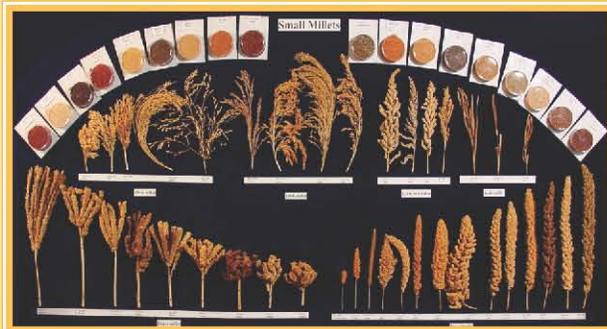


## Managing and Enhancing the Use of Germplasm – Strategies and Methodologies



Technical Manual no. 10

## Managing and Enhancing the Use of Germplasm – Strategies and Methodologies

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## Germplasm Assembly

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The initial step in conservation of genetic resources of seed crops is germplasm assembly. This activity is done by:

- 1A. Germplasm assembly by correspondence.
- 1B. Germplasm assembly by exploration and collection.
- 1C. Germplasm assembly from center's research.

### 1A. Germplasm assembly by correspondence

Samples can be obtained by correspondence if it is known that diversity in an area of interest was already collected. However, in accordance with Article 15 of the CBD, which clearly states that access to genetic resources shall be on mutually agreed terms, material should not be acquired until its status with regard to conservation, distribution and use are clearly defined through formal agreements with the donors.

#### 1A.1. Identification of unique samples for acquisition

Maintaining a sample in the genebank is expensive; therefore, the Genebank Curator should carefully check if the sample already exists in the collection before deciding on acquiring it. Since each genebank adopts its own numbering systems, it is possible that the same accession is available under different identities. Duplication in the collections is best identified by comparing relevant fields in databases, using a computer program such as Genebank Information Management System (GIMS), a stand-alone facility developed at ICRISAT.



#### ***Working with GIMS***

- ***Select the tables from the resident and imported databases that contain passport information of the collections.***
- ***For comparison, select the fields that contain information on accession identity, alternate name from both the tables and run the program.***

***The program checks for similar names/identities in imported data and lists them with relevant accession numbers in the resident database. List of unique accessions in the imported data can also be obtained through the program, if the user wants.***

## 1A.2. Acquiring unique germplasm from other genebanks

- Obtain complete passport information of the collection, especially alternate names or identification numbers, pedigree, original source, etc, from the donating institute.

***Most often, errors are made during data entry, especially with spaces, hyphenation, case and spelling, which require careful checking when comparing databases to identify duplicate accessions. The GIMS program was developed to handle such events.***

- Prepare the final list of unique accessions to be acquired.
- If the material is to be received from other countries, obtain an Import Permit, for example, from the National Plant Quarantine Service, Government of India, by applying to the Director, NBPGR, New Delhi, India on a prescribed form (Annexure 1.2).
- Send the final list of unique accessions along with the Import Permit and green labels for affixing on seed packages, with the following guidelines to the consignor on seed export.

## 1A.3. Guidelines to be followed by consignor (when sending seeds to India)

- The original Import Permit and a Phytosanitary Certificate (PSC) issued by the National Plant Quarantine Services of the exporting country must accompany the material.
- Ask the consignor to complete and send the “Form for Advance Intimation of Import of Seed Samples to India” as advance intimation of export of the proposed seed material (Annexure 1.3).
- The green labels are to be affixed or pasted on the outside of the seed package (Annexure 1.4).
- The consignor should not address the seed consignment to ICRISAT, but he/she should send it directly to Director, NBPGR, New Delhi, India.
- The seed material should be free from soil.
- The seeds should be free of infections (of pathogens) or infestations (by pests) and free of weed seeds, crop residues and inert material.
- Seed samples should not be treated with chemicals.

## 1B. Germplasm assembly by exploration and collection

***The main reasons for collecting germplasm are:***

- Genetic erosion — loss of genetic diversity.
- Gap filling — when diversity is missing or insufficiently represented in an existing collection.
- Need based — for breeding, research, or developmental work.

### ***Germplasm collecting missions are broadly of two kinds:***

- Crop specific or targeted missions to collect material with attributes such as adaptation to high altitude, salinity and cold tolerance; or wild relatives, weedy types and related taxa of a crop, and
- Ecosystem focused missions to collect maximum diversity in different crops occurring and maturing almost at the same time in the region.



- ***Collecting germplasm is expensive. Therefore, make a critical review of the past collection activities of the crop before embarking on a collection trip.***
- ***If germplasm was already collected from the area, correspond with the collector(s) and obtain duplicate samples.***

### **1B.1. Planning collection missions**

The focus of collection in the past has been mainly on conserving the broad range of diversity in the landraces or wild species. The collection team consists of an expert on the crop from the center and a local expert. The collection sites are selected based on the knowledge of the crop specialist or priorities set for the collection. Subsequent to the coming into force of the CBD, and the recognition of sovereignty of countries over their natural resources, access to genetic resources is subject to prior informed consent by the contracting party, ie, national governments. Further, access is granted on mutually agreed terms. It also requires taking measures to share the benefits of commercialization and utilization of genetic resources with provider countries. In line with the changed environment, ICRISAT has revised procedures for germplasm acquisition. The new procedures for acquisition of germplasm are as follows:

- Collections should be done at the specific requests from national agricultural research systems (NARS). The purpose of collection could be for:
  - national and international genebanks,
  - breeding programs,
  - other crop improvement programs, and
  - scientific study.
- Collection sites should be identified through participatory approach with broader group of users including:
  - scientists in NARS or at universities,
  - scientists in the private seed sector,
  - crop based national, regional or international networks,
  - crop and topic specific working groups,
  - development or food aid programs,
  - local, national or international non-governmental organizations (NGOs), and
  - community seed banks or other seed distribution agencies.

Technical and logistic planning begins once the decision for collecting is made. Collection missions should be planned at least one year in advance. The explorer must synthesize all available information such as:

- Environmental heterogeneity
- History and distribution of crop
- Cultural diversity
- History of movement of people
- Threats to genetic diversity
- Soundness of the political climate of the country to be explored.



