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GOOD AGRICULTURAL PRACTICES FOR MEDICINAL PLANTS

सत्यमेव जयते

National Medicinal Plants Board
Department of AYUSH,
Ministry of Health and Family Welfare
Govt. of India

World Health Organization

In collaboration with
WHO country office for India,
New Delhi

Good Agricultural Practices for Medicinal Plants

National Medicinal Plant Board
Department of AYUSH
Ministry of Health and Family Welfare,
Government of India

In collaboration with

World Health Organization (WHO)
2009

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FOREWORD

We in India have a rich heritage of plant based healthcare systems like Ayurveda, Unani and Siddha with a very high degree of societal acceptance. Forests, however, continue to be the main source of the raw material used in the manufacturer of Ayurveda, Siddha and Unani medicines. Concerned with the unsustainable collection from the wild resulting in a large number of species entering the red data book, the Department of AYUSH, through the schemes of the National Medicinal Plants Board (NMPB), has launched major initiatives to promote cultivation of medicinal plants and thereby integrate medicinal plants into the farming systems.

One of the major challenges facing growth and outreach of the traditional/herbal medicinal products is their quality, safety and efficacy. This inter-alia is dependent on the quality of the raw material used in the manufacture of the finished product.

The National Medicinal Plants Board (NMPB), Department of AYUSH has prepared India specific Good Agriculture Practices (GAPs) on the pattern of Good Agriculture and Field Collection Practices (GACPs) developed by the World Health Organisation (WHO) for medicinal plants.

I am confident that these guidelines, once disseminated and adopted, will go a long way in improving the quality of the products that we manufacture and export and thereby help improve the trade of Indian medicinal and herbal products. This will also help improve the health of the people and thereby increase acceptance of Indian Systems of Medicine world over.

(S. Jalaja)

Dated: October 22, 2009

World Health Organization
Country Office for India

FOREWORD

There is a global upsurge in the use of traditional and complementary systems of medicine. The increasing demand for natural herbal products creates a need not only for conserving medicinal plants in-situ, but also for their cultivation outside the forest areas.

The World Health Organisation (WHO) has developed Good Agriculture and Collection Practices in 2003. A number of countries have adapted them and formulated their own guidelines in order to improve and standardize the quality of raw materials used by traditional medicine practitioners and the herbal industry.

I am pleased to note that the National Medicinal Plants Board of the Department of AYUSH, Ministry of Health & Family Welfare, Government of India, has developed India-specific Good Agriculture Practices for Medicinal Plants in collaboration with the WHO Country Office for India.

I would like to compliment the Department of AYUSH and National Medicinal Plants Board for this important initiative.

Dr. S.J. Habayeb
WHO Representative to India

बी० एस० सजवाण, आई०एफ०एस०
मुख्य कार्यकारी अधिकारी
B.S. SAJWAN, I.F.S.
Chief Executive Officer

भारत सरकार
स्वास्थ्य और परिवार कल्याण मंत्रालय
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Government of India
Ministry of Health & Family Welfare
Department of AYUSH
National Medicinal Plants Board

ACKNOWLEDGEMENT

The quality of drugs and nutraceuticals of Ayurvedic, Siddha and Unani systems of medicine, inter-alia, depends on the quality of the raw-material that goes into the manufacture of such products. The World Health Organizations (WHO) has developed Good Agricultural and Collection Practices (GACP) for medicinal plants. The present guidelines draw upon the WHO guidelines and have been adapted to suit the Indian conditions.

The National Medicinal Plants Board expresses its gratitude for the financial assistance provided by the World Health Organizations for the development and publication of these guidelines.

Special thanks are due to WHO-India Office, Ministries of Environment and Forest, Agriculture, Commerce, Science and Technology, Council of Scientific and Industrial Research, Indian Council of Agricultural Research, Indian Council of Forestry Research & Education, Indian Council of Medical Research, Central Council for Research in Ayurveda and Siddha, Central Council for Research in Unani Medicine, Agriculture and Processed Food Products Export Development Authority (APEDA), Indian Institute of Forest Management, and other experts who participated in the meeting of the expert committees and provided their valuable inputs on the draft text, which went through several stages of refinements and improvements.

