of one hectare is about Rs 6 lakh. If the produce is sold as a raw material in the first year, there is every likelihood of a loss. Therefore, it is recommended that the first year production be again used as a planting material and area is increased. During the second year, the sale of produce can give about 100% net profit. The profitability is likely to increase manifolds, if the grower sells it as a planting material.

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Caution: Cultivation of medicinal plants is undertaken by first assuring its market. The growers may like to establish buy back arrangements to minimize the risk of distress selling.

PACKAGE OF PRACTICES FOR CULTIVATION OF ISABGOL

Isabgol

Recent years have seen a major spurt in the demand of medicinal plants not only with in the country but also for its export. More and more number of farmers are entering into this most potential sector. The National Research Centre for Medicinal and Aromatic Plants (NRCMAP), Anand has developed package of practices for cultivation of Isabgol.

Isabgol (*Plantago ovata Forsk.*) is an important medicinal crop grown during *rabi* season mainly in Gujarat, Madhya Pradesh and Rajasthan. The seed coat known as husk has medicinal properties and is used against constipation, irritation of digestive tract, etc. It is also used in food industries for preparation of ice cream, candy, biscuit, etc. At present, India is the sole exporter of the Isabgol husk and seed to the international market.

CLIMATE

Isabgol is a crop of cool and dry season. Unseasonable rain or, even high dew deposition during crop maturity can result in total loss of seed. The regions receiving winter rains are thus not suitable for its cultivation.

SOIL

The crop is traditionally grown in light sandy to sandy loam soils. However, it can also be successfully cultivated on clay loam, medium black cotton and heavy black soils. Good drainage is essential for its successful cultivation.

LAND PREPARATION

Fine tilth is necessary for better germination of the seeds. Depending upon the soil condition, the land should be ploughed and properly harrowed. The whole field may be subdivided into small plots (8–12 m × 3 m) depending upon soil type and slope.

SOWING TIME

Early sowing increases more vegetative growth while late sowing reduces total growth period and increases risk of seed shattering due to pre-monsoon rains towards maturity. Ideal sowing time is second fortnight of November. Drastic yield loss is encountered when sowing is delayed beyond first fortnight of December.

RECOMMENDED VARIETIES

The released recommended varieties and their sources of availability are given below:

Varieties	Source of availability
Gujarat Isabgol 2	Head, AICRP on Medicinal and Aromatic Plants, Gujarat Agricultural University, Anand, Gujarat.
Jawahar Isabgol 4 (MIB 4)	Head, AICRP on Medicinal and Aromatic Plants, KNK College of Agriculture, JNKVV, Mandsaur, Madhya Pradesh
HI 5	Head, AICRP on Medicinal and Aromatic Plants, CCS Haryana Agricultural University, Hisar, Haryana.

SEED RATE

Bold, disease free seeds from previous year's crop can be used for sowing. The optimum seed rate is 3–4 kg/ha. Higher seed rate may increase severity of downy mildew disease.

METHOD OF SOWING

Direct seeding (broadcasting) followed by light sweeping with a broom/ tree twig having foliage. The sweeping should be done by one-way swing. For uniform germination, care should be taken not to bury the seeds deeply in the soil.

IRRIGATION

A light irrigation with slow flow is given immediately after sowing. In case of poor germination even after 6–7 days, a second irrigation should be applied. In sandy loam soils, in general 3 irrigations are recommended—first at sowing and one each at 30 and 70 days after sowing. The last irrigation should coincide with the milk stage of the maximum number of spikes. In the drier region with light soil, more irrigation are to be applied. The plant can withstand low level of salinity, hence slightly saline water (EC upto 4 dS/m) can also be used for irrigation. Increase in salinity level beyond 4 dS/m reduces seed yield.

INTERCULTURAL OPERATIONS

Two hand weedings are generally required within two months of sowing, first weeding should be undertaken at 20–25 days after sowing.

MANURES AND FERTILIZERS

The crop requires very low level of Nitrogen. Hence, inorganic Nitrogen should only be applied if the available Nitrogen in the soil is less than 120 kg/ha. In general, application of 20–30 kg/ha of Nitrogen and 15–25 kg/ha of Phosphorous is optimum. Half of the Nitrogen and full dose of Phosphorous should be applied with the last ploughing and the remaining half of the Nitrogen should be top dressed at 40 days after sowing.

DISEASES AND INSECT-PEST MANAGEMENT

Downy mildew is the major disease of isabgol. Adoption of more than the recommended dose of Nitrogen, seed rate, and irrigation makes the crop more susceptible to this disease. The disease can effectively be controlled by (a) seed treatment with Metalaxyl (Apron SD @ 5 g/kg seed), and (b) spraying Metalaxyl 0.2% (Ridomil MZ) on first occurrence of disease, followed by two sprayings at 12–14 days intervals. Effective disease management can increase seed yield by more than 40% over the untreated crop. However, spraying of fungicides and insecticides must be stopped at least 45 days before harvesting to avoid pesticide residue problem in the produce.

Aphid is the major insect pest of this crop. Aphids generally appear 50–60 days after sowing. Two sprayings of 0.025% Oxydemeton methyl (Metasystox 25 EC) at an interval of 12–15 days can effectively check

the pest. The first spray should generally be done during first fortnight of February, as it increases seed yield by nearly 40% over unsprayed crop. The crop takes 110–120 days to mature. At maturity (by March-April) the leaves become yellowish and spikes turn brownish. To avoid the seed loss by shattering, slightly unripe spikes should be harvested, if there is a possibility of unseasonal rain. However, the husk quality of such a crop deteriorates.

HARVESTING AND YIELD

Harvest the spikes when dew dries (after 10 A.M.). The plants are harvested at the ground level or uprooted when soil is very loose. The harvested plants should be heaped on a clean threshing yard. After couple of days, the seeds are separated by trampling using tractor or bullock. The seeds can also be threshed by motor/tractor operated threshing machine (separating net of Bajra can be used). The seed yield of 800–1000 kg/ha is generally obtained in Gujarat. However, under favourable weather conditions and better management, higher seed yield is obtainable. Dry straw yield of twice the seed yield is generally harvested. Straw can be used as fodder for the farm animals.

MARKETING

There are still not many organized markets. In many areas group of farmers join together and sell the produce to get remunerative prices. The selling price varies generally between Rs 18–25 per kg depending upon the demand and quality of seed.

For more details contact:

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Boriavi 387 310 Anand

ECONOMICS

About Rs 10,000–12,000 net profit per hectare can be obtained.

Caution: Cultivation of medicinal plants is undertaken by first assuring its market. The growers may like to establish buy back arrangements to minimize the risk of distress selling.

PACKAGE OF PRACTICES FOR CULTIVATION OF ALOE VERA

Recent years have seen a major spurt in the demand of medicinal plants not only with in the country but also for its export. More and more number of farmers are entering into this most potential sector. The National Research Centre for Medicinal and Aromatic Plants (NRCMAP), Anand has developed package of practices for cultivation of *Aloe vera*.

Aloe Vera

Aloe vera is known by several names like Ghrit Kumari, Kunvar pathu and Indian Aloe and is widely cultivated because of its wide adaptability and use as a medicinal plant especially in dry areas. The succulent mature leaves having bitter juice are economic parts. Its primary use is in cosmetic industry for preparation of shampoo, face creams, shaving creams and moisturizing agents. It has also diverse use as vegetable and pickle. The leaves possess many medicinal properties and are used to treat fever, enlarged liver, and spleen and other glands, skin diseases, gonorrhea, constipation, menstrual suppressions, piles, jaundice, rheumatic diseases and also for the treatment of burns and bruises.

CLIMATE

It can be grown in almost all parts of India, even under constant drought conditions, except in temperate climate. As its water requirement is very low, it can be cultivated in arid and semi-arid region, especially in Rajasthan, Gujarat, Madhya Pradesh, and Maharashtra.

SOIL

It is grown successfully in marginal to sub marginal soils having low fertility. The plants have tendency to tolerate high soil pH with high sodium and potassium salts. However, its growth is faster under medium fertile heavier soils such as black cotton soils of Central India. Well-drained

loam to coarse sandy loam soils with moderate fertility and pH upto 8.5 should be preferred for its commercial cultivation.

LAND PREPARATION

The root system of Aloevera does not penetrate below 20–30 cm, therefore the soil should not be disturbed too deep. Depending upon soil type and agro-climatic conditions, 1–2 ploughing followed by leveling are recommended. The field should be divided into suitable plot sizes (10–15 m × 3 m) considering the slope and available source of irrigation.

PLANTING TIME

Suckers should be planted in July–August to get better field survival and subsequent growth. However, under irrigated conditions, planting can be done round the year except in winter months (November–February).

Planting Material

The planting material recommended for commercial cultivation are suckers. Nearly three to four months old suckers having 4–5 leaves and about 20–25 cm in length be used as planting material.

SPACING AND PLANTING

Suckers should be planted in about 15 cm deep pits made just at the time of planting at 60 × 60 cm apart. After planting of suckers, the soil around the root zone must be firmly pressed and appropriate care to avoid water stagnation should be taken. About 25,000 suckers are needed for one hectare planting.

MANURING

In general, the crop responds well to the application of manure (FYM or Compost). About 10 to15 tonnes FYM per ha may be applied at the time of soil preparation and also in the subsequent years. If sufficient quantity of wood ash is available, it can be applied in the pits at the time of planting as it helps in establishment of plants and their subsequent growth.

IRRIGATION

The crop withstands stress condition very well but to get good crop, irrigation at critical stages of growth as recommended below must be given.

- Apply first irrigation just after planting of suckers.
- Give 2–3 irrigations subsequently till the plants get established, 4–6 irrigations per year may be enough for its proper growth.
- Depending upon the availability of water, give light irrigation after each picking of leaves.

INTER-CULTURE OPERATIONS

The field should be kept free from weeds throughout the growing period. Two to three hand weedings followed by light hoeing per year promote growth and suckering. The first weeding cum hoeing should be completed within a month after planting. In the subsequent years, two weeding cum light hoeing in each year are sufficient to minimize the weed population. Remove regularly diseased plants and dried flower stakes.

INSECT-PESTS AND DISEASES

There are no major problems of insect pests and diseases, however, mealy bug and anthracnose and leaf spots have been reported from some parts of the country. If there is a termite problem, it can be managed by applying light irrigation.

HARVESTING AND YIELD

Commercial yield is available from second year to fifth year of transplanting. Generally 3–4 pickings per year be taken up, depending upon the growth. On an average 15–20 t/ha fresh leaf can be obtained from second year plantation by adopting fully the recommended practices for its cultivation. Fully developed mature leaves should be harvested for extraction of juice.

MARKETING

In view of international demand, there is now a lot of scope for its cultivation and marketing. However, ascertain its demand in the local/ distant markets before taking up its commercial cultivation.

PROCESSING

The term 'Aloe' used in medicine stands for the dried juice, which flows from the transversely cut bases of the leaves. For processing of "Aloe", the juice should be allowed to drain from the cut leaves into vessels and then concentrated by evaporation, either spontaneously or by frequent boiling. The fresh juice is colourless or yellow but changes to dark brown due to evaporation and boiling. Sun dried or concentrated "Aloe" juice over a fire gives an amorphous, opaque, waxy extract called 'hepatic' or 'livery' aloe. When the juice is concentrated rapidly over a strong fire, the product obtained on cooling is amorphous and semi transparent and is called 'glossy' or 'vitreous' aloe.

Besides the dried juice, the gel is also a very important product. The mucilaginous pulp from the leaf, which is mainly polysaccharides in nature, is used in cosmetic industries and in treatment of many human diseases. The leaves left over after the removal of their exudates can be cut open and mucilage is scraped out with a blunt edged knife for isolation of gel. Extracted mucilage is stirred vigorously in a blender to make it homogeneous mixture (solution). This mixture is strained through a muslin cloth and filtered. The gel is precipitated from the extract and is isolated by centrifugation. This gel is re-dissolved in slightly warm water and transferred to a tube of known weight and dried at a high temperature (< 100°C).

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ECONOMICS

A net profit of about Rs 8,000–12,000 per hectare from marginal to sub-marginal lands can be obtained by selling of leaves. The profitability may increase upto Rs 25,000 per hectare, when it is cultivated in medium fertile soil. In addition, one can earn by selling suckers as a planting material from second year onwards.

Caution: Cultivation of medicinal plants is undertaken by first assuring its market. The growers may like to establish buy back arrangements to minimize the risk of distress selling.

PACKAGE OF PRACTICES FOR CULTIVATION OF SENNA

Recent years have seen a major spurt in the demand of medicinal plants not only with in the country but also for its export. More and more number of farmers are entering into this most potential sector. The National Research Centre for Medicinal and Aromatic Plants (NRCMAP), Anand has developed package of practices for cultivation of Senna.

Senna

Senna (*Cassia angustifolia* Vahl.) leaves and pods are commonly used as natural laxatives, both in the modern as well as in traditional system of medicines. It is cultivated successfully in Tamil Nadu, Andhra Pradesh, Rajasthan, Gujarat, Maharashtra, Karnataka, West Bengal and Tripura. However, leaves of this plant are in demand internationally and preferred as ingredient of herbal tea in Europe.

It is a small 1–2 m high under-shrub, with erect stem, smooth, and pale green, with long spreading branches, bearing leaflets in four to eight pairs. The flowers are small and yellow. The pods are broadly oblong, about 5–8 cm long and 2–3 cm broad, and contain about six seeds. Presently it is cultivated in about 25, 000 ha of area. India is also the largest producer and exporter of Senna leaves, pods and total sennosides concentrate to the world market.

CLIMATE

Senna is usually cultivated as rainfed dry crop and very rarely grown as irrigated crop. It is a deep rooted hardy plant and requires warm and dry weather conditions. The plant requires bright sun shine and occasional rains during its growth period. It is highly sensitive to heavy rainfall and waterlogging conditions.

SOIL

Senna thrives well in sandy loam, red loam and even coarse gravelly soils, alluvial loam and rich clayey rice fields. It can be cultivated successfully

in black cotton soils. When grown in high saline soils, the plant growth is reduced without any symptoms of injury, but shedding of some lower leaves occurs. It can be successfully grown in soils having pH up to 8.5.