- ***Consult state and regional reports, flora and latest published works to get familiarized with climate, ecology, vegetation and agriculture.***
- ***Study herbarium material, particularly of wild relatives to get visual impression of taxa targeted for collection.***
- ***Study critically, the provenance data on the herbarium sheets and take notes on the flowering, fruiting, habitat, altitude and other useful characteristics.***

An itinerary and provisional route should be established using information gathered from above. In wild species, harvesting needs to be done before seed shattering, therefore, timing of the collection mission is important. Crop cycle and seasonal workload should be considered to ensure cooperation by the farmers in the collection. Also efforts should be made to accommodate the farmer's traditional procedures for field entry and harvest, which may include significant ceremonies.

## **1B.2. Technical preparation**

Collecting germplasm requires meticulous planning. The explorer needs to be in the right area at the right time. Prospective collectors should identify local or national collaborators, and have prior discussion or correspondence with them on practical arrangements including:

- Priorities of collecting
- Methodologies and strategies
- Information to be gathered during collection
- Processing and conservation arrangements
- Financial aspects of the mission.



***In line with the principle of national sovereignty over plant genetic resources, and Article 7 of International Code of Conduct for Plant Germplasm Collecting and Transfer, germplasm collectors should secure from relevant authorized government body:***

- ***Prior approval for collecting,***
- ***Material transfer agreements for transfer of the collected material incorporating provisions for further handling, storage, regeneration, utilization and distribution (sample Standard Material Transfer Agreement (SMTA) given as Annexure 1.1).***

### **1B.3. Collecting team**

Collecting team should always be small — not more than three or four; and preferably include a woman. The team leader should be preferably a botanist or breeder/agronomist from the collecting organization. The team should consist of:

- Team leader from collecting organization
- Representative of NARS
- Local expert like extension officer
- Driver with some knowledge of the target region, who should be able to speak local language and carry out basic repairs to the vehicle.

A single team can conduct the collection or it can be coordinated through local or regional staff, depending on the range of maturity encountered in the region. The single team model requires careful planning to coincide the time of collection with seed harvest. If the local extension agents or NGOs are requested to make the final collection, special instructions need to be given for sampling and seed handling.

### **1B.4. Equipment**

The basic equipment needed for collection is as follows:

#### **1. Harvesting**

- |   |  |
|---|--|
| <input type="checkbox"/> cloth bags or nylon net bags   | <input type="checkbox"/> drying stove and stand  |
| <input type="checkbox"/> seed envelopes                 | <input type="checkbox"/> packing sacks   |
| <input type="checkbox"/> strong knife or secateurs      | <input type="checkbox"/> digger and sieves for sifting soil (important for collection of groundnut and its wild species) |
| <input type="checkbox"/> scissors                       | <input type="checkbox"/> pencil, pens and permanent markers of different colors  |
| <input type="checkbox"/> field or collector's notebooks | <input type="checkbox"/> stapler and staples   |
| <input type="checkbox"/> rubber bands for closing bags  | <input type="checkbox"/> pocket knife  |

- labels (preferably tear-off tags) for labeling specimens
- plant press with corrugated aluminum sheets
- absorbent paper for pressing specimen
- gloves
- local currency in small denomination
- receipt pad

## 2. Scientific equipment

- portable altimeter
- Geographical Positioning System (GPS)
- field compass for emergency use
- cameras with close-up lenses and filters
- digital camera with charger
- light meter
- pocket lenses
- soil sample kit
- binoculars
- calendar

## 3. Printed material

- regional flora
- road maps
- vegetation or climate maps
- list of rest houses or hotels
- information on fuel points
- printed slips with institute's address
- collection data sheets
- herbarium and quarantine labels
- visiting cards
- Import Permit or other required permits

## 4. Personal care

- light-weight tents with sealed ground sheet if collecting in areas with no accommodation
- mosquito net
- sleeping bags, pillow and blanket
- cooking equipment and stove
- eating utensils
- large and small water containers
- high quality water filter or purifier system
- electric torch and lamp with spare batteries
- matches
- candles
- tarpaulin

## 5. Other equipment

- cardboard boxes
- hunter shoes
- plastic water shoes
- wide brimmed hat
- sun glasses
- plastic bottles of various sizes
- formaldehyde
- alcohol

## 6. Medicines

- anti-malarial pills appropriate for the region
- insecticide sprays or repellent creams
- first-aid kit
- pain-killer pills
- snake bite kit for commonly found poisonous snakes
- antipyretics (paracetamol or aspirin)
- anti-itch creams or antihistamines
- antacid tablets
- antiseptic cream or liquid
- anti-diarrhea pills

Follow medical advice about vaccinations. Preventive inoculations for typhoid, yellow fever, cholera and other endemic diseases in targeted location(s) for germplasm collections should be taken according to the health laws and regulations of the visiting country or area.

## 7. Transport

- a four-wheel drive motor vehicle with roof rack
- puncture repair kit
- one set of spare parts and tools
- two jerricans for diesel/petrol
- two spare tyres
- engine driven winch and chain or nylon rope
- pump and pressure gauge

When explorations are planned in foreign countries, transportation arrangements and acquisition of articles listed above should be finalized well ahead of time.

## 8. Clothing

- drip-dry clothes that can be layered for warmth and protection
- strong high boots for snake infested areas
- lightweight jackets and long sleeved shirts with plenty of pockets
- sweater and water proof clothing if collecting during rainy season.

In general, clothing should suit the region being visited. Remember that high altitudes can be very cold during nights and in the mornings, even if it is warm during the day.



***When collecting abroad, do not forget to carry with you:***

- ***Permission letter of government, addresses of contact persons and copies of previous correspondence.***
- ***Passport with visas, health certificate and other travel documents.***
- ***Import Permit from home country if the material is to be transported back.***

## 1B.5. Sampling strategy

The sampling strategy should be based on purpose of collection. For example, if it is for a genebank, then concentrate on maximum diversity both among and within landraces, with a minimum number of samples. If it is for a breeding program, focus on identifying sources of improved farmers' varieties, and if it is for development programs, farmers' varieties along with related information would be more important.

## 1B.6. Collection sites

Overall sampling strategy depends on the breeding system and ecological diversity of the area.