NMPB acknowledges the most valuable contribution by Dr. Satyabrata Maiti, Director, Directorate of Medicinal and Aromatic Plants, Anand, Gujrat, who prepared the original text of the guidelines and, thereafter, incorporated all the suggestions and comments received from the various experts, organizations and individuals. Without the untiring and willing support of Dr. Maiti, it would not have been possible to bring out the document in its present form.

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We greatly acknowledge the technical support and guidance received from Dr. D.C. Katoch, National Consultant (Traditional Medicine & Homeopathy) and Mr. Sunil Nandraj, HSD Cluster Head in the WHO-India Office, in steering these guidelines for publication. The contributions made by Dr. Rajendra Gupta, Dr. Baba Brindavanan, Dr. S.K. Pareekh and Dr. Ramesh Chandra Uniyal, who went over the draft critically and made extremely valuable changes, are also gratefully acknowledged. NMPB wishes to place on record the guidance and encouragement received from Mrs. Anita Das, former Secretary, Department of AYUSH and the present Secretary of the Department, Mrs. S. Jalaja, for development of the Good Agricultural Practices (GAPs).

Finally, NMPB would like to place on record its appreciation of the work done by the team consisting of Mr. T.U. Haqqi, Dr. O.P. Mishra, Mr. Parhlad Rai, Dr. S. Bhandarkar, Dr. N. Padmakumar, Dr. Varsha Gupta and Dr. Kavita Tyagi in the National Medicinal Plants Board.

(B.S. Sajwan)
Chief Executive Officer
National Medicinal Plants Board

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ABBREVIATIONS

AICRP	:	All India Coordinated Research Project
APEDA	:	Agricultural and Processed Food Products Export Development Authority
ASU	:	Ayurveda, Siddha and Unani
AYUSH	:	Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy
FAO	:	Food and Agricultural Organization
GAP	:	Good Agricultural Practices
GMP	:	Good Manufacturing Practices
ISM&H	:	Indian Systems of Medicine and Homoeopathy

GOOD AGRICULTURAL PRACTICES

1. Background- Need for Good Agricultural Practices

1.1 India has a rich tradition of plant based health care systems contained in its classical texts like Charak Samhita (1) and Sushruta Samhita (2)**.** In recognition of the diversity of health care practices, the Government of India have recognized Ayurveda, Yoga & Naturopathy, Siddha, Unani and Homoeopathy as the alternative systems of medicine under the National Health Policy.

1.2 Department of Ayurveda, Yoga and Naturopathy, Siddha, Unani and Homoeopathy (AYUSH) in the Ministry of Health and Family Welfare has the responsibility for quality assurance and standardization of the production processes of Ayurveda, Siddha and Unani(ASU) medicines and disseminate the guidelines for production of raw material used in ASU medicines.

1.3 To ensure and enhance the quality of ASU medicines, the Government of India have notified Good Manufacturing Practices under Schedule 'T' of the Drugs and Cosmetics Act 1940. These guidelines on Good Agricultural Practices (GAP) seek to lay down standards for production of raw material that goes in to the making of the ASU medicines and standardize the production processes from farm to factory.

1.4 The Good Agriculture Practices described in this document have been adapted from the WHO guideline on Good Agricultural & Collection Practices (GACP) to suit policy framework on environment and health in India(3).

2. Definition of Good Agricultural Practices; (4,5)

2.1 A good agricultural practice in the context of medicinal plants is a cultivation programme designed to ensure optimal yield in terms of both quality and quantity of any crop intended for health purposes.

3. Scope

3.1. This document is designed to play a facilitator role and shall be recommended to all stake holders.

3.2 In the current form, these GAPs are essentially meant for and applicable to commercial scale of farming.

4. Soil and climatic conditions

4.1 The grower should identify the best possible environment where the plant can express its full potential in terms of both quality and quantity during its entire growth period (germination, growth and maturity). Meteorological data collated for preceding three years should be taken into account while judging the suitability of the site.