LAND PREPARATION

Senna does not require fine tilth. However, weed and pebble free land is recommended. The field should be twice ploughed, harrowed once or twice and appropriately levelled. Considering the slope the whole field should be subdivided into sub plots of suitable sizes, to facilitate drainage of excess water. It must be borne in mind that this crop can not survive waterlogged conditions even for a day.

SOWING TIME

The sowing time varies as per the onset of monsoon. However, in Western India, June–July is the optimum time of sowing. In the southern states, where crop is grown under residual moisture conditions, after harvesting of paddy, it can be sown in September–October. Delay in sowing time considerably reduces vegetative phase, especially in areas where winter sets by the end of October. As a result subsequent foliage yield is drastically reduced.

VARIETIES

ALFT–2 variety-a late flowering type, produces higher yield of foliage crop. A semi spreading type variety -Tinneyvelley senna is very popular in Tamil Nadu. Sona identified by the Central Institute on Medicinal and Aromatic Plants, Lucknow is also grown in some parts of Rajasthan.

Variety	Source of availability
ALFT–2	Head, AICRP on Medicinal and Aromatic Plants, Gujarat Agricultural University, Anand, Gujarat
Tinneyvelly senna	Director of Research, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
Sona	Director, Central Institute for Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh

SEED RATE

Fifteen kg seed per hectare is recommended in irrigated conditions and about 25 kg in rainfed condition to be sown by broadcast. Bold,

disease free and mature seeds should be selected for sowing. Seed should be treated with Thiram at 3 g/kg seed to avoid seedling diseases. Seed rate can be reduced if crop is grown as line sowing under irrigated condition. About six kg seeds per ha is sufficient for optimum plant stand when sown by dibbling.

METHOD OF SOWING

Adopt line sowing with 45 × 30 cm spacing for optimum yield in Western India. Utmost care should be taken to place seeds at a depth of 1–2 cm in soil through dibbling for uniform germination. One light irrigation immediately after sowing enhances germination up to 90% and maintains proper plant stand.

MANURES AND FERTILIZERS

Apply 10 tonnes FYM per ha at the time of land preparation. In the international market, Senna leaves grown organically get a premium price. Therefore, the growers may get certification of organically grown Senna for getting a premium price.

IRRIGATION

Depending upon the soil moisture condition, apply 4–6 irrigations. However, two irrigations are very crucial, one immediately after sowing, and the other at 30 days after sowing if soil moisture is inadequate.

INTERCULTURAL OPERATIONS

Two weeding cum hoeing operations, at 25–30 days and 90 days after sowing (thinning) are required. The growth of this crop is very slow at initial stage and requires more care. Once the plants attain 20–25 cm height, the weed growth gets suppressed automatically.

DISEASES AND INSECT-PEST CONTROL

In the north and western parts, the crop suffers from damping-off disease, when grown in ill drained soils. It is recommended to improve drainage conditions by ensuring proper slopes. Seed treatment with Thiram at 3 g/kg seeds is also beneficial. Leaf spot caused by *Alternaria alternata*

and leaf blight caused by *Phyllostica* spp. are the two most serious diseases. Cloudy days and humid weather conditions are conducive for the spread of the diseases, which first appear on the leaves as visible minute spots and later turn dark brown to black in color. In severe infections, leaves start drying and falling. Pods are also affected in advanced stage of disease development. Two to three sprayings of Dithane M–45 at a week's interval be carried out to check the disease. In such cases harvesting of leaves must be done after 25–30 days of the last spray.

Occasionally, *Catopsilia pyranthe* causes severe damage to foliage by feeding on the leaves and remains active from July to October. In nature, these are heavily parasitized by *Trichogramma chilonis*. Therefore, release of *T. chilonois* @ 1.5 lakh/ha/week in the adult stage coinciding with the egg laying of the pest is a very effective method of this pest management.

CROP ROTATION

Senna fits well as a *kharif* crop in a crop rotation in commercially grown areas. In the southern states it is grown after paddy, and in north and western India it is followed by mustard and coriander.

HARVESTING AND YIELD

Harvesting should be done when bulk of the leaves are fully grown, thick and bluish in color. Mature leaves containing 2.0 to 2.5% and pods containing 2.5 to 3.0% of sennosides are accepted in the industry. When grown under irrigated conditions three harvestings are advised to get the maximum yield. Take first harvest after about 90 days of sowing and the second and third harvest at 150 and 210 days after sowing, respectively. Under rainfed conditions, cutting or uprooting of plants after 4–5 months of sowing can be done.

For seed production, pods need to be collected during February-March, when the plants turn "light brown". Seeds from such harvest have high germination%age. The collected pods are dried and seeds separated. By appropriate adoption of the package of practices, seed yield of 300–400 kg per ha. can be obtained. On an average, under rainfed conditions nearly 600–700 kg dry leaves per ha, and in irrigated conditions about 1500–2000 kg dry leaves per ha. is the optimum yield.

DRYING AND GRADING

Spread the harvested leaves on a clean floor in open sun for 6–10 hours to reduce the moisture. Thereafter undertake shade drying in well ventilated rooms. Undertake regular stirring to ensure uniform drying within 3–5 days (8% moisture in the final produce). Light green to greenish yellow colour is preferable. Improper and delayed drying changes the colour from brown to black, which fetches lower market price. Large leaves and bold pods in yellowish green colour are in demand and fetch a premium price.

STORAGE AND MARKETING

The leaves, after proper drying, should be stored in a cool and dry place. Pressing is done using hydraulic press to reduce the volume for transportation. The loss of sennoside contents in the stored produce is very slow and even after a year of storage, the loss is negligible. The present market price of the leaves is about Rs 8–10 per kg.

ECONOMICS

The crop can give a net profit of about Rs 5,000–10,000 per ha from otherwise marginal lands.

Caution: Cultivation of medicinal plants is undertaken by first assuring its market. The growers may like to establish buy back arrangements to minimize the risk of distress selling.

For more details contact:

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PACKAGE OF PRACTICES FOR CULTIVATION OF LONG PEPPER

Long pepper

Recent years have seen a major spurt in the demand of medicinal plants not only with in the country but also for its export. More and more number of farmers are entering into this most potential sector. The National Research Centre for Medicinal and Aromatic Plants (NRCMAP), Anand has developed package of practices for cultivation of Long pepper.

Long pepper, *Piper longum* (Linn.) used in the Indian System of Medicine is the dried unripe fruit (known as spike in trade).It is used for treatment of cold, cough, bronchitis, asthma, fever, muscular pains, insomnia, epilepsy, diarrohea, dysentery, leprosy, etc. Roots and thicker basal stem portion of the plant are also presently used in many Ayurvedic preparations. A large quantity of long pepper is imported by India from Malaysia, Indonesia, Singapore and Sri Lanka. It is cultivated as a commercial crop widely in areas having high rainfall, high humidity and moderate temperature of about 15–35°C like West Bengal, Assam, Meghalaya, Maharashtra (Akola region), Orissa, Andhra Pradesh (Vishakhapatnam area), Uttar Pradesh, Tamil Nadu (Anaimalai Hills), and Kerala.

CLIMATE

It is cultivated in high rainfall areas of Assam and Meghalaya without any supplemental irrigation and as irrigated crop in other parts. Since it is a shallow rooted crop it requires high humidity and frequent irrigation. The plant should be grown under partial shade for good growth. Thus, it can be successfully cultivated as an intercrop in irrigated coconut and areca nut gardens. It is highly sensitive to drought and also waterlogging conditions.

SOIL

The crop thrives well on a variety of soils. Light porous well drained soil rich in organic content is most suited for its cultivation.

LAND PREPARATION

The field should be prepared with two to three ploughings, followed by one or two harrowings and leveling. Considering the slope of the fields, provide drainage for excess water. The crop can not survive under water logging conditions.

PLANTING MATERIAL

Long pepper is propagated vegetatively by rooted vine cuttings. It is recommended to take three-nodded cuttings from any part of the stem to serve as planting material. Rooting takes about 15–20 days after planting. Cuttings can be directly planted in the field or after induced rooting in the nursery, before finally transplanting in the field.

PLANTING TIME

Plant on the onset of monsoon during May-June. About 60 × 60 cm spacing can be maintained between row to row and plant to plant. If plants are to be raised first in nursery, the best time for nursery raising would be one month earlier to actual planting.

VARIETIES

Grow variety "Viswam" as intercrop. The plant attaints about 72 cm height and has prolonged flowering phase. It bears stout, short, and thick spikes, which are dark green when mature, having dry matter content of about 20%. This variety gives economic yield for about 240–270 days in a year, and the spikes contain about 2.83% alkaloid.

MANURING

In the first year, apply about 20 ton per hectare FYM at the time of land preparation. In the subsequent years, apply FYM before the onset of monsoon. No chemical fertilizers are recommended for use.

INTERCULTURAL OPERATIONS

During first year weeding may be undertaken as and when necessary. Generally two to three weeding are sufficient. Once the crop grows and covers the field, no serious problems of weeding are faced.

IRRIGATION

Ensure irrigation during summer months. Irrigate once or twice in a week depending upon the water holding capacity of the soil. Even during

the monsoon period, if there is a failure of rains for quite some time, apply irrigation. As irrigated crop, spike production continues even in summer months.

PLANT PROTECTION

Phytpophthora leaf, stem rot, and anthracnose are important diseases of long pepper. Spray 0.5 per cent Bordeaux mixture at fortnightly intervals and carry out soil drenching of 1% Bordeaux mixture at monthly interval to reduce the losses caused by these diseases. Application of 0.25% Neem seed kernel extract as spray or any other Neem based insecticides is effective to control mealy bugs and *Helopeltis theivora* damaging tender foliage.

HARVESTING AND DRYING

Vines start fruiting six month after planting. The female spikes take about two months to mature from its inception. A full grown mature spike should be harvested before ripening. In Kerala, three to four pickings can be taken depending upon the maturity of spikes. Harvest spikes when these are blackish green in colour. Yield of dry spikes in first year is about 400 kg/ha and upto 1, 000 kg/ha in the third year. After third year yield declines and after fifth year gradually becomes uneconomical. Besides spikes, thicker roots and basal stem portions should also be cut and dried before crop is abandoned, as these are used as important drug constituents in the Ayurvedic and Unani systems of medicine. On an average 500 kg roots are obtainable per hectare. Dry the harvested spikes in the sun for 4–5 days. Green spike to dry spike ratio is about 5 : 1. Dried spikes should be stored in moisture proof container. The produce should not be stored more than a year.

CHEMICAL COMPOSITION

Fruits contain volatile oil, resin, piperine (4–5%) and a terpenoid substance. Roots contain piperlongumine as major alkaloids in addition to piperine.

ECONOMICS

The crop gives a net profit of about Rs 25,000–75,000 per hectare from second year of planting. At the terminal year, the profitability increases due to extra income from the dried roots and stem sold as piplamul.

Caution: Cultivation of medicinal plants is undertaken by first assuring its market. The growers may like to establish buy back arrangements to minimize the risk of distress selling.

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TECHNOLOGY OF REJUVENATION OF OLD UNPRODUCTIVE MANGO ORCHARDS

In the recent past, there has been about 30 to 35% decline in productivity of old and dense mango orchards. The Central Institute for Subtropical Horticulture (CISH), Lucknow has developed technology of rejuvenation of old and unproductive mango orchards. The important components of the technology package are indicated below:

A view of old and unproductive mango orchard

PRUNING

- Prune tree branches 5 times at 2.5 m to 6.5 m and above from ground. Dried, diseased and undesired branches are to be completely removed. Based upon architecture of the individual tree, retain main branches to make the frame work for development of open canopy with outward growth. To check the microbial infection, treat the cut surfaces with paste of cow dung.
- Two to three months after pruning, there is profuse emergence of new shoots leading to bushy growth and unhealthy competition for light and nutrition among the shoots. To facilitate development of open canopy of healthy shoots and to check the competition for nutrition and light, recurrent selective thinning operations should be undertaken.

MANAGEMENT OF PRUNED TREES

- Basins and irrigation channels should be prepared during January after completion of pruning. Depending upon temperature and soil moisture status, pruned trees must be irrigated at an interval of 15–20 days from March till the onset of monsoon.
- Trees need intensive care for survival of emerging new shoots and development of ideal canopy. Apply 2.5 kg Urea, 3 kg Single Super Phosphate (SSP) and 1.5 kg Muriate of Potash besides 100–120 kg well decomposed Farm Yard Manure (FYM) in the basin prepared around each pruned tree. Half dose of Urea and full dose of Single

A view of 50 years old pruned orchard

Super Phosphate (SSP) and Muriate of Potash should be applied during the end of February. Before application of fertilizer, moisture must be ensured in the basin. The remaining half dose of Urea is applied during onset of monsoon. Full dose of FYM should be applied in the first week of July. Hoeing and weeding needs to be done before application of manures and fertilizers.

- Mulching may be followed for conserving soil moisture in the basins during April to June. Dried grasses, mango leaves, straw or black polythene sheet may be used for mulching. All these management practices must also be followed for unpruned trees in alternate rows to secure higher yield from them.

INTER CROPPING

- Pruning of trees make the orchard space open with greater availability of sunlight. Inter-space between the rows of trees can be successfully utilized for intercropping. Flowers like marigold, gladiolus, etc., vegetables (cucurbits, okra, lobia) during *kharif* season and potato, pea, brinjal, cauliflower, cabbage etc. during *rabi* season and spices (ginger and turmeric) are ideal intercrops. Intercropping generates additional employment and income for farm families.

THINNING OF SHOOTS

Development of healthy umberalla canopy after two years of pruning

- Three to four months after pruning i.e. during March-April, there is profuse emergence of shoots on pruned branches. If they are allowed to grow, there is undesirable competition among shoots for space, light, nutrition and growth. Consequently, dense and bushy canopy of unhealthy shoots with poor bearing potential develops on pruned trees. Therefore, selective and regular thinning of shoots should be carried out to facilitate development of open and spreading canopy of healthy shoots.
- Retain only outwardly growing 8–10 healthy shoots per branch and remove the rest so that they get proper nourishment and develop into ideal canopy. Thinning operations are undertaken during June and August.
- Infestation of stem borer can be easily identified by wooden frass fallen on ground from the affected branches. Holes and oozing of gum in affected branches are the other indicators of its infestation. Larvae of the insect tunnel inside the trunk and destroy the conductive

tissues. As a result, the branch and foliage start drying. Larvae can be pulled out from the hole by using thin wire or cycle spoke or they can be traced along the tunnel from gum oozing spot. To control larvae hidden inside the branch and trunk, place cotton-wick soaked with Nuvan insecticide inside the hole, and sealing these with mud.