- Collections should not be made from sites that are less than 10 km apart, unless,
  - landraces grown are morphologically different,
  - there is marked change in altitude or cropping systems,
  - a formidable barrier such as a mountain or a river exists, or
  - local people are ethnically different from previous collection site.
- Disjunct populations occupying remote and distinct ecological habitats should be collected.
- Priority for taking sample should be farmers' field. Samples can be taken from farmers' store, local markets if there is not enough time to cover fields over a whole region. Local tribal markets offer enormous diversity, including little known cultigens of local distribution.
- Samplings must be made over as many different environments and regions as possible.
- Collect away from main roads since introduction of advanced cultivars begins in regions close to main roads.
- Ascertain from local farmers and ***avoid collecting introduced and improved cultivars.***
- Avoid collecting duplicates. However, landraces or 'old' cultivars with the same name and essential features, if grown in ecologically distinct sites, could be different eco-strains and, therefore, can be sampled.

## 1B.7. Sample size

As a rule of thumb, obtain random sample by taking heads or pods every three paces, along a number of transects through the crop.

- Collect not less than 50 and not more than 100 panicles from each field, in case of cereals. If the species produces heads with large number of seeds (eg, sorghum and millets), collect only small portions of the heads.
- Take five ripe pods from each of three adjacent plants every three paces, in case of legumes.

It is best to collect a larger sample keeping in mind that seeds may be needed for base and active collections as well as for duplicate conservation. Larger quantity is also needed in case of genetically heterogeneous samples than for more uniform samples. Additional

non-random samples may be collected if the collector sees interesting forms, which are not included by random sampling.

### 1B.8. Useful tips when collecting

- It is advisable to start work in the morning after an early breakfast. Carry packed lunch. Get back to the camping site before sunset.
- Note down meter reading before the vehicle starts for work each day. Keep record of distances covered daily, petrol filling and other expenses incurred (distilled water, coolant and oil) and enter these in the logbook.
- Hold discussions with local officers, block or village extension workers and old farmers, and assemble relevant information on crops and locations for collecting diversity. Do this each evening a day ahead of the collecting itinerary and prepare a tentative program to be followed — villages/route/distances to be covered by vehicle and on foot.
- If the team is coming back to the same camping site, it is advisable to follow a circuitous route so that more villages can be covered.
- Do not plan to cover more than 100 or 200 km on “bad” roads and 300 km on “good” roads.
- Spare time for market survey, backyard surveys, visit to farmers’ homes to see stored produce and other observations. Also, allot time for discussions with farmers, extension workers and others.
- Allow enough time to collect herbarium specimens (especially wild species) and take photographs.
- On reaching the camp each evening, take out the collection, check and label them properly, press herbarium specimens, and complete notes in the logbook as well as in the field data book.
- Make it a principle to complete your daily work the same evening, re-equip your bag with items needed for the next day’s collecting before retiring.



- ***Be inquisitive to acquire information on anything interesting.***
- ***Do not be over zealous to take more material than that agreed with the farmer.***
- ***Money may have to be paid occasionally to collect the desired germplasm from farmers.***
- ***Never forget to convey your gratitude to the farmer before leaving.***

### 1B.9. Documentation

Data gathering is an important part of collection. Absolute minimum information to be recorded is:

- Collectors' and collection number
- Date and site of collection
- Geographical coordinates of collection sites
- Status of sample (wild, weedy, cultivated)
- Source of collection (field, market sample or farm store)
- Label the collection bags both within and outside.

For convenience in the field, carry standardized collecting record books (specimen page presented as Annexure 1.5).

*Use tear-off tags for this purpose. The label inside accompanies the sample when it is cleaned, threshed or placed in storage containers. The label outside helps in initial sorting of the samples.*

- Identify the collection site precisely using a Geographical Positioning System (GPS). If the site is not obvious from the map, then record the names of adjacent villages and kilometer reading of the vehicle at known places before and after the site.
- Document information on traditional knowledge from the farmers growing the varieties (Fig.1B.9.1), including:
  - farmer's name and description of environment,
  - landrace or cultivar characteristics as described by the farmer,
  - end use of the landrace or cultivar and its specific properties,
  - normal cultural practices used with the landrace or cultivars, and
  - history of the landrace or cultivar with the farmer.

A farmer's survey form incorporating the above details developed and used by Bramel-Cox and Christinck (1998) is in Annexure 1.6.



*Figure 1B.9.1. Collecting information along with germplasm sample.*

## 1B.10. Handling and processing of collected samples

- Collect the seeds in small paper bags (15 cm × 7 cm) with metal or ordinary hand fold.
- Use cloth bags that allow circulation of air (eg, muslin bags) when panicles or mature pods are to be collected.
- Thresh, winnow and clean the seeds if time permits and facilities are available at the base camp.
- Dry the seeds under shade or with a drying agent or by allowing ample aeration within the sample to reduce the moisture content.

If it becomes necessary to travel for collecting new material while holding the already collected germplasm, the exploration team should ensure safety of the collected material until collection is completed and it is transported to the genebank.

Primary focus of collection is to meet the needs of the National Programs or the local communities. The collected material should be first evaluated by growing in the local environment. The grow-out could be used for seed multiplication and characterization of the collection in the country of origin in cooperation with the partners. Field days are arranged to identify locally-adapted cultivars, so that the benefits of the collection are shared in the country of origin and among the local communities. Ensure that materials are acquired using SMTA (see Annexure 1.1).



***Exposing seeds to unfavorable environmental conditions during transportation can be very damaging. Therefore, care must be taken:***

- ***to maintain the material at optimum temperature and moisture content even when the distance for transportation is short, and***
- ***to see that the container or box is cushioned, and no damage is done to the seeds during transport.***

***Recruit couriers to accompany the team when collecting on long expeditions in remote places, and send perishable material or seeds with limited viability to the base camp for onward transmission to headquarters.***

## 1C. Germplasm assembly from center's research

### 1C.1. Acquisition of genetic stocks

Germplasm accessions screened and 'purified' through selection for desirable characteristics, and mutants identified in germplasm grow-outs serve as important raw material for crop improvement. These include sources of resistance to biotic and abiotic constraints, male sterile lines, dwarfs and other genetic stocks. Genebanks should acquire such material along with complete pedigree information.

## 1C.2. Acquisition of elite breeding material

Elite germplasm generated in the breeding programs for specific traits or with proven high yield such as released cultivars and genetic stocks may also be acquired by the genebank. While acquiring, ensure that the material has complete pedigree information and key morphological data.