4.2 The selected site should qualify in terms of overall soil health for the purpose of cultivation of medicinal plant species. The following should be avoided;

4.2.1 Sites designated with high-degree stress factors (salinity, acidity and toxicity), water logging conditions, industrial wastes and affluent.

4.2.2 Sites in proximity to grave yards, crematoria or having a traceable history of such usage.

4.3. A well drained fertile soil with optimum level of water holding capacity and productivity status should be used for medicinal plants cultivation.

4.4. In soils with low fertility levels use of soil amendments as per the specific site and requirement of species are to be followed. The latest soil test report on physico-chemical parameters and nutrient profile should be obtained to decide the nature and quantity of soil amendments required.

4.5 The site must be in proximity to a reliable source of irrigation water.

4.6 The quality of irrigation water should have been adequately understood and classified in the context of both soil type and the target crop in terms of total salt concentration, Sodium absorption ratio, Bicarbonate and Boron concentration etc.

4.7 When the end-product is required to conform to standards of residual contaminants, the irrigation water must be analyzed for heavy metals and residual pesticides also.

4.8 When shade-loving crop is planned for, availability of shade across the field should be ascertained. Provision for artificial shading should be examined in the light of crop economics.

5. Seeds and propagation material

5.1 The seed/planting material should be accompanied with the following information:-

- Name as per pharmacopoeial nomenclature and trade name
- Botanical name
- Cultivar/ Selection / Phenotype/ Chemotype/ Genotype
- Projected quality of crop in terms of physico-chemical analysis/ marker based analysis – on the basis of earlier data/ reports

5.2 Marker based analytical projection for the end-product is mandatory requirement when the crop is meant for phyto-pharmaceutical industries.

5.3 When the planting material is obtained from wild resources as it happens during initial crop cycles, efforts should be made to establish its correct identity.

5.4 Precautions

5.4.1 Seed

- The seeds chosen for cultivation purposes must be physically free from pests, diseases, foreign and inert matter.
- The seed should be fresh and must have originated from recent harvests and in the accompanying document; the supplier should mention the date of harvest.
- The seed which is collected from wild sources must invariably be from recently collected lots and only mature seed should be collected.
- Prescribed seed treatment protocols if any, for the target species, must be completed well in advance so as to match the planting season.
- The process for seedling production under nursery conditions should be initiated as per the recommended agronomic practices for the target species and carried out reasonably well before the actual schedule of field transplantation. Only healthy seedlings should be transplanted.

5.4.2 Stem cutting

- When the grower takes the responsibility of root induction in stem cuttings under nursery conditions for eventual transplantation into the field, the source of cuttings should be well authenticated for both botanical identity and quality of vegetative propagules.
- The stem cuttings collected for root induction should be of uniform dimensions in terms of length and diameter and should be in tune with the requirements laid down for the target species. Only healthy stem cutting giving desired rooting should be used.

5.4.3. Root cutting

The propagation materials in form of 'ready-to-transplant saplings' or root cuttings should be of uniform size and maturity, both in terms of aerial and underground parts, and must be free from any disease and infection.

6. Crop management for cultivation

6.1 Field preparation

The soil should be brought to the desired tilth to facilitate favourable environment for growing seed and seedling. The field operation performed should provide better rhizospheric environment, soil porosity and texture, and keep it free from weeds for initial 20-30 days.

6.2 Sowing and transplanting

6.2.1 The recommended rate of seedlings per unit of land area should be adhered to. The placement of seeds should take place at the appropriate depth in the moist zone of the soil.

6.2.2 In cases where saplings are transplanted the spacing norms in terms of row-to-row and plant-to-plant distance should governed by the needs of target crop as envisaged in the agronomic protocol for target species.