- New shoots can get affected with leaf cutting weevil insect and anthracnose disease. This weevil damages shoots by cutting the leaf across the lamina like scissors. It can be managed by two spays of 0.2% carbaryl (Sevin) insecticide (@ 3 g per liter water) at an interval of 15 days. Brown spots on young leaves are the characteristic symptom of anthracnose disease. Copper oxychloride (3 g per liter water) should be sprayed twice at an interval of 15 days for its management.

YIELD

After two years of pruning, the pruned trees become rejuvenated with development of healthy and productive canopy and start flowering and fruiting. On an average, about 60 kg of fruit per tree per year can be secured from trees rejuvenated after pruning at a height of 5 m from ground. By adopting this technology, the productivity can be restored and with progressive increase in yield, orchards once again become productive and remunerative.

Fifty years old rejuvenated tree in good bearing after two years

COST

Rejuvenation technique involves both fixed and variable costs. The fixed cost is for equipments for pruning, thinning, spraying and other activities. The variable cost includes labour, manure and fertilizers, cultural operations, pesticides, etc. Fruits harvested from pruned trees have better quality compared to those harvested from unpruned trees. The average variable cost for rejuvenation is about Rs 160 per tree per year. Rejuvenation technology has ecological significance as it provides an effective and remunerative alternative to uprooting and rehabilitating old and dense orchards. By adopting the recommended rejuvenation technology trees can regain life for another 20–25 years with enhanced quality fruiting potential, sustainable production and competitive returns.

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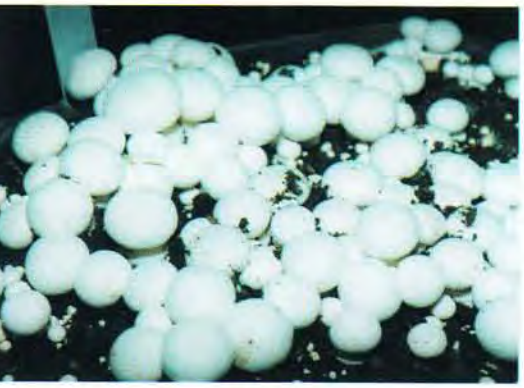
MUSHROOM (WHITE BUTTON) CULTIVATION



Button mushroom

Cultivation of white button mushroom is being undertaken by the farmers on a large scale, especially in the cooler hilly regions. One crop can easily be taken during the winter season in the plains and foot hills of North India. Economic cultivation of white button mushroom requires high levels of skills; hence it will be desirable to undergo specialized training at some appropriate institution before undertaking this as activity. The National Research Centre on Mushroom, Solan has developed package of practices for cultivation of white button mushroom.

COMPOST PREPARATION

Mushroom should be grown on an artificially prepared substrate called 'compost', and is prepared by two methods, viz; long method and short method. The compost preparation by short method is relatively more expensive and technical, and therefore, may not be economical for seasonal growers. The long method of compost preparation is most suitable for seasonal growers.

Compost preparation by long method

Ingredients

• Wheat straw	300 kg
or	
Paddy straw	400 kg
• Calcium Ammonium Nitrate	9 kg
• Urea	3 kg
• Muriate of Potash	3 kg
• Single Superphosphate	3 kg
• Wheat bran	15 kg
• Gypsum	30 kg
• BHC or Lindane Dust (5%)	250 gms
• Molasses	5 kg

MIXTURE PREPARATION

Spread over a concrete floor the base materials (wheat/paddy straw) and sprinkle water 2–3 times a day to allow it to absorb sufficient moisture (75%) for two days (48 hrs). Alongside, 12–16 hrs before stacking of wet wheat/paddy straw; molasses, wheat bran and fertilizers should be mixed in a separate heap, lightly watered and covered with moist gunny bags.

PILE MAKING

Mix thoroughly the wet mixture of fertilizers and wheat bran and moist wheat/paddy straw and stack in a heap (150 cm width × 150 cm height). The length of the heap depends on the quantity of the base material used. Press heap from the top and left as such for five days.

TURNING SCHEDULE

Eight turnings as per the following schedule should be adopted:

First	Give first turning on 6th day. The heap is dismantled by using wooden or iron boards and remade for proper aeration. Water may be added if needed. In order to provide equal opportunity to decompose entire mixture, the turning should be done in a way that the central portion should be at bottom, top portion should be placed at the centre and the bottom portion (inner side) is kept on the top (outer side).
Second	Give second turning on 10th day.
Third	The heap is turned for the third time on 13th day and gypsum is added.
Fourth	Fourth turning is given on 16th day.
Fifth	Give fifth turning on 19th day.
Sixth	Give sixth turning on 22nd day.
Seventh	Give seventh turning on 25th day.

All the above turnings should be given following the method of first turning.

Eighth	Eighth tuning is given on 28th day. BHC or lindane dust is also mixed. At this stage check ammonia and moisture percentage by pressing compost between palm and fingers.

If no water flows out from compost but palm and fingers become only moist, it indicates that right moisture level (68–70%) in the compost exists. In order to test presence of ammonia, the compost should be smelled. If there is a feeling of smell similar to that of animal urine in the cow shed, then one more turning should be given. The temperature of ammonia free compost should be brought to 25°C and after that spawning is carried out.

Spawning

The above prepared compost is used for spawning. The spawn should be white with silky mycelium and free from undesirable smell. Before starting the spawning, spawning area, utensils and implements to be used in the spawning should be treated with 2% formalin solution. The workers should also wash their hands with soap so as to prevent infections to the compost. Spawning is done @ 0.5–0.75% (In 100 kg compost mix 500–750 gm spawn).

Filling of spawned compost

Prepare wooden/bamboo shelves at 60 cm. interval in vertical direction (height wise) in any well ventilated room. Two days before the spawning, treat the room (roof, walls and floor) with 2% formalin solution and keep it closed for over night.

Fill 10–15kg spawned compost in polythene bags and fold them just like paper envelopes. The bags are then placed on shelves close to each other. Maintain 22–25°C temperature and 80–85% humidity in the room.

PREPARATION OF CASING SOIL AND ITS APPLICATION

Casing soil

Spawn run takes place after 12–15 days of spawning and dark brown compost turns whitish. At this stage, application of casing soil is essential for fruiting. Casing soil is an equal mixture of two years old Farm Yard Manure and loam soil. Spray the casing with 2% formalin solution (Add 2 liter formalin, 40% a.i., in 40 liters of water, and keep it covered with polythene sheet for 10–15 days. Remove the sheet a day before its application. The casing preparation work should be done 15 days in advance.

Application

Open the spawn run compost bags, level their surface and slightly pressed. Then, a casing soil layer of 3–4 cm thickness is applied on the

even surface of bags. During this period, 22–25°C temperature and 80–85% humidity is maintained. The cased bags require much attention. Check temperature and moisture in the bags daily. Light spray of water is also carried out.

Post-casing Management

A week after casing, mycelium is impregnated in the casing layer and the room temperature is lowered from 22–25°C to 14–18°C. The pinheads start appearing within 7–10 days and mature in next few days. At this stage, more humidity is required; hence 85–90% humidity should be maintained. Watering should be done twice a day (morning and evening). In addition to temperature and humidity, good ventilation is also required at this stage. Therefore, the cropping room should have ventilators, windows and door fitted in the right direction. By opening the ventilators, windows and doors for some time in the morning and evening, required air may be provided.

Harvesting

Pinheads become fully grown mushrooms in 2–4 days and harvested by twisting when their cap diameter is 3–4 cm and are in closed condition (button stage). The harvested mushrooms should be consumed or sold off as soon as possible as it is a perishable vegetable. Harvest mushrooms daily and complete production is obtained in 8 to10 weeks. On an average, one quintal compost produces about 12 kg mushroom.

ECONOMICS

Cost of cultivation varies from place to place depending upon the cost of raw material, labour, site conditions, and marketing opportunities etc. On an average, production cost is between Rs 10–15 per kg. The produce is sold at about Rs 30 to 50 per kg depending upon the season and location of market, etc.

For more details contact:

Director
National Research Centre
for Mushroom (ICAR)
Chambaghat
Solan 173 213

SAND DUNES STABILIZATION

Shifting sand dunes

More than half (about 58%) of the area of arid zone in the western Rajasthan is covered by drifting or semi-stabilized sand dunes. Due to high wind velocity, the sand dunes engulf agricultural fields, canals, wells, railway lines, highways, buildings, etc., and thus cause immense losses. Some of the dunes are highly active and are thus a major menace to the inhabitants. The Central Arid Zone Research Institute (CAZRI), Jodhpur has developed technology for sand dunes stabilization. This technology involves the following steps:

- Protection from the biotic interference,
- Establishment of micro-wind breaks (mulching) on the dune surface to reduce sand movement, and
- Afforestation of treated dunes.

Sand dunes stabilization through micro-wind breaks

PROTECTION FROM BIOTIC INTERFERENCE

Due to high human and livestock population, whatever vegetation grows on the dunes is either harvested by the inhabitants or grazed by animals. This leads to barren dunes. These areas must be protected from biotic pressure. On the dunes angle-iron-barbed wire fencing is most effective.

ESTABLISHMENT OF MICRO-WIND BREAKS

The locally available brushwood materials should be effectively used for construction of windbreaks. The brushwood materials should be buried upside down on the dunes, keeping one feet height on the dune surface in parallel rows or in a chess board design. The brushwood of following bushes can be used:

- Senia (*Crotalaria burhea*)
- Bui (*Aerva persica*)
- Kheep (*Leptadenia pyrotechnica*)
- Thorns of Bordi (*Ziziphus nummularia*), *and*
- Khejri (*Prosopis cineraria*)

AFFORESTATION OF DUNES

After construction of micro-wind breaks, these dunes must be revegetated by suitable grasses/creepers/trees or shrubs, sown on the leeward side of micro-wind breaks. Some the grasses/creepers/trees suitable for afforestation of dunes are:

Grasses	Sewan (*Lasiurus sindicus*), Anjan (*Cenchrus ciliaris*), Murat (*Panicum turgidum*).
Creepers	Tumba (*Citrullus colosynthes*), Kachri (*Cucumus* sp.)
Trees/shrubs	Israeli babul (*Acacia tortilis*), *Nubica* (*Acacia nubica*), *Kumat* (*Acacia senegal*), Bhu-bavali (*A. jaquimontii*), Bavenosa (*A. bavenosa*), Angrezi babul (*Prosopis juliflora*), Phog (*Calligonum polygonoides*), Bordi (*Ziziphus nummularia*), Ami (*Clerodendrum phlomoidis*).

Acacia senegal - a tree suitable for afforestation of dunes

GUIDELINES FOR REVEGETATION

Sow grass and creeper seeds directly. In case of trees/shrubs, transplant nursery-raised 5 month old seedlings. Trees should be planted at a spacing of 5 × 5 m.

It is necessary to follow all these operations as a time-bound activity. It is recommended that fencing work should be completed by the end of June, the micro-wind breaks establishment should be done before July, i.e. onset of monsoon. Tree-shrub nursery should be raised in February or March and transplanting of trees/shrubs should be done at the onset of monsoon. By proper adoption of the above steps, it is possible to effectively stabilize the dunes.

YIELD AND OTHER ADVANTAGES

Once the trees are established, the under-storey of grass/creepers start to regenerate, and after 15 years of establishment, the wood yield of *Acacia tortilis* is expected between 33 to 53 t/ha. Recently, the CAZRI has also developed technology of gum extraction from *A. tortilis*, thus it was possible to harvest about 400–500 gm of gum from each tree.

This technology got a very wider acceptance by the State Government Forest Department for community participatory management and stabilization of sand dunes.

For more details contact:

Director
Central Arid Zone Research Institute (ICAR)
Jodhpur 342 003

RECLAMATION OF ALKALI SOILS OF INDO-GANGETIC PLAINS

A barren vast stretch of alkali affected areas

Alkali soils (also called sodic) contain sufficient amount of exchangeable sodium (ESP), more than 15% to cause soil dispersion and increase in the soil pH (>8.5), thereby adversely affecting both the physical and nutritional properties of the soil. This also brings significant reduction in crop growth. The conductivity of the soil saturation extract is usually less than 4 dSm^{-1}. Highly deteriorated alkali soils may have pH as high as 10.7. Nearly 28 lakh hectares area is affected by sodicity and are primarily spread in the Indo-Gangetic alluvial plains in the states of Haryana, Punjab, Uttar Pradesh and parts of Bihar and Rajasthan. The Central Soil Salinity Research Institute (CSSRI), Karnal has developed an economically viable, environment friendly and socially acceptable package of reclamation technology.

RECLAMATION TECHNOLOGY

Reclamation of alkali soils basically requires partial or complete removal of exchangeable Sodium and its replacement by Calcium. This can be accomplished in many ways depending on local conditions, available resources and the kind of crops to be grown on the reclaimed land. If the cultivator can spend very little for reclamation and is willing to wait for many years before he can get an economic crop yield, reclamation can be accomplished simply by growing rice during *kharif* season followed by a *rabi* crop (wheat), along with the incorporation of farmyard/green manures.

However, to obtain reasonably quick soil reclamation and economic crop yields cropping must be preceded by:

- Application of a chemical amendment preferably gypsum in required quantity.
- Thereafter leaching for removal of salts, mostly sodium sulphate, derived from the reaction of the amendment with the alkali soil.
- Adoption of rice-wheat-dhaincha (*Sesbenia aculeata*) as green-manuring crop.