## 1D. Current policy on germplasm acquisition

The genebank should have a clear policy on acquisition so that the volume of material acquired is within limits of the management capacity of the genebank. When storage space or the resources to maintain the collections are limiting, acquire germplasm based on priority.

### Prioritization

Germplasm usually consists of the whole range of genetic variation found in the crop, contained in:

- Primitive cultivars,
- Landraces,
- Wild and weedy forms,
- Genetic stocks,
- Elite breeding material, and
- Improved varieties (both obsolete and modern).

Acquisition of germplasm should be based on value or perceived threat of extinction. Value can be assessed by the usefulness of traits, and adaptation to unique environments. Landraces, wild and weedy species should receive high priority for acquisition due to the imminent threat of replacement, followed by genetic stocks. Consider the ability to be able to manage the species before acquiring wild species.

## 1E. Identification of gaps in the germplasm collections

Identification of gaps in the germplasm collections is necessary to assess completeness of the collection and exploration for further collection.

### Procedure to identify gaps:

- Using Microsoft Encarta®, an electronic atlas (MS Encarta® Interactive World Atlas 2000), retrieve the geographic coordinates of locations to fill the gaps for accessions not having the information.
- Using Arc View, a GIS tool, check the accuracy of the coordinates by plotting all accessions on latest political boundary map of each country.

- Using the FloraMap, a GIS tool, create the probability distribution map for each species in different countries.
- Overlay the collection sites or sampled sites on the probability map and identify the districts without and/or with few collection sites and high probability (>70%).
- Using Diva-GIS, assess the diversity in the assembled germplasm for each trait.
- Overlay the probability map, collection sites and the diversity index of assembled germplasm and identify the gaps in trait-wise diversity.
- Use land cover maps of FAO to know the type of vegetation and land cover in the areas identified.
- Consult local government officials and extension officers working in targeted area for crop cultivation and cropping pattern and then finalize the area for exploration.

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**STANDARD MATERIAL TRANSFER AGREEMENT\***

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**PREAMBLE**

## WHEREAS

The International Treaty on Plant Genetic Resources for Food and Agriculture (hereinafter referred to as “the **Treaty**”)<sup>1</sup> was adopted by the Thirty-first session of the FAO Conference on 3 November 2001 and entered into force on 29 June 2004;

The objectives of the **Treaty** are the conservation and sustainable use of **Plant Genetic Resources for Food and Agriculture** and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security;

The Contracting Parties to the **Treaty**, in the exercise of their sovereign rights over their **Plant Genetic Resources for Food and Agriculture**, have established a **Multilateral System** both to facilitate access to **Plant Genetic Resources for Food and Agriculture** and to share, in a fair and equitable way, the benefits arising from the utilization of these resources, on a complementary and mutually reinforcing basis;

Articles 4, 11, 12.4 and 12.5 of the **Treaty** are borne in mind;

The diversity of the legal systems of the Contracting Parties with respect to their national procedural rules governing access to courts and to arbitration, and the obligations arising from international and regional conventions applicable to these procedural rules, are recognized;

Article 12.4 of the **Treaty** provides that facilitated access under the **Multilateral System** shall be provided pursuant to a Standard Material Transfer Agreement, and the **Governing Body** of the **Treaty**, in its Resolution 1/2006 of 16 June 2006, adopted the Standard Material Transfer Agreement.

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<sup>1</sup> *Note by the Secretariat:* as suggested by the Legal Working Group during the Contact Group for the Drafting of the Standard Material Transfer Agreement, defined terms have, for clarity, been put in bold throughout.

\* In the event that the SMTA is used for the transfer of Plant Genetic Resources for Food and Agriculture other than those listed in Annex I of the Treaty:

The references in the SMTA to the “Multilateral System” shall not be interpreted as limiting the application of the SMTA to Annex I Plant Genetic Resources for Food and Agriculture, and in the case of Article 6.2 of the SMTA shall mean “under this Agreement”;

The reference in Article 6.11 and Annex 3 of the SMTA to “Plant Genetic Resources for Food and Agriculture belonging to the same crop, as set out in Annex I to the Treaty” shall be taken to mean “Plant Genetic Resources for Food and Agriculture belonging to the same crop”.

## ARTICLE 1 — PARTIES TO THE AGREEMENT

1.1 The present Material Transfer Agreement (hereinafter referred to as “**this Agreement**”) is the Standard Material Transfer Agreement referred to in Article 12.4 of the **Treaty**.

1.2 **This Agreement** is:

BETWEEN: *(name and address of the provider or providing institution, name of authorized official, contact information for authorized official\*)* (hereinafter referred to as “the **Provider**”),

AND: *(name and address of the recipient or recipient institution, name of authorized official, contact information for authorized official\*)* (hereinafter referred to as “the **Recipient**”).

1.3 The parties to **this Agreement** hereby agree as follows:

## ARTICLE 2 — DEFINITIONS

In **this Agreement** the expressions set out below shall have the following meaning:

“**Available without restriction**”: a **Product** is considered to be available without restriction to others for further research and breeding when it is available for research and breeding without any legal or contractual obligations, or technological restrictions, that would preclude using it in the manner specified in the **Treaty**.

“**Genetic material**” means any material of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity.

“**Governing Body**” means the **Governing Body** of the **Treaty**.

“**Multilateral System**” means the **Multilateral System** established under Article 10.2 of the **Treaty**.

“**Plant Genetic Resources for Food and Agriculture**” means any **genetic material** of plant origin of actual or potential value for food and agriculture.

“**Plant Genetic Resources for Food and Agriculture under Development**” means material derived from the **Material**, and hence distinct from it, that is not yet ready for **commercialization** and which the developer intends to further develop or to transfer to another person or entity for further development. The period of development for the **Plant Genetic Resources for Food and Agriculture under Development** shall be deemed to have ceased when those resources are **commercialized** as a **Product**.

\* *Insert as necessary. Not applicable for shrink-wrap and click-wrap Standard Material Transfer Agreements.*

A “shrink-wrap” Standard Material Transfer Agreement is where a copy of the Standard Material Transfer Agreement is included in the packaging of the **Material**, and the **Recipient’s** acceptance of the **Material** constitutes acceptance of the terms and conditions of the Standard Material Transfer Agreement.