6.2.3 The seedling at optimum stage of transplanting should be uprooted and transplanted immediately thereafter.

6.2.4 Replenishment of plant populations to compensate mortality losses should be carried out within a reasonable timeframe and in consideration of the gestation period of the target crop.

6.3 Manures and fertilizers

6.3.1 Use of organic manure is preferred for growing medicinal plants . However, mineral nutrition through inorganic source may be opted for in consideration of the nutritional needs of the target crop vis-à-vis the soil characteristics.

6.3.2 Use of compost, vermi-compost, poultry manure, green leafy manure is desirable. Similarly, use of microbial fertilizers for distinct purposes like, nitrogen fixing or for phosphate solubilizing is desirable.

6.3.3 The use of sludge, city waste, night soil and any other manure with known or assumed toxicities must be avoided.

6.3.4 Specialized nutritional care for distinct purposes such as root production or enhancement of leafy bio-mass etc should be opted for in the light of recommended agronomic practices for target species.

6.4 Irrigation

6.4.1 Total water requirement of the crop should be estimated in the light of available agronomic protocol. Accordingly, the irrigation cycles should be planned for and implemented to ensure optimal plant growth.

6.4.2 Water harvesting and water conservation methods should be followed wherever possible.

6.4.3 The quality of water should be considered in the light of prevailing soil conditions. A reasonably recent report of soil and water analysis should be taken into account for this purpose.

6.4.4 The soils having the problem of drainage should be dealt in specific manner so as to provide outlet for excess water, if any. The impounding of water through heavy rains should not be allowed.

6.5 Weeding and intercultural operations

6.5.1 Initial flush of weeds must be controlled effectively so as to ensure a weed free environment to young plants. The weeding and hoeing cycles should be so arranged as to keep the field free from weeds.

6.5.2 The prescribed schedule of all inter-cultural operations such as weeding, hoeing, topping, nipping of buds, pruning, shading and earthing up etc., must be adhered to in a manner to optimize the overall productivity.

6.5.3 Use of herbicides should be avoided as far as possible. In case of their inevitable usage, available evidence of safety to the target crop should be considered adequately.

6.6 Crop protection

6.6.1 Comprehensive preventive and control measures enumerated in the agronomic protocol should be used for disease, insect and pest management to minimize loss of the final crop and its quality.

6.6.2 In general crop protection plans should be limited to the use of bio-control agents and bio-pesticides. Under compulsive circumstances care should be taken to use smallest effective dosage of pesticides on the basis of crop protection protocols prescribed for the target species.

6.6.3 When chemical pesticides are used for crop protection, residue analysis should be carried out through appropriate testing agencies following standard procedures.

7. Harvest and post harvest management

7.1. Harvesting

7.1.1 The principle of "maximizing sustainable production" as laid down for the subject crop should be adhered to.

7.1.2 The harvesting season should be determined and followed on the basis of qualitative parameters set for the end product of the constituents rather than the total vegetative yield.

7.1.3 Harvesting should be carried out only on favorable days avoiding the risks of dew, rain or exceptionally high humidity.

7.1.4 The containers used for harvested materials should be kept clean. Care should be taken to ensure freedom from the risks of cross contamination by other species, weeds and such other extraneous matter.

7.1.5 Cutting devices employed for harvesting should be selected so as to minimize the contamination by soil particles. While harvesting, care should be taken to avoid incidental and concurrent harvest of weeds.

7.2 Primary processing

7.2.1 Washing and cleaning methods for freshly harvested materials should be laid down in consideration of the target plant part. The procedure for this purpose should ensure removal of soil particles adhering to the materials.

7.2.2 Freshly harvested materials should not be stored as such and the drying process should be initiated in a continuum. Where necessary, the length of such storage should be minimized and handled in a manner to prevent degradation or rotting.

7.2.3 Processing yards or sites should be clean, well ventilated, and have the facilities for protection against sunlight, dust, rain, rodents, insects and livestock.

7.2.4 The drying procedure and the temperature employed for this purpose should be in conformity with the quality needs of the farm produce. In case the agronomic package prescribes specific procedures for this phase, compliance to the same should be ensured. In high humidity conditions, it may be necessary to dry the produce appropriately.