On-farm development

- Proper land leveling is a must for initiating the reclamation. Provide strong bunds on all sides of the farm to control ingress of water from the adjoining areas. The on–farm development works should be done in early summer before on-set of rains. Do not go in for deep ploughing.
- Gypsum (Calcium Sulphate), is by far the most commonly used soil amendment. Though many other soil amendments (sulphur, sulphuric acid, calcium chloride, aluminium sulphate, etc.) could also be used but these are more expensive than gypsum and therefore, uneconomic to use. Press mud from sugar factories using sulphitation process can also be used for reclamation of sodic lands. Iron pyrites is still another promising amendment provided it contains about minimum of 8% water-soluble sulphur.
- The amount of amendment must be applied based on soil analysis. However, 12–15 tonnes of gypsum per hectare (which is only 50% of gypsum requirement of 0–15 cm soil) is sufficient enough to reclaim upper 15 cm soil depth of a highly deteriorated soil (pH as high as 10.7) for successfully growing rice-wheat in rotation. About 25% less gypsum may be applied by applying 10–15 t/ha FYM along with gypsum. Salt tolerant rice varieties (CSR-I0, CSR–13, CSR–27) and wheat (KRL 1–4, KRL 19) can also be grown successfully by using gypsum @ 25% gypsum requirement.
- The amendment should be uniformly applied in whole field and thoroughly mixed within the top 10 cm soil, followed by ponding of irrigation/ rain water for about 10–15 days to promote leaching and create better soil ionic environment.
- After the excess water has disappeared and the land has been properly cultivated and fertilized, rice should be transplanted without puddling, ensuring 3 to 4 seedlings per hill and maintaining 15 to 20 cm distance between the hills. Raise nursery on good soil. The crop should be managed as per the normal crop management practices. As far as possible, reclamation should start with rice as the first crop. Wheat, barley and berseem are the best choices for continuing the reclamation process during *rabi* season. Recommended crop varieties should be planted at the appropriate time. It is desirable to go in for a green-manure crop during summer, which besides improving soil physical conditions can also save about 60–70 kg/ha of Nitrogen in the following rice crop.

Gypsum application

A first crop of rice after reclamation

- While growing wheat crop during *rabi* season, ensure that there is no stagnation of standing water. Apply light but frequent irrigation (total quantity of irrigation water remains the same).

OTHER MANAGEMENT TIPS

Efficient, balanced and integrated nutrient management is an integral part of reclamation of sodic lands. Therefore, to sustain productivity during and after reclamation the following recommendations must be practised:

- These soils are highly deficient in organic matter and Nitrogen. During the first few years after reclamation, crops are fertilized with about 25% more Nitrogen compared to recommended dose for normal soil. Split application of Nitrogen through urea (1/3rd as basal, 1/3rd each at 21 and 45 days crop growth) should be given. In rice, basal dose of urea should be applied before puddling under pre-submerged conditions to reduce ammonia volatilization losses and to enhance Nitrogen use efficiency.
- Apply 25 to 40 kg Zinc Sulphate per hectare to rice for first few years and then it should be applied on soil test basis.
- Farmyard manure, organic residues and green manures help in increasing the productivity. It is extremely important to integrate the use of organic resources and chemical amendments.
- Though sodic soils initially are high in available phosphorus, both rice and wheat require phosphorus fertilization @ 22 kg P/ha after 4–5 years, when available phosphorus comes down to critical soil test value i.e. 12 kg/ha to sustain productivity and to maintain soil fertility.
- Maintain submerged conditions during rice and well drained conditions during wheat/barley/berseem to avoid water stagnation and damage to the crops, by ensuring light and frequent irrigations.

SOURCES OF GYPSUM AVAILABILITY

Gypsum is being marketed by the Land Reclamation and Development Corporations established in many States. The farmers can contact the State Departments of Agriculture as well. The addresses of a few firms supplying gypsum are also given below. This is in no way is a recommendation of any particular source.

Gypsum Supplying Firms :

1. The Fertilizer Corporation of India Ltd., Paonta 'A' Road, Jodhpur (Rajasthan).
2. J & K Minerals Ltd., Mining Department, House No. 33, Block 'B' Sector C, Gandhinagar, Jammu, J & K.
3. Hindustan Copper Ltd., P.O. Khetri Nagar, Rajasthan.
4. Bikaner Gypsum Ltd., Bikaner, Rajasthan.
5. The Himalaya Stone and Lime Co., Rishikesh, (Dehraduin), D.P.
6. Akhil Lime and Minerals, 4-Raja Road, Dehradun, D.P.

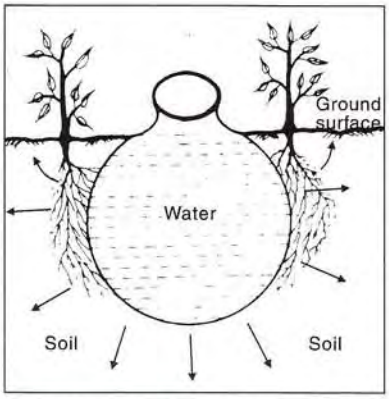
For more details contact:

Director
Central Soil Salinity Research Institute (ICAR)
Karnal 132 001

PITCHER IRRIGATION TECHNOLOGY FOR VEGETABLE PRODUCTION IN ARID AREAS

Water being a scarce resource, its conservation strategies would play a very dominating role in achieving higher production levels with limited water. As agriculture in the arid and semi-arid regions has to depend upon saline groundwater, a number of indigenous techniques have been developed and recommended. One such technique advocated by the Central Soil Salinity Research Institute (CSSRI), Karnal is the pitcher irrigation. The pitchers recommended for use are commonly made by the village artisans. The pitcher irrigation has been appropriately named to highlight the basic component of the system, the pitcher. It is an ordinary earthen pitcher commonly used in rural areas to cool water during the summer seasons. Unglazed pitchers, each of 5–8 liter capacity would be appropriate for use.

STEPS IN INSTALLATION



Pitcher irrigation is useful for vegetable production

1. Mark the locations of the pitchers on the farm area. Install pitchers at a wider distance for creeping crops while distance is kept less for erect type crops.

2. At each location dig a circular pit at least 60 cm deep and of 90 cm diameter. Keep separately the soil dug out from the pit.

3. Break the soil clods completely (to less than 1 cm diameter) and mix enough farmyard manure and basal dose of fertilizers (phosphorus and potash). Also add soil amendment for reclamation if needed. Apply Nitrogen along with irrigation water through the pitchers. Place this mixture of the soil in the pit to give at least a depth of 30 cm.

4. Place the unglazed pitcher at the center of the pit. Use the dug out and the mixture to fill the remaining portion so as to cover the whole space from the bottom to the neck of the pitcher. In case of heavy soils, a thin layer of sand is also placed around the pitchers. Tap the mixture thoroughly to ensure good contact between the soil and the

pitcher. In the absence of a good contact, the water will either not flow out of the pitcher or the flow will be irregular.

5. Fill the pitcher with clear water. Rainwater could be used after filtering through a sand filter.
6. After 2–3 days of filling the pitcher, sow at least 6–8 seedlings/seeds around the pitcher. The seeds or seedlings should be equidistant from the pitcher and also from each other. The ideal location for the seeds/seedlings is just outside the outer boundary of the pitcher wall. Start filling the water at pre-determined interval (optimum schedule may be 2 days for saline and 3 days in case of fresh water).

WATER REQUIREMENT

Water requirement in the pitcher irrigation technique depends upon:

- Number of pitchers per ha
- Type of crop grown
- Available quality of water and the filling schedule.

An early filling schedule should be adopted with saline water as compared to fresh water. The water requirement in a 3 day filling schedule is about half of the daily filling schedule. The water requirement could be as low as 2.8 cm/ha to 12.5 cm/ha as the number of pitchers/ha increase from 800 to 5000. Thus water requirement may not exceed a maximum of 2 irrigations equivalent in the surface irrigation method. These calculations are with an assumption that the crop is of three and a half to four months duration with a maximum replenishment rate of 2.5 liters/day.

Precautions

- Keep the mouth of the pitcher closed to prevent sunlight to enter the pitcher so that algae formation and growth is minimized.
- Use only clear water for filling.
- Properly dry the pitchers before storing.

YIELD

A large number of crops can be grown through pitcher irrigation technique. It is more useful for vegetables and horticultural crops. Creeping types

A good crop of grapes through Pitcher irrigation

of crops can be grown with lesser number of pitchers. The yields of several crops, when fresh water was used to irrigate the crop are given below. Even grape and tomato could be established well.

Yield of Various Crops With Fresh Water (EC = 0.5 dS/m)

Crop	Yield (Kg/pitcher)	Crop	Yield (Kg/Pitcher)
Watermelon	11.3	Tomato	5.8
Muskmelon	7.4	Cauliflower	5.2
Bottle gourd	21.5	Brinjal	5.1
Bitter gourd	7.5	Cabbage	4.8
Ridge gourd	4.5	Radish	8.0
Cucumber (Kakri)	14.0	Grapes	3.5

Saline water irrigation through earthen pitcher

USE OF SALINE WATER IN PITCHERS

The vegetable crops are quite sensitive to salts. In most crops saline water of 2–3 dS/m can only be used except for chillies, where water of 4.5 dS/m could also be used. Through pitcher irrigation technology, most of the crops can be grown with waters having EC > 5 dS/m, except ridge gourd and grapes. Cauliflower could be grown even with a saline water of 15 dS/m by adopting improved crop production approaches.

ECONOMICS

The total cost with 2,500 pitchers per hectare is about Rs 11,200 with the variable cost of Rs 9,640 per season. Benefit-cost ratio through pitcher irrigation is about 3 for tomato crop and more than 2 for most of the other vegetables. This is a simple technology, and the economic viability of the technique among others depends upon the life of the pitcher. Unlike surface placed pitchers, buried pitchers transmit the water into the soil and pitcher wall does not act as an evaporating surface. Thus, no salts get accumulated on the pitcher wall.

For more details contact:

Director
Central Soil Salinity Research Institute (ICAR)
Karnal 132 001

ENRICHED COMPOST PRODUCTION TECHNOLOGY

Most of the Indian soils are deficient in Phosphorus and also are under continuous cropping. The yearly removal of Phosphorus is more than its addition. If the traditional technology of compost making is improved in terms of nutrients content, it can help in minimizing nutrient depletion to a greater extent. The Indian Institute of Soil Science (IISS), Bhopal has developed phospho-compost/N-enriched phospho-compost technology. In this technique, phosphate solubilising microorganisms (*Aspergillus awamori, Pseudomonas straita, and Bacillus megaterium*), phosphate rock, and bio-solids are used to enrich manurial value compared to FYM and ordinary compost.

- The phospho-compost and N-enriched phospho-compost are prepared by windrow method and in the pits prepared for NADEP compost.
- For the production of one ton of phospho-compost, 1900 kg organic/ vegetable wastes/straw, 200 kg cow dung (on dry weight basis), and 250 kg phosphate rock (18% P_2O_5) are used.
- The compost becomes ready for field application within 90–100 days period.
- The phospho-compost contains 2–3% P_2O_5.

Since there is multi-nutrient deficiency in Indian soils, the IISS, Bhopal has also developed N-enriched Phospho-compost technology to enrich manurial value, particularly Sulphur and Nitrogen content of the compost. For this add Nitrogen as urea @ 0.5–1% (w/w) and Pyrites @ 10% (w/w) to the composting mixture. The N-enriched phospho-compost normally contains 1.4–1.6% N and 15–20 C: N ratio

ECONOMICS

The cost of supplying one Kg of super phosphate through phospho-compost is around Rs 9 as compared to Rs 16–17 supplied through Single Super Phosphate or Diammonium phosphate.

For more details contact:

Director
Indian Institute of Soil Science (ICAR)
Nabi Bagh, Berasia Road
Bhopal 462 038

UREA TREATMENT OF POOR QUALITY ROUGHAGES

Urea treatment of poor quality roughages

Cereal straws of wheat, paddy, oats, barley and stovers like sorghum, bajra, etc. assume special significance as these constitute the largest proportion of roughage (about 80%), and most of the livestock subsist on such fodders alone. The voluntary intake by animals of cereal straws and stovers is also low. Thus the animals fed on such straws suffer from malnutrition. The National Dairy Research Institute (NDRI), Karnal has developed a technology of urea treatment of roughages.

STEPS OF UREA TREATMENT

1. Take 100 kg of straw or stovers and put them on the cemented/ *pakka* floor.
2. Take the fertilizer grade urea @ 4 kg.
3. Dissolve the Urea (4 kg) in 20–30 liters of water and mix it till it completely dissolves.
4. Spray the urea solution with any sprayer on straw lot.
5. Mix Urea solution and straw thoroughly with hand fork (about 5–6 turnings).
6. Stack under the plastic sheets/gunny bags cover to have anaerobic condition and allow it to react for about 3 weeks.
7. Take the straw out from stack. Give 2 to 3 turnings so that excess of ammonia gets evaporated in the atmosphere.
8. The colour of the straw is changed from yellowish to dark brown during the reaction time. Treated straw is ready to use as animal feed for livestock.

Precautions

- Uniformly spray urea solution on straw lots and thoroughly mix.
- Provide complete anaerobic condition for better reaction while stacking the treated straw.

- Precautions should be taken to save the treated material from rains etc.
- Keep the children away from the stack to avoid the ill effect of ammonia on their health.

FEEDING

The treated material serves as maintenance ration. However, supplementation of concentrate mixture as well as green fodder will improve the performance of the producing animals especially lactating animals. The treated straw can be fed to growing calves, producing and non-producing adult animals of cattle, buffaloes, goats and sheep. The treated straws become soft and more pliable, thus increase its palatability, and increased voluntary consumption of straw.

The animals fed on such treated straws should be provided with sufficient quantity of common salt and commercially prepared mineral mixture. The supplementation of vitamins may also be beneficial, which can be supplied through commercial preparations or by feeding 2–3 kg green fodder per day per animal. The treated material can be fed to any ruminant animals having more than six month's age. The change in colour of the treated straw happens due to reaction of the chemical with straw and does not affect straw quality.

ADVANTAGES

- The ingredients are readily available in the market.
- It is not hazardous during the process/treatment of roughages.
- The Urea gets converted into ammonia and then ammonia reacts with fibre to complete the reaction.
- Being a source of alkali it helps in breaking the lignocelluloses bonds and thereby increases the digestibility of the energy producing components.
- The digestibility of organic matter and crude fibre also increases leading to higher amount of available energy to the livestock.
- It increases protein content by two to three times.
- The Urea treatment of straws does not cause any pollution problems.
- The Urea-treated straw does not create urea toxicity in the animal.

- This treatment also acts as preservative thus minimizing the straw spoilage.