A “click-wrap” Standard Material Transfer Agreement is where the agreement is concluded on the internet and the Recipient accepts the terms and conditions of the Standard Material Transfer Agreement by clicking on the appropriate icon on the website or in the electronic version of the Standard Material Transfer Agreement, as appropriate.

“**Product**” means **Plant Genetic Resources for Food and Agriculture** that incorporate<sup>2</sup> the **Material** or any of its genetic parts or components that are ready for **commercialization**, excluding commodities and other products used for food, feed and processing.

“**Sales**” means the gross income resulting from the **commercialization** of a **Product** or **Products**, by the **Recipient**, its affiliates, contractors, licensees and lessees.

“**To commercialize**” means to sell a **Product** or **Products** for monetary consideration on the open market, and “**commercialization**” has a corresponding meaning. **Commercialization** shall not include any form of transfer of **Plant Genetic Resources for Food and Agriculture under Development**.

### ARTICLE 3 — SUBJECT MATTER OF THE MATERIAL TRANSFER AGREEMENT

The **Plant Genetic Resources for Food and Agriculture** specified in *Annex 1* to **this Agreement** (hereinafter referred to as the “**Material**”) and the available related information referred to in Article 5b and in *Annex 1* are hereby transferred from the **Provider** to the **Recipient** subject to the terms and conditions set out in **this Agreement**.

### ARTICLE 4 — GENERAL PROVISIONS

- 4.1 **This Agreement** is entered into within the framework of the **Multilateral System** and shall be implemented and interpreted in accordance with *the objectives* and provisions of the **Treaty**.
- 4.2 The parties recognize that they are subject to the applicable legal measures and procedures, that have been adopted by the Contracting Parties to the **Treaty**, in conformity with the **Treaty**, in particular those taken in conformity with Articles 4, 12.2 and 12.5 of the **Treaty**.<sup>3</sup>
- 4.3 The parties to **this Agreement** agree that (*the entity designated by the **Governing Body***),<sup>4</sup> acting on behalf of the **Governing Body** of the **Treaty** and its **Multilateral System**, is the third party beneficiary under **this Agreement**.
- 4.4 The third party beneficiary has the right to request the appropriate information as required in Articles 5e, 6.5c, 8.3 and *Annex 2, paragraph 3*, to **this Agreement**.
- 4.5 The rights granted to the (*the entity designated by the **Governing Body***) above do not prevent the **Provider** and the **Recipient** from exercising their rights under **this Agreement**.

<sup>2</sup> As evidenced, for example, by pedigree or notation of gene insertion.

<sup>3</sup> In the case of the International Agricultural Research Centers of the Consultative Group on International Agricultural Research (CGIAR) and other international institutions, the Agreement between the Governing Body and the CGIAR Centers and other relevant institutions will be applicable.

<sup>4</sup> *Note by the Secretariat*: by Resolution 2/2006, the Governing Body “invite[d] the Food and Agriculture Organization of the United Nations, as the Third Party Beneficiary, to carry out the roles and responsibilities as identified and prescribed in the Standard Material Transfer Agreement, under the direction of the Governing Body, in accordance with the procedures to be established by the Governing Body at its next session”. Upon acceptance by the FAO of this invitation, the term, “the entity designated by the Governing Body”, will be replaced throughout the document by the term, “the Food and Agriculture Organization of the United Nations”.

## ARTICLE 5 — RIGHTS AND OBLIGATIONS OF THE PROVIDER

The **Provider** undertakes that the **Material** is transferred in accordance with the following provisions of the **Treaty**:

- a) Access shall be accorded expeditiously, without the need to track individual accessions and free of charge, or, when a fee is charged, it shall not exceed the minimal cost involved;
- b) All available passport data and, subject to applicable law, any other associated available non-confidential descriptive information, shall be made available with the **Plant Genetic Resources for Food and Agriculture** provided;
- c) Access to **Plant Genetic Resources for Food and Agriculture under Development**, including material being developed by farmers, shall be at the discretion of its developer, during the period of its development;
- d) Access to **Plant Genetic Resources for Food and Agriculture** protected by intellectual and other property rights shall be consistent with relevant international agreements, and with relevant national laws;
- e) The **Provider** shall periodically inform the **Governing Body** about the Material Transfer Agreements entered into, according to a schedule to be established by the **Governing Body**. This information shall be made available by the **Governing Body** to the third party beneficiary.<sup>5</sup>

## ARTICLE 6 — RIGHTS AND OBLIGATIONS OF THE RECIPIENT

- 6.1 The **Recipient** undertakes that the **Material** shall be used or conserved only for the purposes of research, breeding and training for food and agriculture. Such purposes shall not include chemical, pharmaceutical and/or other non-food/feed industrial uses.
- 6.2 The **Recipient** shall not claim any intellectual property or other rights that limit the facilitated access to the **Material** provided under **this Agreement**, or its genetic parts or components, in the form received from the **Multilateral System**.
- 6.3 In the case that the **Recipient** conserves the **Material** supplied, the **Recipient** shall make the **Material**, and the related information referred to in Article 5b, available to the **Multilateral System** using the Standard Material Transfer Agreement.
- 6.4 In the case that the **Recipient** transfers the **Material** supplied under **this Agreement** to another person or entity (hereinafter referred to as “the **subsequent recipient**”), the **Recipient** shall

<sup>5</sup> *Note by the Secretariat:* The Standard Material Transfer Agreement makes provision for information to be provided to the **Governing Body**, in the following Articles: 5e, 6.4b, 6.5c and 6.11h, as well as in *Annex 2*, paragraph 3, *Annex 3*, paragraph 4, and in *Annex 4*. Such information should be submitted to:

The Secretary

International Treaty on Plant Genetic Resources for Food and Agriculture  
Food and Agriculture Organization of the United Nations  
I-00100 Rome, Italy

- a) do so under the terms and conditions of the Standard Material Transfer Agreement, through a new material transfer agreement; and
- b) notify the **Governing Body**, in accordance with Article 5e.

On compliance with the above, the **Recipient** shall have no further obligations regarding the actions of the **subsequent recipient**.

6.5 In the case that the **Recipient** transfers a **Plant Genetic Resource for Food and Agriculture under Development** to another person or entity, the **Recipient** shall:

- a) do so under the terms and conditions of the Standard Material Transfer Agreement, through a new material transfer agreement, provided that Article 5a of the Standard Material Transfer Agreement shall not apply;
- b) identify, in *Annex 1* to the new material transfer agreement, the **Material** received from the **Multilateral System**, and specify that the **Plant Genetic Resources for Food and Agriculture under Development** being transferred are derived from the **Material**;
- c) notify the **Governing Body**, in accordance with Article 5e; and
- d) have no further obligations regarding the actions of any **subsequent recipient**.