7.2.5 Sorting procedure, if any, should be ideally carried out after completion of drying phase and before the material is packed.

7.3 Packaging, storage and transportation

7.3.1 The selection of packaging material should be based on the quality requirements and possible length of storage before consumption. It should be clean, dry and undamaged.

7.3.2 Essential product description such as the product name, plant part, month and year of harvest and the name of farmer/farming agency must be legibly inscribed on every pack. If the material was tested before, an appropriate label may be used indicating quality approval.

7.3.3 While packaging, mechanical damages and undue compacting of the dried plant material that may result in undesirable quality changes should be avoided. Care should be taken to avoid overfilling of the containers.

7.3.4 The storage area should be a dry place protected from insects and rodents and such other factors that may be detrimental to the quality of the product.

7.3.5 Organic herbs must be stored separately from the non-organic products.

7.3.6 When multiple commodities are handled in the same storage area, care must be taken to prevent product mix up and cross contamination. Plant materials having strong aromatic compounds should be kept at a reasonably good distance from others.

8. Documentation

8.1 All the documents pertaining to entire cultivation process should be maintained in a manner that ensures easy accessibility and traceability for the concerned personnel. The content of documents should be simple and easily comprehensible for the key personnel engaged at the site.

8.2 Agronomic protocol for target crop involving all stages of cultivation including the component of pre-planning should be adopted. Appropriate compliance reports should be generated for each stage and sub-stages of various operations and dates on which they were carried out. The records should include:

8.2.1 Meteorological data, reasonably recent reports of soil and water testing and any other grounds employed for site/ crop selection

8.2.2 The source, quantity and time of procurement/ collection of seeds/ planting materials, relevant documents accompanying the supplies.

8.2.3 All procedures adopted for handling the planting materials and for procedures employed during the nursery phase.

8.2.4 Soil preparation and transplantation procedures

8.2.5 Crop management phase comprising irrigation cycles, the kind of manures and fertilizer used, and the time, amount and method of their use; the type of pesticides used- including insecticides, fungicides and herbicides – and the amount, time and method of their use, if any.

8.2.6 Compliance records to weeding cycles and inter-culture practices.

8.2.7 Procedural deviations that could affect the quality of crop

8.2.8 Extraordinary situations encountered (such as weather conditions or new types of diseases/ pest infestations etc.) during the crop cycle and spontaneous management practices that were adopted

8.2.9 Reports of any laboratory tests and/ or the observations by technical experts carried out on the standing crop or the materials used during cultivation, if any.

8.2.10 Adequate photographic records should support the documentation on a need and operational convenience basis.

8.2.11 The documents suggested above and any other documents having a relevance to the target crop must be maintained for a minimum period of 3 years for crops with gestation periods less than 1 year and for a minimum period of 5 years for those crops having a gestation periods exceeding one year.

9. Personnel and Equipment

9.1 Key resource persons engaged at the site (such as farm owner/ supervisor) must be conversant with all aspects related to the target crop such as, quality requirements of the end product, crop husbandry etc.

9.2 The personnel should have basic exposure to subject matters like safety and hygiene.

9.3 Appropriate measures/ systems should be in place to ensure that personnel suffering from infectious diseases are not engaged at the site.

9.4 The machinery used in fertilizer and pesticide application must be calibrated at prescribed schedules and calibration certificates/ records should be maintained.

9.5 Equipments must be clean and mounted where applicable, in an easily accessible manner. Scheduled servicing procedures must be adhered to keep them in working order.

9.6 Additional care should be taken for cleaning those machine parts that get into direct contact with the harvested medicinal plant.

9.7 The material used for the equipment, particularly that coming into direct contact, should be safe. Equipments that pose a risk of hazardous metallic contamination of the harvested crop should be avoided.