For more details contact:

Director
National Dairy Research Institute (ICAR)
Karnal 132 001

ECONOMICS

Feeding treated straw as basal ration for both growth and milk production can reduce the allowances of concentrate mixture by 25%, without lowering down the productivity of the animals.

UREA MOLASSES LIQUID DIET (UMLD) FOR LIVESTOCK

In many parts of the country, natural calamities like floods and droughts are recurring features, which have adverse effect on agricultural production in general and on livestock production in particular. Survival of livestock at minimum cost, using alternate/possible feeding strategies is the primary aim during such adverse circumstances. Due to the inaccessibility and transportation difficulties of bulky material, the availability of traditionally used feed/fodder becomes unassured.

Molasses being rich in energy and sulphur, and have high bulk density can be used as potential drought/scarcity feed after supplementing deficient nutrients viz., protein, minerals and vitamins required for essential body processes. The Indian Veterinary Research Institute (IVRI), Izatnagar has standardized urea molasses liquid diet (UMLD) for feeding as survival ration to growing cattle and buffaloes for longer duration.

MATERIALS REQUIRED

For 100 kg UMLD

- Molasses 84 kg
- Protein pellets 10 kg
- Urea 3 kg
- Mineral mixture 2 kg
- Phosphoric acid 1 g, and
- Vitamin supplement (Vitablend), 25 g/100 kg

Constituents

Protein pellets containing (on % dry matter basis)

- Deoiled mustard cake, 23
- Mustard oil cake 11

- Crushed jowar grain, 10
- Molasses, 10
- Guar corma, 9
- Cotton seed meal, 8
- Deoiled ground nut meal, 7
- Rice polish, 6
- Wheat bran, 4
- Malt sprout, 3
- Maize gluten, 3
- Deoiled rice bran, 2
- Mineral mixture, 2
- Common salt, 2

PREPARATION

To prepare UMLD, Urea is mixed in the molasses and left overnight in a plastic trough. Next morning, it is shaken well and other ingredients are mixed.

ADVANTAGE

It can be used as a survival ration during scarcity like floods/droughts.

For more details contact:

Director
Indian Veterinary
Research Institute (ICAR)
Izatnagar 243 122

ECONOMICS

Being a survival diet, UMLD can save lives of millions of precious livestock. However, the cost of the feed is about Rs 250/quintal.

UREA AMMONIATED NEEM SEED KERNEL CAKE FOR LIVESTOCK

Neem Seed Kernel Cake (NSKC) is a protein rich by-product of Neem oil industry, and is easily available. It was hitherto utilized as fertilizer-cum-pesticide only. The cake as such was not used for animal feeding due to the presence of bitter and toxic triterpenoids (azadirachtin, salanin, nimbin, nimibidiol, etc.). Further, even when the Neem seed kernel cake is fed, besides being unpalatable, it is harmful to animals and affect growth, male reproductive system and overall performance. The Indian Veterinary Research Institute (IVRI), Izatnagar has developed technology of treating the cake with fertilizer grade urea and converting it into a wholesome substitute of conventional oil cakes in the concentrate mixtures of various species of livestock.

MATERIALS REQUIRED

- Fertilizer grade Urea
- Neem seed kernel cake

PREPARATION PROCEDURE

1. Take fertilizer grade Urea @ 2.5 kg/quintal of Neem seed kernel.
2. Soak NSKC in an airtight container having solution containing fertilizer grade Urea (2.5% w/w) at the rate of 1part of NSKC: 1.2 parts of urea solution for 5 to 6 days with intermittent stirring.
3. Sun dry the ensiled cake and ground it for incorporation into concentrate mixture of various species of livestock.

Decorticate/Dehull the Neem Seed and Solvent Extract to Recover Oil to obtain NSKC

Advantages

- Urea ammoniated, sun-dried and ground NSKC is suitable to feed cattle and buffalo calves, growing lambs and kids and broiler poultry and rabbits without any detrimental effect.

- Urea ammoniated neem seed kernel cake provides a wholesome protein rich substitute to spare costly and scarce vegetable protein sources in the livestock feed.

For more details contact:

Director
Indian Veterinary Research Institute (ICAR)
Izatnagar 243 122

ECONOMICS

Besides reducing the cost of conventional oil cake used in concentrate mixture of livestock by 30 to 45%, it can also mitigate the shortage of protein rich feeds to overcome the demand and supply of scarce and costly oil cakes.

FRESHWATER PEARL CULTURE

Freshwater pearl culture

Pearl is a natural gem and is produced by a mollusc. While the demand of pearls in India and elsewhere is increasing, due to over exploitation and pollution, their supplies from nature have reduced. India is importing a large quantity of cultured pearls every year from the international markets to meet the domestic demand. The Central Institute of Freshwater Aquaculture (CIFA), Bhubneshwar has developed technology of freshwater pearl culture from common freshwater mussels, widely distributed in freshwater habitats throughout the country.

Generally a natural pearl is of small size and irregular shape. A cultured pearl is also a natural pearl, the only difference being the human intervention in surgical implantation of a live mantle graft and nucleus for hastening pearl formation to the desired size, shape, colour and lusture. In India, three species of commonly available freshwater mussels viz., *Lammelidens marginalis, L. corrianus* and *Parreysia corrugata* can be used to produce good quality pearls.

TECHNOLOGY

In nature, a pearl is formed when a foreign particle *viz.*, piece of sand, insects etc. by chance enters into the body of mussel and the mussel can not throw that out and instead makes a shiny coating on the particle layer by layer. This simple phenomenon is being exploited in pearl culture practices. As a farming practice, the freshwater pearl culture operation involves six major steps sequentially:

- Collection of mussels,
- Pre-operative conditioning,
- Surgery,
- Post-operative care,
- Pond culture, and
- Harvesting of pearls.

Collection of Mussels

The healthy mussels should be collected manually from the freshwater bodies like pond, river etc. and kept in buckets or containers having water. The ideal mussel size to be used for pearl culture should be of 8–10 cm.

Pre-operative Conditioning

The collected mussels should be kept in crowded condition in captivity (1 mussel/liter of water) with aged tap water for pre-operative conditioning for 2 to 3 days. This pre-operative conditioning helps in weakening of adductor muscles for easy handling during surgery.

Mussel Surgery

Depending on the place of surgery, the implantation is of three types *viz.*, mantle cavity implantation, mantle tissue implantation and gonadal. The key raw materials required during the surgical implantations are beads or nuclei, which are usually made from mollusc shell or other calcareous materials.

Mantle cavity implantation: In this procedure round (4–8 mm diameter) or designed (images of any shape) beads are inserted into the mantle cavity region of mussel (skin like structure covered on each side of the body of mussel) after opening the two valves (without causing injury to mussels at both ends) of animal and separating carefully the mantles of anterior sides from the shell by help of surgical set. Implantation could be done in mantle cavities of both the valves. In case of implantation of designed beads care should be that the design portion faces the mantle. After placing the beads in desired place the gaps created during implantation should be closed by pushing the mantle onto the shell.

Mantle tissue implantation: Here the mussels are divided into two groups; the donor and the recipient mussels. The first step in this procedure is preparation of graft (small pieces of mantle tissue). This is done by preparing a mantle ribbon (a strip of mantle along the ventral side of the mussel) from a donor mussel, which is sacrificed, and cutting that into small pieces (2 × 2 mm). The implantation is done on recipient mussels, which are of two types *viz.*, non-nucleated and nucleated. In the former, only the graft pieces are introduced into the pockets created at the inner side of posterior pallial mantle present at the ventral region of the mussel. In the nucleated method, a graft piece followed by a small nucleus (2 mm diameter) is introduced in the pockets. In both the procedures care should

be taken that graft or nucleus does not come out of the pocket. Implantations could be done at mantle ribbon of both valves.

Gonadal implantation: This procedure also involves preparation of grafts similar to mantle tissue method. First a cut is made at the edge of the gonad of the mussel. Then a graft is inserted into the gonad followed by nucleus (2–4 mm diameter) so that the nucleus and graft are in close contact. Care should be that nucleus touches the outer epithelial layer of the graft and the intestine is not cut during the surgery.

Post-Operative Care

Implanted mussels are kept in post-operative care unit in nylon bags for 10 days with antibiotic treatment and supply of natural food. The units should be daily examined and dead mussels and the ones that reject the nucleus should be removed.

Pond Culture

After post-operative care the implanted mussels should be stocked in the ponds by keeping them in nylon bags (2 mussels per bag) and hanging from bamboo or PVC pipes and placed in ponds at one meter depth. The mussels are cultured at stocking density of 20,000–30,000/ha. The ponds should be periodically fertilized with organic manure and inorganic fertilizer to sustain the plankton productivity. Periodical checking of mussels with removal of dead ones and cleaning of bags should be carried out throughout the culture period of 12–18 months.

Pearl Harvest

The mussels should be harvested at the end of the culture period. The individual pearls can be taken out from the mantle tissue or gonad of the live mussels. The mussels are sacrificed in case of mantle cavity method. The products obtained through different surgical implantation methods vary. In the mantle cavity method these are shell attached half round, in mantle tissue method as unattached, small irregular or round pearls; while in gonadal method as unattached big irregular or round pearls.

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SHRIMP FARMING TECHNOLOGY

Since ages shrimp culture as a traditional activity is being practiced. It was only in early nineties that modem scientific shrimp farming got a boost and since then a phenomenal expansion has been achieved. Presently, hardly 15% of the total potential brackish water area available in the country (about 1.7 lakh ha) is under shrimp farming. During 2001–2002, India exported cultured shrimps worth Rs 3,500 crores, which constituted 85% of the total shrimps exported from the country. The Central Institute of Brackishwater Aquaculture (CIBA), Chennai has developed scientific shrimp farming technology with good management practices for sustainable production of shrimps from the culture systems. However, shrimp culture technology and the system of culture depends on several factors like:

- Site characteristics,
- Design of shrimp farms,
- Pond preparation,
- Stocking,
- Water quality management, etc.

Site Characteristics

Undertake a thorough study of the site with reference to meteorological factors (wind, temperature, light, rain, humidity etc.,), location factors (tides, waves, currents, accessibility, prior uses, gradients etc.,), soil quality (soil texture, topography, nutrient and microbial content, leachable toxins), water quality (physical, chemical and biological) and social, legal, and economic aspects.

Improved traditional farm

Design of Shrimp Farms

The farm can either be open or a closed system. If sufficient good quality water is readily available, it is simpler to have low cost open systems. However, if the source water is of poor quality, pre-treatment/ sedimentation is required to be undertaken in reservoir ponds. In larger farms, Effluent Treatment Ponds are essential.

Pond Preparation

It is an essential component of shrimp farm management and is carried out to remove the accumulated metabolites of the earlier culture, elimination of pests and predators, enhancement of the nutrient status of water, and growing natural food organisms. This comprises of:

- Drying of pond bottom
- Sediment removal
- Tilling/ploughing/raking
- Liming
- Water intake
- Chlorination/dechlorination
- Fertilization/manuring

Stocking

The stocking of the pond with hatchery reared, disease free and high quality shrimp seed will ensure a successful culture. It is recommended to have a stocking density of 6–10/m^2 for sustainable production in improved traditional and semi-intensive systems of culture.

Water Quality Management

Another essential component of the shrimp pond management is water quality management. Nutrients and organic wastes produced in shrimp culture ponds consist of solid matter (mainly uneaten feed, faecal matter and phytoplankton) and dissolved metabolites (mainly ammonia, phosphate, carbon dioxide, nitrites and nitrates). In order to maintain these within the tolerable limits, the following methods should be adopted:

- Water exchange
- Aeration
- Application of chemicals/pro-biotics to improve water and soil quality

Scientific farming

FEED AND HEALTH MANAGEMENT

The growth of the shrimp essentially depends on the quality of feed used. It is recommended to go in for compounded feeds, fulfilling the nutritional requirements of the shrimps at different stages of growth, and with good acceptability, digestibility and FCR. Since more than 50% of

Different grades of shrimp feed

the recurring expenditure is on feed, its management in a shrimp farm is of great importance. While over feeding will lead to nutrient loading, under feeding will result in poor growth of the cultured shrimps. Hence feeding rate and feeding frequency should be regulated using feed check trays.

Health Management plays very important role to prevent the occurrence of diseases in the cultured shrimps. Since disease manifestation is a complex interaction of shrimp, pathogen and environment, holistic management approach involving the following processes need to be adopted.

- Undertake continuous monitoring of the health of the shrimps using rapid diagnostic techniques.
- Exclude pathogens from the culture ponds by proper water management and preventing the entry of carriers of pathogens.
- Use prophylactic treatments and use of probiotics to exclude harmful bacteria from the pond ecosystem
- Use non-specific immuno stimulants to enhance the immune response of the shrimps
- Avoid environmental stress by proper water and soil management following bio-augmentation and bioremediation methods.

Waste Management

This is extremely essential in large farms to reduce the nutrient loading in the source water. For the farms above 5 ha, effluent treatment ponds are essentially needed.

HARVESTING AND MARKETING

Harvesting and marketing of the produce from shrimp farms is relatively easy as the processors or their agents readily agree to collect it at the farm site.

CAPITAL INVESTMENT AND RETURN

In order to construct a 5 ha farm, Rs 15 to 20 lakhs will be needed depending on the soil characteristics, distance and elevation of the site with reference to the source water. Recurring Expenditure of a 5 ha farm will be around Rs 12 to 16 lakhs per annum. The cost of production is around Rs 120 to 160 per kg of shrimp.

By following proper management practices, it is possible to produce from a 5 ha farm, 10 tonnes of shrimp, at a farm gate price of Rs 30 lakhs. It is expected to earn on an average, a net profit of Rs 2 lakhs per ha, by complete adoption of the recommended practices.

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SHRIMP HATCHERY TECHNOLOGY

Presently about 1.70 lakh hectares of brackish water area is under shrimp farming with a seed requirement of about 12–15 billion post larvae, which is being met by about 237 commercial shrimp hatcheries having installed capacity of 11.4 billion post larvae. It is estimated that by 2020 AD, the area under shrimp farming may be nearly double, leading to a demand of 30 billion post larvae annually. Hence there is an enormous scope for establishment of commercial shrimp hatcheries in the country.