6.6 Entering into a material transfer agreement under paragraph 6.5 shall be without prejudice to the right of the parties to attach additional conditions, relating to further product development, including, as appropriate, the payment of monetary consideration.

6.7 In the case that the **Recipient commercializes** a **Product** that is a **Plant Genetic Resource for Food and Agriculture** and that incorporates **Material** as referred to in Article 3 of **this Agreement**, and where such **Product** is not **available without restriction** to others for further research and breeding, the **Recipient** shall pay a fixed percentage of the **Sales** of the **commercialized Product** into the mechanism established by the **Governing Body** for this purpose, in accordance with *Annex 2* to **this Agreement**.

6.8 In the case that the **Recipient commercializes** a **Product** that is a **Plant Genetic Resource for Food and Agriculture** and that incorporates **Material** as referred to in Article 3 of **this Agreement** and where that **Product** is **available without restriction** to others for further research and breeding, the **Recipient** is encouraged to make voluntary payments into the mechanism established by the **Governing Body** for this purpose in accordance with *Annex 2* to **this Agreement**.

6.9 The **Recipient** shall make available to the **Multilateral System**, through the information system provided for in Article 17 of the **Treaty**, all non-confidential information that results from research and development carried out on the **Material**, and is encouraged to share through the **Multilateral System** non-monetary benefits expressly identified in Article 13.2 of the **Treaty** that result from such research and development. After the expiry or abandonment of the protection period of an intellectual property right on a **Product** that incorporates the **Material**, the **Recipient** is encouraged to place a sample of this **Product** into a collection that is part of the **Multilateral System**, for research and breeding.

- 6.10 A Recipient who obtains intellectual property rights on any Product developed from the Material or its components, obtained from the Multilateral System, and assigns such intellectual property rights to a third party, shall transfer the benefit-sharing obligations of this Agreement to that third party.
- 6.11 The **Recipient** may opt as per *Annex 4*, as an alternative to payments under Article 6.7, for the following system of payments:
- a) The **Recipient** shall make payments at a discounted rate during the period of validity of the option;
  - b) The period of validity of the option shall be ten years renewable in accordance with *Annex 3* to **this Agreement**;
  - c) The payments shall be based on the **Sales** of any **Products** and of the sales of any other products that are **Plant Genetic Resources for Food and Agriculture** belonging to the same crop, as set out in *Annex 1* to the **Treaty**, to which the **Material** referred to in *Annex 1* to **this Agreement** belongs;
  - d) The payments to be made are independent of whether or not the **Product** is **available without restriction**;
  - e) The rates of payment and other terms and conditions applicable to this option, including the discounted rates are set out in *Annex 3* to **this Agreement**;
  - f) The **Recipient** shall be relieved of any obligation to make payments under Article 6.7 of **this Agreement** or any previous or subsequent Standard Material Transfer Agreements entered into in respect of the same crop;
  - g) After the end of the period of validity of this option the **Recipient** shall make payments on any **Products** that incorporate **Material** received during the period in which this Article was in force, and where such **Products** are not **available without restriction**. These payments will be calculated at the same rate as in paragraph (a) above;
  - h) The **Recipient** shall notify the **Governing Body** that he has opted for this modality of payment. If no notification is provided the alternative modality of payment specified in Article 6.7 will apply.

## ARTICLE 7 — APPLICABLE LAW

The applicable law shall be General Principles of Law, including the UNIDROIT Principles of International Commercial Contracts 2004, the objectives and the relevant provisions of the **Treaty**, and, when necessary for interpretation, the decisions of the **Governing Body**.

## ARTICLE 8 — DISPUTE SETTLEMENT

- 8.1 Dispute settlement may be initiated by the **Provider** or the **Recipient** or the (*the entity designated by the **Governing Body***), acting on behalf of the **Governing Body** of the **Treaty** and its **Multilateral System**.
- 8.2 The parties to **this Agreement** agree that the (*the entity designated by the **Governing***

**Body**), representing the **Governing Body** and the **Multilateral System**, has the right, as a third party beneficiary, to initiate dispute settlement procedures regarding rights and obligations of the **Provider** and the **Recipient** under **this Agreement**.

- 8.3 The third party beneficiary has the right to request that the appropriate information, including samples as necessary, be made available by the **Provider** and the **Recipient**, regarding their obligations in the context of **this Agreement**. Any information or samples so requested shall be provided by the **Provider** and the **Recipient**, as the case may be.
- 8.4 Any dispute arising from **this Agreement** shall be resolved in the following manner:
- a) Amicable dispute settlement: The parties shall attempt in good faith to resolve the dispute by negotiation.
  - b) Mediation: If the dispute is not resolved by negotiation, the parties may choose mediation through a neutral third party mediator, to be mutually agreed.
  - c) Arbitration: If the dispute has not been settled by negotiation or mediation, any party may submit the dispute for arbitration under the Arbitration Rules of an international body as agreed by the parties to the dispute. Failing such agreement, the dispute shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce, by one or more arbitrators appointed in accordance with the said Rules. Either party to the dispute may, if it so chooses, appoint its arbitrator from such list of experts as the Governing Body may establish for this purpose; both parties, or the arbitrators appointed by them, may agree to appoint a sole arbitrator, or presiding arbitrator as the case may be, from such list of experts. The result of such arbitration shall be binding.

## ARTICLE 9 — ADDITIONAL ITEMS

### Warranty

- 9.1 The **Provider** makes no warranties as to the safety of or title to the **Material**, nor as to the accuracy or correctness of any passport or other data provided with the **Material**. Neither does it make any warranties as to the quality, viability, or purity (genetic or mechanical) of the **Material** being furnished. The phytosanitary condition of the **Material** is warranted only as described in any attached phytosanitary certificate. The **Recipient** assumes full responsibility for complying with the recipient nation's quarantine and biosafety regulations and rules as to import or release of **genetic material**.

### Duration of Agreement

- 9.2 **This Agreement** shall remain in force so long as the **Treaty** remains in force.