Annexure-I

A model structure for developing monographs on GAP for individual species of medicinal plants

1. Name of medicinal plant

I. Scientific name ----------

II. Pharmacopoeial name of the medicinal plant ----------

III. Local name (specify language) ----------

2. Part to be employed as the medicinal plant material

(Description of the part of the plant used for medicinal purposes)

---

3. Characteristics of the medicinal plant

(Describe the agro-morphological and botanical characteristics of the medicinal plant concerned.)

---

4. Characteristics of medicinal plant material and major production areas

I. Characteristics of the medicinal plant material ----------

---

II. Major production areas of the medicinal plant material should be mentioned

---

5. Characteristics of strain(s) for cultivation

I. Taxonomical identity ----------

II. Ecological characteristics ----------

III. Major chemical compound responsible for drug value along with chemical profile

---

IV. Preferred growing conditions ----------

a) Climatic conditions ----------

(Rain fall, Temperature and Daylight length)

b) Soil conditions

Soil type ----------

Soil condition (pH, water retention capacity; nutrient status as per soil test report etc.)

c) Shade requirements, if any. ----------

6. Cultivation methods

I. Species and strains

II. Propagation methods

III. Cultivation

a) Suitable cultivation conditions:

b) Propagation

c) Sowing

d) Planting/nursery

e) Manures & fertilizers including microbial fertilizers

f) Crop management

g) Diseases and pests management

h) Harvesting stage, time & procedures

i) Post harvest handling & processing

j) Expected yield with desired quality

7. Quality evaluation of the medicinal plant material

I. National quality standard of the medicinal plant material
(Defined as the quality and quantity standard)

II. Name of major chemical/ chemicals constituents and its percentage

III. Chemical structure of selected major constituents

IV. Chemical profile, if known

8. Comparative summary table of the characteristics of different cultivated strains, if any

Morphological characteristics of each strain chemotype, morphotype etc. being cultivated, including height, growth, morphology/shape of root, stem, leaf, flower, fruit and 'seed, resistance/tolerance to diseases/pests, and composition and quantitative indications of major chemical constituents of the medicinal plant.

9. Cultivation calendar

A tabulated schedule of cultivation practices whichever to be followed indicating the type of care and management work/ actions and their timing during the entire growing period.

10. Background data and other information

I. Source of seed, propagation material, etc ----------

To assess the appropriateness/suitability of cultivation and characteristics of seed/propagation material. Cultivation should be carried out according to the recommended cultivation practices.

II. Photographs (3-5)

Plant and plant part material; also showing working methods/ equipment as appropriate

Annexure-II

Sample record for cultivated medicinal plants

1. Identification of cultivated medicinal plant

Scientific name _____
Pharmacopoeial name _____
Local name (language for)_____
Plant part for medicinal use & harvested _____
Identification of cultivation site _____
Field location _____
State/District/Village _____

2. Identification of cultivator

Name of cultivator_____
Contact address _____
Period of cultivation _____

3. Seeds and propagation materials

Source of the planted material _____
Physical description of the planted material _____
Commercially available (circle): Yes/No
If yes, name of cultivar _____ Name of supplier _____

4. Cultivation

4.1 Method of propagation materials establishment (circle): direct seed sowing/transplants

Date of sowing/transplanting _____ Percentage emergence _____
Date of re-sowing/replanting _____Percentage stand establishment _____

4.2 Spacing

I. Row x Row (cm) _____
II. Plant x Plant (cm) _____ Covered area (m^2) _____

Number of plants per unit area _____
Crop rotation _____
Soil and irrigation water analysis as per the standards methods:

4.3 Fertilizers and chemicals (if used)

Fertilizer applied before planting (circle): organic (composted animal manure)/chemical
Name _____ Method _____
Time/date (d/m/y) _____ Rate _____
Fertilizer applied after planting (top dressing): organic (composted animal manure)/chemical
Name _____ Method _____
Time/date (d/m/y) _____ Rate _____