The quality of the seed plays a very important role in shrimp seed production or hatchery technology as the shrimps do not mature and spawn under captive conditions. The early larval forms being purely marine, very much need marine environment for growth and survival. Hatchery technology therefore, aims to provide the larvae, conducive environment with stable water quality and proper quantity of quality feed. The Central Institute of Brackish Water Aquaculture (CIBA), Chennai has developed package of practices for shrimp hatchery technology. Based on production capacities, the shrimp hatcheries are classified as backyard, medium, and large scale hatcheries.

Hatchery produced shrimp post larvae

It is recommended that the ideal sites for shrimp hatchery are those that are located:

- Near calm seacoast.
- Away from any freshwater/brackish water inflow.

Water quality parameters like salinity, temperature and pH play important role in successful operation of a hatchery. Many contaminants and pollutants like pesticides and heavy metals should be well within the safe levels for the larvae as shown below:

Parameters	Tolerable Limit	Optimal Levels
Temperature (°C)	18–36	28–32
Salinity (ppt)	26–34	30–34
pH	7–9	8–8.4
Dissolved oxygen (ppm)	> 3	> 4
Ammonia–N (ppm)	≤ 0.1	< 0.01
Nitrite–N (ppm)	≤ 0.1	< 0.01

INFRASTRUCTURE REQUIREMENTS

A. Shrimp hatchery should have provisions for

- brood stock maintenance
- induced maturation (shrimps)
- spawning/hatching
- larval rearing
- live-feed culture (phytoplankton/zooplankton), and
- post larval rearing

B. Provision of four major infrastructure systems to maintain live organisms in the hatchery

- Assured seawater supply system consisting of water intake, pumps, settlement and treatment tanks, reservoir, filtration units, and distribution pipelines to various systems.
- Air-supply system consisting of air blowers and distribution system.
- Tanks of different capacities for maturation, spawning, hatching, larval rearing, algal culture, Artemia hatching and post larval rearing.
- Sheds to house the different systems.
- Analytical laboratory for water quality and health management.

Since the Shrimp hatcheries may have varying post larval production capacities—ranging from 2 to 200 million per annum, the capacities of above-mentioned items of infrastructure will proportionately vary according to the production capacity.

MANAGEMENT OF HATCHERY

Water quality management

To get clean and clear water without any suspended particles and harmful pathogens, requires settlement of the pumped water, chemical treatment with chlorine, de-chlorination, filtration through rapid sand filters and biological filters, UV filtration for algal culture and larval rearing.

Feed management

Maintain pure culture of diatoms and unicellular algae, mass culture

A small scale shrimp hatchery

of diatoms and algae, hatching of artemia cysts, preparation of suspension diet and artificial feed.

Schedule of water quality and feed management

Days	0	1	2	3	4	5	6	7	8	9	10	12	15	20	30
Larval stages	Nauplius			Protozoea					Mysis				Postlarva		
Feeding schedule															
Algae/Diatoms				20,000–50,000 cells/ml											
Artemia nauplii									3–5 /ml				2–5/ml		
Suspension feed/ Palletized feed													5–10 g/t/day in small doses		
Water exchange	No change Only filling			30%					50%				50–100%		

Health management

Proper larval rearing is very important for Indian conditions as there had been an outbreak of White Spot Virus disease. Seed being one of the major source of this virus and vertical transmission of the virus has been established, the hatcheries should invariably adopt the following precautionary principles:

- Screen wild spawners and broodstock for virus.
- Treat wild and induced matured spawners with formalin to remove the external pathogens.
- Wash and treat eggs with formalin.
- Wash and treat of nauplii with formalin before stocking in larval rearing tanks.
- Apply probiotics in the larval rearing tanks.
- Screen all the feed used in the hatchery for virus/bacteria
- Screen post larvae of 5 days (PL5) for White spot virus before transfer to nursery tanks.
- Acclimatize the post larvae to the pond salinity conditions in the nursery.

The above recommended schedule is a generalized one. Various hatcheries adapt the same according to the conditions of the source water, water treatment methods followed and availability of live feed. Some of the hatcheries even use additional feed items such as Spirulina powder, Artemia

flake diets, commercial micro-encapsulated diets, etc.

CAPITAL INVESTMENT AND RETURN

Investment

The capital investment depends on the production capacity of the hatchery., the sea water quality and the availability of shrimp spawners. A hatchery of ten million capacity costs about Rs 20–25 lakhs, while for a 200 million hatchery capacity the cost is about Rs 80–100 lakhs. The recurring expenditure for production of one million post larvae (PL20) is about Rs 1.5 to 2.0 lakhs depending on the cost of spawners.

Return

Depending on the demand during stocking season, the cost of seed at the hatchery varies between Rs 300 to Rs 600 per thousand post larvae. Hence, on an average, sale price of Rs 4.0 to 4.5 lakhs per million of post larvae can be expected. The expected profit margin depending upon the management capacity is in the range of Rs 2–3 lakhs per million post larvae produced.

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HATCHERY TECHNOLOGY FOR FRESHWATER PRAWN

Freshwater prawn

The giant freshwater prawn, *Macrobrachium rosenbergii* (scampi) is a highly valued delicious food and commands very good demand in both domestic and export market. Due to its fast growth rate, high market demand, attractive price and its compatibility to grow with carps, it is fast becoming one of the most important cultured species in the inland aquaculture system in the country. This species can also be cultured in low saline brackish water areas (salinity <10 dS/m) and can be cultured either alone (monoculture) or as a polyculture in combination with carps, tilapia and chanos. It is also a suitable species for incorporation in the paddy cum fish culture. Culture of freshwater prawn can be carried out in earthen ponds, cement cisterns, pens or in cages. However, most of the operations are being carried out in earthen ponds.

The Central Institute of Freshwater Aquaculture (CIFA), Bhubaneshwar, has developed a viable hatchery technology for the production of high quality seed and for table size prawn production. The technology involves:

- Captive generation of high quality Broodstock in earthen ponds,
- Semi-closed, two phase clear water larval rearing, and
- High density rearing of post-larvae.

A. Captive Generation of Broodstock

The advanced juveniles, weighing more than 5 gram should be stocked @ 1–2/m^2, by keeping male to female ratio of 1: 4, in well prepared earthen ponds. The prawns should be fed with specially formulated broodstock diet (crude protein 38%, lipid 8%), twice daily @ 10% of the prawns weight for the first two months and subsequently at the rates of 2–5% of the biomass. The ponds should be monitored and managed on a regular basis to maintain optimum water quality. The prawns attain maturity in 2–3 months. Thereafter, females bearing advanced embryos are collected from these ponds regularly for the seed production purpose.

B. Semi-closed, Two Phase Clear Water Larval Rearing

Two-phase clear water technology is suitable for larval rearing for non-coastal hatcheries. This technology may be adopted after suitably modifying

as per location specific requirements also. The steps involved in the larval rearing technique are:

- Healthy mother prawns (bearing grey eggs on their pleopods and weighing more than 50 gram should be selected from the brood stock pond/tank and disinfected for thirty minutes with 0.3 ppm Copper Sulphate or 30 ppm formalin.
- Mother prawns are then stocked @100–150 g/m^2 (2–3 number of 50 gram female) in brackish water (salinity ≤ 5%) and reared till hatching. Tanks should be checked daily for appearance of larvae.
- Once hatching occurs it may continue for 24–48 hours. The spent females should be removed from the tank and released back to the brood stock pond.
- The salinity of the larval rearing medium is then increased to 12% and the rearing is continued in the same tank.
- During the first phase, the larvae (also called as Stage I or Zoea I) should be stocked in conical tanks at a high density (200–400 larvae per litre). About 50% of the medium is usually exchanged every other day with fresh medium of identical salinity. The larvae are reared for 10–12 days in this phase.
- In the second phase, the advanced larvae should be stocked at the rate of 50–80 per litre of medium in large cement tanks of a greater surface area and reared till metamorphosis. About 50% of the medium should be exchanged every other day.
- The freshly hatched *Artemia nauplii* should be given as live food to the prawn larvae, 4–5 times per day in the early stages (Stages II to V or VI). During later stages it can be given once during late evening in combination with wet larval feed which is usually given during day time. The brine shrimp *nauplii* are fed to the prawn larvae @ 5 to 50 *nauplii* per larva per day. About 2 kg of *Artemia* cysts is required to produce one lakh post-larvae.
- Wet larval feed (egg custard, minced fish/mollusc flesh; protein level of more than 50%) is fed @50–200 µg/larva/day depending on the larval stage. The wet feed is given during day time.
- The larval rearing tanks should be cleaned daily by siphoning off excess food particles and metabolic waste from the tank bottom. This should be done after stopping aeration, preferably in the evening hours before exchange of water and introduction of live food (*Artemia nauplii*).

- Daily monitoring of water temperature, salinity, pH and dissolved oxygen levels should be carried out to maintain the water quality at optimum level for successful seed production as per the given parameters.

Water temperature	29–31°C
Salinity	10–13%
pH	7.0–8.5
Dissolved oxygen	>5 ppm
Nitrite	< 0.1 ppm
Ammonia NH_3–N	< 0.1 ppm

- The appearance of first post-larva is usually observed 20 days after hatching, normally between 22 and 32 days (at 28–32°C) and 90% larvae metamorphose within next 10 days.
- The post-larval production normally ranges from 35–40 per litre and the cycle lasts for 35 to 40 days.
- The post-larvae are gradually acclimatized to freshwater and reared at high densities (2000–5000/m^2) for 10–15 days in hatchery. The post-larvae should be fed on formulated diet @100% of the biomass daily. After a week or a fortnight, the post-larvae are suitable for stocking in grow-out ponds.

C. Culture Technology of Freshwater Prawn

The technology aims at a sustainable production of 1.0 to 1.5 tonnes prawn/ha/crop. The technology involves an initial nursery phase of two months followed by a grow-out phase of six months. Prawn culture technology includes the following steps:

- Preparation of pond,
- Eradication of competitors and predators,
- Fertilization of pond with organic and inorganic manures,
- Provision of hide outs,
- Stocking of ponds with juveniles,
- Feeding,
- Management of water quality,
- Pond aeration,
- Sampling of prawns for growth measurement,
- Disease control, and
- Harvesting.

In the nursery phase hatchery produced post-lavae should be reared for two months in well-prepared earthen nurseries (0.02 to 0.1 ha)

@ 20–50/m^2. The post-larvae need to be fed twice daily with formulated pellet diet in crumble form @ 25–50% of the biomass. Aeration should be provided from an aerator for about 8 hours daily. The ponds are monitored and managed on a regular basis to maintain optimum water quality.

The nursed juveniles, weighing nearly one gram should be harvested from the nurseries and stocked in well prepared earthen production ponds @ 4–6/m^2. The prawns are fed daily with formulated pellet diet (2–3 mm size) @ 10% of the biomass initially and then reduced to 3% of the biomass at the end of the culture period. Daily monitoring of critical water quality parameters such as dissolved oxygen, pH, and temperature is essential to prevent any loss of stock due to poor water quality.

Phytoplankton bloom and decaying waste materials are usually the main reasons for dissolved oxygen depletion in prawn ponds. Regular monthly sampling with cast nets or small mesh seine nets should be done to assess growth of the prawns. After four months, prawns that achieved marketable size (more than 30 gram) are removed by using a seine net of suitable mesh size. Selective harvesting should continue once every 3–4 weeks for another 3–4 months and finally the pond may be harvested by complete draining of water.

Harvested prawn from grow out ponds

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AGRICULTURAL ENGINEERING

LOW COST GREENHOUSE

A typical low cost Green House

The greenhouse technology is one of the surface covered cultivation technologies, in which a structure is constructed in different shapes suiting the local environmental conditions of the area. The All India Coordinated Project on Application of Plastics in Agriculture has developed technology of constructing low cost green houses. The basic structures are constructed using bamboo/wood/GI pipe for low cost greenhouses. These structures are covered with a cladding material of ultra violet (UV) stabilized low density polyethylene plastic sheets, which allow only short wave length light to pass through it and it is opaque for long wave radiations.

The short wave radiations are helpful for crop production and therefore are allowed to fall either on crops or soil surface, and get reflected as long wave radiations. These are then allowed to remain within the greenhouse thereby, enhancing the inside temperature.

RAW MATERIALS

Bamboo/wood/GI pipe and UV stabilized film (200 μ). Normal carpentry tools are needed for its construction.

COST

The cost of construction varies as per cost of raw material i.e. bamboo/wood/GI pipe for different locations. The total cost varies from Rs 80–150/m^2. The technology is best suited for growing of off-season vegetables/flowers and nursery. Depending upon the crop, it was possible to achieve 2 to 5 times more productivity and also 8–21 days earliness. Higher benefit cost ratio was found for Capsicum–Cabbage–Green Onion, Tomato–Pea–Tomato, Chilli (nursery)–Chilli, and Spinach (one cut) –Broccoli–Sweet Pepper crop sequences.

For more details contact:

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Ludhiana 141 004

AVAILABILITY

Necessary design is available from Project Coordinator, AICRP on Application of Plastics in Agriculture, Central Institute on Post Harvest Engineering and Technology, Punjab Agricultural University Campus, Ludhiana (Punjab).

LAC SCRAPPER CUM GRADER

Lac scrapper cum grader is a machine developed at the Central Institute of Post Harvest Engineering and Technology (CIPHET), Ludhiana for scrapping and grading the stick lac obtained from the trees, to minimize the human drudgery involved in the traditional process.

Lac scrapper cum grader

TECHNICAL SPECIFICATIONS

The machine comes in two variants of 20 kg/hour and 50 kg/hour capacities and is easily scalable as per the requirements of the user. The scraper cum grader has been tested successfully and extensively in the lac growing areas by the Indian Lac Research Institute, Ranchi. It comprises of:

- A frame
- Feed hopper
- Scrapping rollers
- Rotor
- Crusher and an oscillating grader (to separate the lac into three distinct grades, which can be used directly by the lac processing industry to manufacture different products).

The machine is power operated with a maximum capacity of 50 kg/hour of stick lac processing, which is fifty times faster than the traditional manual process of scrapping. Under field conditions, it has been found suitable to scrap and grade the stick lac of all the major and minor host plants into three grades, up to 20 mesh, 20–30 mesh and >30 mesh size.

PRICE

A 20 kg/hour capacity machine costs nearly Rs 30,000, while the cost of 50 kg/hour capacity is Rs 50,000.