## ARTICLE 10 — SIGNATURE/ACCEPTANCE

The **Provider** and the **Recipient** may choose the method of acceptance unless either party requires **this Agreement** to be signed.

### Option 1 –Signature\*

I, (*Full Name of Authorized Official*), represent and warrant that I have the authority to execute **this Agreement** on behalf of the **Provider** and acknowledge my institution's responsibility and obligation to abide by the provisions of **this Agreement**, both by letter and in principle, in order to promote the conservation and sustainable use of **Plant Genetic Resources for Food and Agriculture**.

Signature..... Date.....

Name of the **Provider** .....

I, (*Full Name of Authorized Official*), represent and warrant that I have the authority to execute **this Agreement** on behalf of the **Recipient** and acknowledge my institution's responsibility and obligation to abide by the provisions of **this Agreement**, both by letter and in principle, in order to promote the conservation and sustainable use of **Plant Genetic Resources for Food and Agriculture**.

Signature..... Date.....

Name of the **Recipient** .....

### Option 2 – Shrink-wrap Standard Material Transfer Agreements\*

The **Material** is provided conditional on acceptance of the terms of **this Agreement**. The provision of the **Material** by the **Provider** and the **Recipient's** acceptance and use of the **Material** constitutes acceptance of the terms of **this Agreement**.

### Option 3 – Click-wrap Standard Material Transfer Agreement\*

I hereby agree to the above conditions.

\* Where the Provider chooses signature, only the wording in Option 1 will appear in the Standard Material Transfer Agreement. Similarly where the Provider chooses either shrink-wrap or click-wrap, only the wording in Option 2 or Option 3, as appropriate, will appear in the Standard Material Transfer Agreement. Where the "click-wrap" form is chosen, the Material should also be accompanied by a written copy of the Standard Material Transfer Agreement.

**LIST OF MATERIALS PROVIDED**

This *Annex* contains a list of the **Material** provided under **this Agreement**, including the associated information referred to in Article 5b.

This information is either provided below or can be obtained at the following website: (*URL*).

The following information is included for each **Material** listed: all available passport data and, subject to applicable law, any other associated, available, non-confidential descriptive information.

(*List*)

**RATE AND MODALITIES OF PAYMENT UNDER ARTICLE 6.7  
OF THIS AGREEMENT**

1. If a **Recipient**, its affiliates, contractors, licensees and lessees, **commercializes** a **Product** or **Products**, then the **Recipient** shall pay one point-one percent (1.1 %) of the **Sales** of the **Product** or **Products** less thirty percent (30%); except that no payment shall be due on any **Product** or **Products** that:
  - (a) are **available without restriction** to others for further research and breeding in accordance with Article 2 of **this Agreement**;
  - (b) have been purchased or otherwise obtained from another person or entity who either has already made payment on the **Product** or **Products** or is exempt from the obligation to make payment pursuant to subparagraph (a) above;
  - (c) are sold or traded as a commodity.
2. Where a **Product** contains a **Plant Genetic Resource for Food and Agriculture** accessed from the **Multilateral System** under two or more material transfer agreements based on the Standard Material Transfer Agreement only one payment shall be required under paragraph 1 above.
3. The **Recipient** shall submit to the **Governing Body**, within sixty (60) days after each calendar year ending December 31<sup>st</sup>, an annual report setting forth:
  - (a) the **Sales** of the **Product** or **Products** by the **Recipient**, its affiliates, contractors, licensees and lessees, for the twelve (12) month period ending on December 31<sup>st</sup>;
  - (b) the amount of the payment due; and
  - (c) information that allows for the identification of any restrictions that have given rise to the benefit-sharing payment.
4. Payment shall be due and payable upon submission of each annual report. All payments due to the **Governing Body** shall be payable in (*specified currency*)<sup>6</sup> for the account of (*the Trust Account or other mechanism established by the **Governing Body** in accordance with Article 19.3f of the **Treaty***).<sup>7</sup>

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6 *Note by the Secretariat:* The Governing Body has not yet considered the question of currency of payment. Until it does so, Standard Material Transfer Agreements should specify United States dollars (US\$).

7 *Note by the Secretariat:* This is the Trust Account provided for in Article 6.3 of the Financial Rules, as approved by the Governing Body (*Appendix E* to this Report). The details of the Trust Account when established, will be introduced here, and communicated to Contract Parties.

**TERMS AND CONDITIONS OF THE ALTERNATIVE PAYMENTS SCHEME  
UNDER ARTICLE 6.11 OF THIS AGREEMENT**

1. The discounted rate for payments made under Article 6.11 shall be zero point five percent (0.5 %) of the **Sales** of any **Products** and of the sales of any other products that are **Plant Genetic Resources for Food and Agriculture** belonging to the same crop, as set out in Annex 1 to the **Treaty**, to which the **Material** referred to in *Annex 1* to **this Agreement** belong.
2. Payment shall be made in accordance with the banking instructions set out in paragraph 4 of *Annex 2* to **this Agreement**.
3. When the **Recipient** transfers **Plant Genetic Resources for Food and Agriculture under Development**, the transfer shall be made on the condition that the **subsequent recipient** shall pay into the mechanism established by the **Governing Body** under Article 19.3f of the **Treaty** zero point five percent (0.5 %) of the **Sales** of any **Product** derived from such **Plant Genetic Resources for Food and Agriculture under Development**, whether the **Product** is **available or not without restriction**.
4. At least six months before the expiry of a period of ten years counted from the date of signature of **this Agreement** and, thereafter, six months before the expiry of subsequent periods of five years, the **Recipient** may notify the **Governing Body** of his decision to opt out from the application of this Article as of the end of any of those periods. In the case the **Recipient** has entered into other Standard Material Transfer Agreements, the ten years period will commence on the date of signature of the first Standard Material Transfer Agreement where an option for this Article has been made.
5. Where the **Recipient** has entered or enters in the future into other Standard Material Transfer Agreements in relation to material belonging to the same crop[s], the **Recipient** shall only pay into the referred mechanism the percentage of sales as determined in accordance with this Article or the same Article of any other Standard Material Transfer Agreement. No cumulative payments will be required.

**OPTION FOR CROP-BASED PAYMENTS UNDER THE ALTERNATIVE PAYMENTS  
SCHEME UNDER ARTICLE 6.11 OF THIS AGREEMENT**

I (*full name of **Recipient** or **Recipient's** authorized official*) declare to opt for payment in accordance with Article 6.11 of **this Agreement**.