4.4 Herbicides applied before planting, if any

Name _____ Method _____
Time/date (d/m/y) _____ Rate _____

4.5 Herbicides applied after planting, if any

Name _____ Method _____
Time/date (d/m/y) _____ Rate _____

4.6 Special operations done, if any

Name _____ Method _____
Time/date (d/m/y) _____ Rate _____

4.7 Plant protection chemicals applied, if any

Name _____ Method _____
Time/date (d/m/y) _____ Rate _____

5. Harvest/Collection

Date of harvest _____ Time of day _____
Conditions _____ Method _____
Yield _____

6. Drying practices

Drying method _____

(Sun drying/Shade/Mechanical)

Duration of drying (days) _____

Moisture content (after drying) (%) _____

7. Unusual circumstances that may influence quality

(Extreme weather conditions, exposure to hazardous substances, pest outbreaks, etc):

Annexure III

Terminology

Chemotype : It is a chemically distinct entity in a plant or organism, with differences in the chemical constituents.

or

Phenotypically similar species i.e. indistinguishable morphological, when distinguished through chemical constituents are called chemotype

or

Plants of the same species that is chemically different but otherwise indistinguishable.

Genotype : The genetic constitution (the genome) of a cell, an individual or an organism.

or

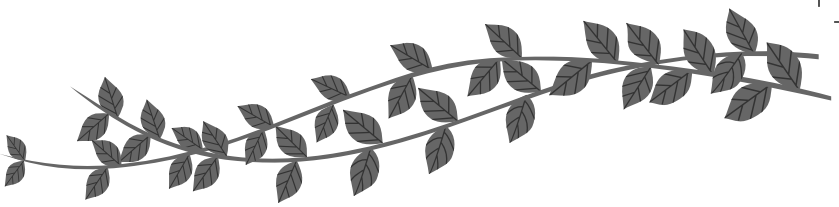
Phenotypically dissimilar species with minor mutation when identify through DNA profiling or genotypes

Irrigation : The application of water to soil to assist in the production of crops, especially during stress periods.

Irrigation water : Water which is artificially applied in the process of irrigation. It does not include precipitation

Inter crop : The crops raised in an orchard or other widely spaced crops for increasing the income from the same piece of land. e.g. short duration vegetables, pulses, oilseeds etc.

Inter cropping : Refers to growing of two or more generally dissimilar crops simultaneously on the same piece of land, base crop necessarily in distinct row arrangement. The recommended optimum plant population of the base crop is suitably combined with appropriate additional plant density of the associated crop, and there is crop intensification in both time and space dimensions.



Phenotype	:	The physical appearance of an organism as distinguished from its Genetic wake- up.
Ploughing	:	Operations carried out with the help of tractor drawn or bullock drawn implements known as plough, before the crops are sown.
Pollution	:	Contamination of natural environment by the addition to air or water of substances potentially toxic or otherwise harmful to man and animals for example, SO_2, CO_2, radio-active fall out insecticides etc.
Rouging	:	To remove weeds or off-type or diseased plants from a standing field crop.
Seedling	:	The juvenile stage of a plant grown from seed. Usually indicates plants which have up to and including about 4 true leaves.
Seed certification	:	A means to maintain and make available to the public, sources of high quality seeds and propagating materials of superior varieties so grown and distributed as to insure genetic identity. This is done by means of inspections of fields and seeds and by regulations for checking on the production, harvesting and cleaning of each lot of seed.
Tillage	:	The use of implements for mechanical manipulation to prepare seed beds conducive for field crop production

Annexure IV

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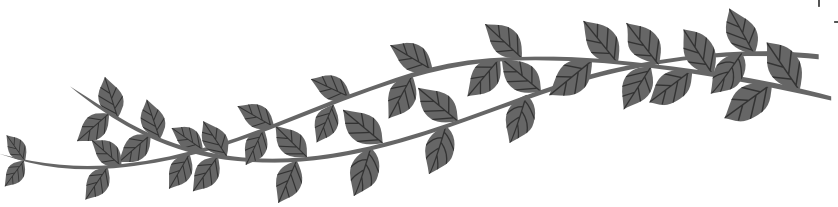

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