For more details contact:

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Central Institute of Post Harvest Engineering and Technology (ICAR), P.O. PAU, Ludhiana 141 004

AVAILABILITY

The machine is available from the Central Institute of Post Harvest Engineering and Technology, Ludhiana as per the requirements of the user.

TRACTOR DRAWN PNEUMATIC PLANTER

A tractor drawn pneumatic planter has been designed by the Central Institute of Agricultural Engineering (CIAE), Bhopal for placement of seeds at desired depth and spacing in the soil for a better crop stand and higher production and productivity. The pneumatic planting concept is based on the suction principle, in which an aspirator is used to develop suction pressure in the metering chamber of the pneumatic disc. A few seeds are held against the orifice hole made on the periphery of seed metering plate due to suction. The seeds remain attached at the hole till it reaches to a position where the suction pressure is cut off. As soon as the suction pressure is cut off, the seeds fall on the soil surface due to gravity.

Tractor drawn pneumatic planter

TECHNICAL SPECIFICATIONS

Number of rows:	Adjustable 6, 4, and 2 rows and optional 10 rows.
Seed metering:	Pneumatic disc suction principle.
Suitability for crops:	Rapeseed mustard, soybean, sunflower safflower, groundnut, Pigeon pea, cotton, maize, wheat, pea and okra, etc.
Planting spacing:	Row spacing and hill spacing in a row are adjustable as desired.
Special provisions:	Provision for inter row and check row planting.
Power source requirement:	35 H.P. Tractor for operation.
Capacity:	0.5–0.6 ha/h (2 m tool bar).
Overall length:	200 cm (without line markers).
Overall width:	152 cm.
Overall height:	200 cm.
Weight:	300 kg (empty).
Hopper capacity:	10 kg each row.

PRICE

Rs 48,000 (Rupees Forty Eight Thousands) approximately

AVAILABILITY

1. Central Institute of Agricultural Engineering Nabibagh, Berasia Road, Bhopal-462 038
2. M/S Vinod Enterprises, 104, Sector-I, Industrial Area, Bhopal.

For more details contact:

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INTEGRATED TURMERIC PROCESSING UNIT

Integrated turmeric processing unit

Turmeric rhizomes, after harvesting, need to be washed in water to remove the adhering earth. Thereafter it is boiled in water to achieve desired softness, and sun dried. Subsequently it is polished to remove the outer dirty skin and to improve the appearance and colour of the rhizome. A hand operated Integrated Turmeric Processing Unit has been fabricated by the AICRP on Post Harvest Technology, CIPHET, Ludhiana to perform all the three operations—washing, curing and polishing in the same unit.

TECHNICAL SPECIFICATIONS

A hexagonal drum (30 cm side of hexagon and 60 cm length) is rested on a stand with movable bush arrangement. The drum is made with replaceable washing and polishing plates. Perforated aluminum plates are used for washing. Plates made of inner expanded wire mesh and outer oven wire mesh is used for polishing operation. The drum is rotated inside a water tank placed below the drum for washing. The bottom portion of the drum is submerged inside the water in the tank.

WORKING

When the drum is rotated manually by means of a handle, the adhering earth on the rhizomes is washed away and collected in the water tank, which has a provision for discharge of the mud water through an extended pipe at the bottom of the tank connected with gate way valve. After necessary washing, the tank is placed over fire and covered with a hood during curing operation so that turmeric in the drum is cured. During curing, the drum needs to be rotated 3 to 4 times to achieve uniform curing of the rhizomes. The same drum by simply changing the plates is also used for polishing of dried turmeric. Turmeric is loaded in the drum by opening one of the plates working as door. After the operation the drum is tilted vertically side wise by opening the bush lock and rested on another stand. Drum needs to be rotated 3 to 4 times. Turmeric is discharged by opening the door plate.

Capacity	200 kg/hour for washing, 50 kg/batch for curing, and 100 kg/hour for polishing
Power	Manually operated
Cost	Rs 6000.00 approximately

The drum is then loaded and the bush is locked with the stand for operation of next batch. This unit can also be used for washing and peeling of ginger by connecting wooden planks, which are corrugated inside in the drum.

AVAILABILITY

The machine is available from the Central Institute of Post Harvest Engineering and Technology, Ludhiana as per the requirements of the user.

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LAC CULTIVATION (*RANGEENI*) IN *PALAS* AND *BER*

Lac is an important source of income especially for the tribal population of lac growing areas. *Palas* and *ber* trees are abundantly available in the plateaus of Jharkhand State on which farmers produce lac. In order to have sustainable lac production from those trees, the Indian Lac Research Institute (ILRI), Ranchi. has developed improved techniques for combined lac production from *palas* and *ber*.

PARTITIONING OF HOST TREES

By giving proper rest to host trees, it is possible to have less attack of enemy insect leading to increased lac production. Therefore, the trees should be divided in groups and lac cultivation done alternatively by giving proper rest to trees. The available *palas* trees should be divided in two groups and a third group is made of the *ber* trees. Six months before inoculation, all *ber* trees and one group of *palas* trees should be pruned in April. During October-November, the two groups of tree are inoculated. In April, next year *ari* lac crop from *ber* trees is harvested and the second group of *palas* trees are pruned. The lac crop on first group of *palas* trees is left for self inoculation in June-July and in October-November complete crop should be harvested.

The lac thus obtained is used for inoculation of other group of *palas* trees and the group of *ber* trees. If some lac encrustation are left on *palas* trees after harvesting, these should be left as such and be harvested while pruning in April. Thus on two groups of *palas* trees, *Baisakhi* and *Katki* and on *ber* trees *Baisakhi* crop can be taken regularly.

Those of the farmers having only *palas* trees, the above technique can be adopted by dividing *palas* trees in three groups.

PRUNING OF TREES

For survival of lac insects on host trees, presence of abundant number of new and succulent shoots is essential. The *palas* trees on which lac crop is taken should be pruned in April and all trees of *ber* should be pruned in April-May. *Ber* tree needs pruning initially only once. Later on *ari* harvesting can also serve the purpose of pruning.

PRUNING CONSIDERATIONS

- Undertake only mild pruning.
- Branches which are more than 2.5 cm (1 inch) in diameter should not be pruned.
- Branches between 1.25 to 2.5 cm (0.5 to 1 inch) diameters should be pruned beyond 0.5 m from its point of emergence. However, the branches of less than 1.25 cm (0.5 inch) diameter should be pruned right at its point of emergence.
- Branches which are dry, broken or split, disease infected should be fully pruned.
- Undertake pruning with a sharp knife, and tree pruner by giving a slant cut, so that during rainy season rain water does not stagnate.

INFESTATION OF HOST TREES

During October-November, pruned trees should be inoculated with healthy broodlac. Following aspects should be considered during inoculation:

- One meter length of broodlac is sufficient to inoculate 25 m length of new shoot. On an average, for a medium sized *palas* and *ber* trees, 0.25-0.50 kg and 1-2 kg of broodlac respectively will be required. However, this quantity of broodlac can be varied depending tree size.
- Inoculate mature and healthy broodlac free from enemy insect. For this, branches 15-20 cm (6-8 inch) in length (weighing about 50-100 g) are filled in a bag (made of nylon net of 60 mesh size) and these bags should be tied on the branches of the tree.
- In case nylon net bags are not available, treat the broodlac by dipping in 0.05 % solution of Endosulfan (Thiodan) for 8 to 10 minutes and allowed to dry. The dried broodlac (100g bundle) is then tied with nylon strings on the tree branches in a way that it remains in contact with the branch. This will enable insects to crawl on branches of the tree from the broodlac.

broodlac

CONTROL MEASURES OF ENEMY INSECT

For sustainable production of broodlac, control of enemy insect is essential. The rainy season crop (*Katki*) is more prone to attack. About six weeks after self inoculation, spray 0.05 solution of Thiodan (Endosulfan) in June-July. If need be, second spray may be carried out after one month of first

Different quality lac

For more details contact:

Director
Indian Lac Research Institute
(ICAR),
Ranchi 834 010
Jharkhand

spray. In order to prepare Endosulfan solution, add 20 ml of Endosulfan solution in 14 liter of water and thoroughly mix it. This solution can be used either for broodlac treatment or for spray on the trees.

REMOVAL OF USED BROODLAC (*PHUNKI*)

Remove *Phunki* from the tree after three weeks of inoculation; otherwise emergence of enemy insect takes place which may spread in the new crop. The lac encrustation on *phunki* must be removed by scraping with pruning knife or scraping machine and can be appropriately marketed.

CROP HARVESTING

Ari lac from *ber* should be harvested by scraping in April-May for marketing. The harvesting of *palas* crop should be undertaken in October-November when yellow spots appear on lac encrustation and lac insect start emerging out of the cell. Usually yellow spots appear ten days before emergence of lac insect.

CENTRALLY SPONSORED SCHEMES IN AGRICULTURE

FACILITIES AND SERVICES PROVIDED BY CENTRALLY SPONSORED SCHEMES IN AGRICULTURE

KISAN CALL CENTRES

In order to provide an easy access to agricultural information for decision support, the Government of India has taken up a major initiative of launching a network of Kisan Call Centres for farmers on 21st January, 2004. The Call Centres are accessible on Toll Free Telephone No. 1551 and are presently located in Delhi, Bangalore, Chandigarh, Chennai, Hyderabad, Kanpur, Kolkata and Mumbai. The Centres are manned by agricultural graduates to answer queries related to weather, seeds, fertilizer and similar issues. These Call Centres provide advice in the local language and operate on all seven days in a week. While, online answers are available during the day shift, the answers are given 24 hours of the day. Beyond office hours, the queries are recorded and responded to by post.

KISAN SATELLITE CHANNEL

The Prime Minister of India launched a Kisan satellite TV channel on 21st January, 2004 so that well tested and easily adoptable agricultural technologies and technologies which are in the pipeline generated by the Agricultural Research Institutions and State Agricultural Universities are easily transferred to the farming community and other stake holders through a very vital medium i.e. Doordarshan. At present, the national telecast for kisan channel is through the Indira Gandhi National Open University cable network. The programme is of one hour duration and transmitted from 6–7 AM, 8–9 AM and 5.30–6.30 PM and 7.30–8.30 PM. The programme likely to be further expanded to two hours to be repeated four times in near future. Similarly, from February 2004, 96 FM Stations of the All India Radio and 12 Doordarshan Kendras in the country (Hisar, Varanasi, Muzaffarpur, Indore, Rajkot, Jalpaiguri, Sambalpur, Shillong, Dibrugarh, Gulbarga, Daltonganj and Vijayawara) will also have one hour agricultural broadcast/telecast.

For more details contact:

Joint Secretary (Extension), Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendra Prasad Road, New Delhi

PILOT PROJECT ON FARM INCOME INSURANCE

This scheme has been launched very recently to provide comprehensive risk protection, financial security, incentive to adopt progressive farming practices, to enhance food and livelihood security, and income protection for entire produce, including produce kept for his own consumption and other policies.

For more details contact:
Agricultural Insurance Company/Bank Branch/ nearest Primary Agriculture Cooperative Society or Agriculture Insurance Co. of India Ltd.
13th Floor, Amba Deep
Kasturba Gandhi Marg
Connaught Place, New Delhi
(Website:www.aicofindia.org)

The Scheme covers all farmers, loanee farmers on compulsory basis and non-loanee farmers on voluntary basis and is operative in 20 districts of 13 States for wheat and rice during *rabi* 2003–2004 season. Though the premium rate is to be charged on actuarial basis, there is a subsidy in premium upto 75% to small/marginal farmers and 50% to the others. The claim becomes payable if the actual income for the season false short of guaranteed income.

NATIONAL AGRICULTURAL INSURANCE SCHEME (NAIS)

The NAIS is being implemented as a Central Scheme in 18 States and 2 Union Territories with the objective of i) providing insurance coverage and financial support to the farmers in the event of failure of any of the notified crop as a result of natural calamities, pest and diseases, ii) encouraging farmers to adopt progressive farming practices, high value inputs and higher technology in agriculture, and iii) helping stabilize farm incomes particularly in disaster years. The Scheme is available to all farmers irrespective of the size of their hoardings and is compulsory for loanee farmers and optional for non-loanee farmers. It covers all food crops (cereals, millets and pulses), oil seeds and annual commercial/horticulture crops for which past yield data are available for adequate number of years.

For more details contact:
General Insurance Corporation of India or
Joint Secretary, Credit Division, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendra Prasad Road, New Delhi.

The small and marginal farmers are provided subsidy for 50% of premium and the subsidy is phased out over a period of five years. The lowest unit of insurance has been identified as Gram Panchayat level. At the beginning of each crop season, the State Government/Union territory in consultation with the General Insurance Corporation of India (GIC) notifies the crops and defines the areas which will be covered under the scheme during the season.

GENERATION OF INFORMATION ON WHOLESALE PRICES, ARRIVALS AND TRENDS IN VARIOUS MARKETS FOR HORTICULTURE PRODUCE AND DISSEMINATION OF INFORMATION THROUGH MEDIA AND PUBLICATIONS

The Scheme is implemented through the National Horticulture Development Board and provides for assistance to farmers, exporters, dealers, and research organizations etc. in establishment of nutritional gardens in rural areas, distribution of fruit plants and vegetable seeds in mini kits, zero energy cool chambers, and for demonstrations. Scheme provides for Rs 250 per mini kit per family, Rs 2,500 per zero energy cool chamber per school/village in a panchayat selected for the demonstration and upto Rs 5,000 per school per panchayat selected for demonstration.

For more details contact:

Executive Director
National Horticulture Board
85, Institutional Area, Sector 18, Gurgaon, Haryana or
Horticulture Commissioner,
Horticulture Division,
Department of Agriculture and Cooperation,
Krishi Bhawan,
Dr Rajendra Prasad Road
New Delhi, or Director of Horticulture of the concerned state.

TRAINING IN PLANT PROTECTION

In order to build human resource development in plant protection technology, the National Plant Protection Training Institute, Rajendra Nagar, Hyderabad (Andhra Pradesh) is providing training to unemployed agricultural graduates for Post Graduate Diploma Course in Plant Protection of 10 months, beginning July every year. The nominations are received through concerned State Government/Union territory.

For more details contact:

Plant Projection Advisor
Directorate of Plant Protection Quarantine and Storage, NH IV Faridabad, Haryana or
Director, National Plant Protection Training Institute, Rajendra Nagar, Hyderabad, Andhra Pradesh, or Director of Agriculture of the concerned State

PROMOTION OF INTEGRATED PEST MANAGEMENT (IPM)

This Central Sector Scheme is in operation since 1991 and aims at best mix of all known pest control measures to keep the pest population below economic threshold level. The Scheme provides for popularization of 20 IPM packages to be implemented as per local needs. Provision has been made for popularizing IPM approach among farming Communities, organizing regular pest surveillance and monitoring, rearing biological control agents for their field use and conservation, promoting use of bio-pesticides, neem based pesticides, bacillus based bio-pesticides, insect pathogen as alternative to chemical pesticides, training to master trainers, extension workers and farmers, field releases of laboratory reared bio-control agents for the control of pests and issuing insect pest and disease situation bulletins for the benefit of state functionaries and farmers.

For more details contact:

Subject Matter Specialist (Plant Protection), State Department of Agriculture at the District Level of the concerned State) or
Plant Protection Advisor
Directorate of Plant Protection Quarantine and Storage
Government of India,
NH IV, Faridabad 121 001
Haryana

NATIONAL PULSES DEVELOPMENT PROJECT

This centrally sponsored scheme provides assistance to the States for various components (i) seed related (purchase of breeder seed, production of foundation and certified seed, mini kits and crash programme for production of seeds of pulses), demonstrations (frontline, block and IPM), improved method of irrigation, distribution of improved farm implements and plant protection equipments, distribution of rhizobium cultures, nutrients and micro-nutrients, gypsum/pyrites and seed treatment chemicals, and training of farmers. The scheme is being implemented on 75: 25 basis as Central and State shares respectively. At present, the farmers who take up production of pulses in projected districts in 28 States are covered under the scheme.

For more details contact:

Directorate of Agriculture of the concerned State or Mission Director TMOP Division, Department of Agriculture and Cooperation, Dr Rajendera Prasad Road, Krishi Bhawan, New Delhi

INTENSIVE COTTON DEVELOPMENT PROGRAMME (ICDP) UNDER MINI MISSION II OF TECHNOLOGY MISSION ON COTTON

This Scheme is in operation since February 2000 as a centrally sponsored scheme with provision of (a) assistance for production of breeder, foundation and certified seed and its distribution, (b) field and integrated pest management demonstrations, (c) training of farmers and extension workers, and (d) distribution of plant protection equipment, water saving devices, bio-agents and pheromone traps. The activities are implemented through State Departments of Agriculture, Indian Council of Agricultural Research, State Agricultural Universities and Krishi Vigyan Kendras. The scheme is in operation in nine major states of Punjab, Haryana, Rajasthan, Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Gujarat Madhya Pradesh, two States with small areas under cotton (Uttar Pradesh and Orissa) and two non-traditional States (West Bengal and Tripura).

For more details contact:

Director of Agriculture of the concerned State or AgricultureCommissioner Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi

MINI KIT PROGRAMME FOR RICE, WHEAT AND COARSE CEREALS

The Scheme aims at increasing the productivity by popularizing the use of newly released hybrids/high yielding varieties and spread the area coverage under location specific high yielding varieties/hybrids. The rice mini kit programme was stared in 1972–73, wheat mini kit programme from 1974–75 and coarse cereals mini kit programme from 1974–75. The components of the scheme are seed mini kit distribution programme and state level training programmes.

For more details contact:

Director of Agriculture of the concerned State or Agriculture Commissioner, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi

POST HARVEST TECHNOLOGY IN OIL SEEDS, PULSES AND MAIZE

The Post Harvest Management of oil seeds, pulses and maize is an integral part of the strategy for accelerating supply of these essential and vital Indian dietary commodities in proportion to the growing population. The Scheme is being implemented under Central Sector since 1991 and aims at integrated approach to step up production through scientific handling of harvest, procurement, storage care, and efficient scientific processing. The eligible beneficiaries are: farmers groups, non-government organization, small entrepreneurs engaged in processing, cooperatives/private processors/ state governments/public sectors and other entrepreneurs. The Ministry of Agriculture provides 100% grants while the Council of Scientific and Industrial Research is the nodal agency for mobilizing the funds. The interested agencies/organizations are required to send a proposal to the Ministry of Agriculture.

For more details contact:

Director of Agriculture/ Director of Small Scale Industries of the concerned State or Assistant Commissioner (TMOP and M) Department of Agriculture and Cooperation, 2nd Floor, B–Wing, Janpath Bhawan, Janpath, New Delhi

HORTICULTURE DEVELOPMENT TECHNOLOGY AND TRANSFER

The scheme is being implemented as a Central Sector Scheme of the National Horticulture Development Board including components of (i) introduction of new technologies, (ii) visit of progressive farmers, (iii) experts services from India/Abroad, (iv) technology awareness, (v) organization/ participation in seminars etc. (vi) Udyan Pandit, (vii) publicity, (viii) observation cum study tours abroad, and (ix) honorarium to scientists for effective transfer of technology. The scheme provides for 100% financial assistance upto Rs 10 lakhs per project for production related projects and upto Rs 25 lakh to research and development efforts. Second class sleeper rail/ordinary bus fares and Rs 100 per day per farmer for a group of 30 farmers is also provided for study visits of farmers.

For more details contact:

Executive Director, National Horticulture Board, 85, Institutional Area, Sector 18, Gurgaon, Haryana, or Horticulture Commissioner, Horticulture Division, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendra Prasad Road, New Delhi

HORTICULTURE PROMOTION SCHEME

The scheme is funded through the National Horticulture Development Board and provides for techno -economic feasibility studies to review the present status of horticulture development in particular areas/state, identify constraints and suggest remedial measures, and develop short term and long term strategies. Full financial assistance is provided through professional consultants and the eligible promoters include Non-Governmental Organisations, Association of Growers, Agricultural Produce Marketing Committees/Boards, Municipal Corporations, Agro Industries Corporations, etc.

For more details contact:

Executive Director, National Horticulture Board, 85, Institutional Area, Sector 18, Gurgaon, Haryana or Horticulture Commissioner, Horticulture Division, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendra Prasad Road, New Delhi

CAPITAL INVESTMENT SUBSIDY FOR CONSTRUCTION/ EXPANSION/MODERNISATION OF COLD STORAGE/STORAGES FOR HORTICULTURE PRODUCE

For more details contact:

Executive Director, National Horticulture Board, 85, Institutional Area, Sector 18, Gurgaon, Haryana or Horticulture Commissioner, Horticulture Division, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi

The Scheme is implemented by the National Horticulture Development Board and provides for assistance upto Rs 2 crores for expansion of existing capacity (Rs 4,000 per metric ton), subsidy @ 25% of the capital cost of modernization and rehabilitation and for other storages. 50% term loan is provided by banks through National Bank for Agriculture and Rural Development (NABARD) refinance. The subsidy would flow from National Horticulture Development Board and operated by NABARD through commercial/cooperative banks and by National Cooperative Development Corporation (NCDC) where cooperatives seek loan from NCDC.

COCONUT DEVELOPMENT BOARD

As a part of the central sector scheme, the Coconut Development Board aims at (i) increasing production and productivity of coconut, (ii) bringing additional area under coconut in potential non-traditional areas, (iii) developing new technologies for product diversification and bi-product utilization, (iv) strengthening mechanism for transfer of technologies, (v) elevating the income level of small and marginal farmers engaged in coconut cultivation, (vi) building sound information base for coconut industry, and (vii) generating ample employment opportunities for the rural sector. All the farmers can avail of the facilities through the concerned State Governments. The Scheme provides for production and distribution of quality planting material, integrating farming practices, technology demonstration, etc. The pattern of assistance is available for production and distribution of planting material, expansion of area under coconut, integrating farming for productivity improvement, financial assistance to coconut based industries @ 25% of the cost of building/plant/machinery or Rs 2.5 lakhs whichever is less, setting up of pilot plants for the integrated coconut processing @ 50% of the cost of building plant/machinery or maximum of Rs 5 lakhs, financial assistance for introduction of Agmark/ ISO standards in Coconut Processing Units @ 25% of the cost of laboratory equipments or Rs 1 lakh whichever is less.

For more details contact:

Chairman
Coconut Development Board, Kochi (Kerala)

OIL PALM DEVELOPMENT PROGRAMME

A centrally sponsored scheme is being implemented since 1992–93 as a part of the oil palm development programme carried out by the Horticulture Departments/Agriculture Departments of the concerned State

Governments. Financial assistance is provided to the farmers for purchase of planting material (75% of the cost of seedlings with a maximum of Rs 5,400 per hectare) in major oil palm growing states namely Andhra Pradesh, Karnataka and Tamil Nadu, and assistance for cultivation cost (50% of the cost of inputs during the gestation period of 4 years with a ceiling of Rs 15,500 per hectare admissible upto 6 hectares for individual farmer, assistance for drip irrigation (50% of the cost for small, marginal, SC, ST, Women farmers and 35% for other category of farmers).

The scheme also provides for assistance for training, extension and publicity, establishment and provision for staff for implementation, seed gardens, and frontline demonstration projects and for leaf nutrient analysis laboratories, etc. to the State Governments.

For more details contact:

Director of Agriculture/ Horticulture of the concerned State or Joint Secretary, Technology Mission on Oil Seeds and Pulses, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi

INTEGRATED PROGRAMMES FOR DEVELOPMENT OF HORTICULTURE IN TRIBAL/HILLY AREAS

This central sector scheme is in operation since 2000–01 with the objective of (i) production of quality planting material of improved cultivars, (ii) new planting with seed/planting material of improved high yielding varieties, (iii) improving productivity through adoption of improved cultivation technology, plant protection chemicals, nutrient and water management, (iv) transfer of technology through farmers participatory demonstrations, training visits, publicity through media support, extension literature etc., and (v) creation of on-farm and post-harvest infrastructure such as collection centres, packaging, transport, storage and marketing. The assistance is provided for crop production, area expansion, transfer of technology, demonstration cum seed multiplication, crops of medicinal plants, irrigation, horticulture machinery and equipment, evaluation technology, and alternative marketing systems. All farmers in the selected districts: Adilabad (Andhra Pradesh) Bastar (Chhattisgarh), Panchmahal (Gujarat), Ranchi (Jharkhand), Keonjhar (Orissa), and Almora (Uttaranchal) can avail the benefits. The Scheme is implemented through the identified state designated agencies.

For more details contact:

Director of Agriculture/ Horticulture of the concerned State or Joint Secretary Technology Mission on Oil Seeds and Pulses, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi

DEVELOPMENT OF COMMERCIAL HORTICULTURE THROUGH PRODUCTION AND POST-HARVEST MANAGEMENT

This scheme is being implemented by the National Horticulture Board as a central sector scheme and covers high quality commercial horticulture crops, indigenous crops/produce, herbs, aromatic and medicinal plants, seeds and nursery, bio-technology, bio-pesticides, organic foods, establishment

For more details contact:

Director of Horticulture/ Agriculture of the concerned States or Executive Director, National Horticulture Board, 85, Institutional Area, Sector 18, Gurgaon, Haryana or Horticulture Commissioner, Horticulture Division, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi

of horticulture health clinics/laboratories (for agriculture/horticulture/ unemployed graduates), consultancy services, bee keeping, special transport vehicles, development of horticulture ancillary industries e.g. tools, equipments, plastics, packaging, etc. The project provides for assistance of maximum of Rs 25 lakhs per project. However, for the north-eastern/tribal/hilly areas the maximum limit of subsidy is Rs 30 lakhs per project.

For more details contact:

Director of Agriculture of the concerned State or National Agriculture Bank (NABARD) or Joint Secretary, Fertilizer Division, Department of Agriculture and Cooperation, Krishi Bhawan, Dr Rajendera Prasad Road, New Delhi (Website: http: agricoop.nic.in/fert1.htm)

NATIONAL PROJECT ON USE OF BIO-FERTILIZERS

This Scheme was launched in March 1983 with the objective of (i) producing and distribution of bio-fertilizers, (ii) developing standards for different bio-fertilizers and quality control, and (iii) training and field demonstrations. The Government provides non-recurring grants upto Rs 20 lakhs to set-up bio-fertilizer production units of 150 metric ton capacity. The grant is offered to State Departments of Agriculture/Cooperatives/ Public Sector Undertakings of fertilizers/Non-Governmental Organizations, and private agencies provided their proposals are received from respective State Governments. One time grant-in-aid upto Rs 1.5 lakh is also provided for establishments of blue green algae sub-centres to produce 30–40 tons of blue green algae per annum provided the proposals are received through respective state agencies.

For more details contact:

Director of Agriculture/ Director of Soil Conservation of the concerned State or Managing Director Land Reclamation and Development Corporation of the concerned State

PILOT SCHEME ON RECLAMATION OF ALKALI SOILS IN HARYANA, PUNJAB and UTTAR PRADESH and EEC ASSISTED PROJECT FOR RECLAMATION AND DEVELOPMENT OF ALKALI SOILS IN BIHAR AND UTTAR PRADESH

These two schemes are being implemented from 1975–76 and 1993–94 respectively and aim at improving the income level of small and marginal farmers by reclaiming the potentially fertile alkali soils. Grants are provided for on-farm development, tube well boring, soil amendment, green manuring, fertilizers, seeds and seedlings. At present subsidy is available from 50–75% on use of gypsum/pyrites as soil amendment and custom hiring services for on-farm development, land leveling, etc.

WATER SHED DEVELOPMENT PROJECT IN SHIFTING CULTIVATION AREAS (WDPSCA)

As a part of the central assistance to State plans, this Scheme is being implemented since 1994–95 so as to encourage overall development of jhum areas on water shed basis, reclaiming the land affected by shifting cultivation, and socio-economic upgradation of Jhumia families to encourage them for settled agriculture. The Scheme can be taken up by government and non-government organizations, scientific and technical institutions in the north-eastern states, where a minimum of 25% area is under shifting cultivation and 50% and more families are engaged in shifting cultivation as the only means of livelihood and are living below poverty line. Gram Panchayats/Village Councils/Village Authority/Village Development Boards/ Non-Governmental Organizations can apply for selection of water shed projects for 100% special central assistance.

For more details contact:

District Nodal Officer Watershed Development of the concerned district in the state or Director of Agriculture of the concerned State