Signature .....

Date.....

**NATIONAL BUREAU OF PLANT GENETIC RESOURCES  
INDIAN COUNCIL OF AGRICULTURAL RESEARCH  
NEW DELHI, INDIA**

**APPLICATION FOR PERMIT TO IMPORT GERMPLASM/  
TRANSGENICS/GENETICALLY MODIFIED ORGANISMS (GMOs)  
(FOR RESEARCH PURPOSES)**

**The Director,  
National Bureau of Plant Genetic Resources  
Pusa Campus, New Delhi 110012**

I hereby apply for a permit in accordance with provisions of Clause-6(2) of the Plant Quarantine (Regulation of Import in to India) Order, 2003 issued under the Sub-section(1) of Section (3) of the Destructive Insects & Pests Act, 1914 (2 of 1914), authorizing the import of plants/planting materials for research purposes as per details given below:

1. Name and Address of the applicant:
2. Research and Development (R&D) status/affiliations of the organization:
3. Exact description of seeds/planting material to be imported:
  - (a) Common and Botanical name:
  - (b) Germplasm/variety/hybrid/composite/ synthetic provenance/clone/others
  - (c) Form of material required (seed/rooted plants/ scions /tubers/cuttings/bulbs in vitro cultures)
  - (d) Parentage, if known
  - (e) Place of collection/origin of the material to be imported (country/state)
4. Whether transgenic/GMO or not?  
[If yes, attach the approval letter issued by RCGM (DBT) in original]
5. Name and address of the organization/institution producing the material
6. Number of samples to be imported
7. Quantity to be imported (separately for each accession/ variety/hybrid/transgenic/GMO)
8. Suggested source of availability of material including published reference, if known

9. (a) Whether the aforesaid germplasm/variety/ hybrid was imported by you earlier? If so, details there of (year, quantity, source, etc)  
(b) Was the material shared with other scientists/ National Gene Bank at NBPGR?
10. Expected date and mode of arrival in India
11. Mode of shipment (airmail/air freight/ accompanied baggage)
12. Place where imported seeds/planting material will be grown and scientists under whose supervision the seeds/planting material will be grown

### **DECLARATION**

1. I hereby declare that the germplasm under import has no commercial value/exclusive ownership and may be shared freely for research purpose.
2. This germplasm does not contain any terminator genes.
3. I undertake that the material is exclusively for research purposes.

Place:

Date:

Signature of the applicant & address

For further information contact Tel. No.91-11-25843697 or Fax. 91-11-25844295 or Email-director@nbpgr.ernet.in and web address-http://nbpgr.ernet.in

**Form for Advance Intimation of Export of Seed Samples to India**

To:  
The Director  
National Bureau of Plant Genetic Resources  
IARI Campus  
NEW DELHI 110 012

The following consignment has been dispatched separately to you for plant quarantine clearance and forwarding to ICRISAT.

- 1. Name and address of consignor \_\_\_\_\_
  - 2. i) Crop (with botanical name) \_\_\_\_\_
  - ii) No. of boxes/bags/cartons \_\_\_\_\_
  - iii) Distinguishing marks \_\_\_\_\_
  - 3. Weight \_\_\_\_\_
  - 4. Mode of dispatch \_\_\_\_\_
  - 5. Particulars of Phytosanitary certificate \_\_\_\_\_
  - 6. General health, pest incidence/intensity on crop at the time of seed collection \_\_\_\_\_
  - 7. Date(s) of collection \_\_\_\_\_
  - 8. Remarks, if any \_\_\_\_\_
- Date \_\_\_\_\_

Signature: \_\_\_\_\_  
Name: \_\_\_\_\_

Cc: Chief Plant Quarantine Officer, ICRISAT, Patancheru, Andhra Pradesh 502 324, India

Note: Duplicate copy of Phytosanitary Certificate should be attached with this letter to facilitate release of the seed material.

**Seed for Experimental Purposes  
No Commercial Value  
for the Use of  
ICRISAT**  
International Crops Research Institute for the Semi-Arid Tropics  
Patancheru, Andhra Pradesh 502 324, India



**Seed Unfit for Consumption  
Phytosanitary Certificate  
and Import Permit Enclosed**

**DIRECTOR  
NATIONAL BUREAU OF PLANT GENETIC RESOURCES  
(NBPGR)  
PUSA CAMPUS  
NEW DELHI-110 012, INDIA**

From: .....

.....

.....  
(Please use capital letters)



## ICRISAT – Genetic Resources Unit – Collection Data Sheet

1. Collection Number  2. ICRISAT Accession No.

3. Crop Species \_\_\_\_\_

4. Collector(s) \_\_\_\_\_ 5. Date \_\_\_\_\_

6. Country \_\_\_\_\_ 7. State/Province \_\_\_\_\_ 8. District \_\_\_\_\_

9. Village \_\_\_\_\_ 10. Precise locality \_\_\_\_\_

11. Altitude \_\_\_\_\_ m 12. Latitude \_\_\_\_\_ 13. Longitude \_\_\_\_\_

14. Soil & topography \_\_\_\_\_

15. Precipitation : < Normal  Normal  >Normal

16. Sample source: Field  Threshing Floor  Store  Market   
Institution  Other

17. Local name \_\_\_\_\_ 18. Type/Race, etc: \_\_\_\_\_

19. Ethnic group \_\_\_\_\_ 20. Donor's name \_\_\_\_\_

20. Donor's source: Own  Local  Market  Others

21. Cultural practices: Rainfed  Irrigated  Flooded  Transplanted

22. Planting date \_\_\_\_\_ 23. Harvesting date \_\_\_\_\_

24. Associated Crop: Sole  Mixed  With \_\_\_\_\_

25. Population variability: Uniform  Low  Medium  High

Diseases \_\_\_\_\_

Insects \_\_\_\_\_

28. Agronomic score: Very poor  Poor  Average  Good  Very good

29. Remarks: \_\_\_\_\_

## Farmer's survey form\*

Farmer's name \_\_\_\_\_

Village/district \_\_\_\_\_

**Site characteristics** \_\_\_\_\_

Topography (local name) \_\_\_\_\_

Site (local name) \_\_\_\_\_

Soil (local name) \_\_\_\_\_

**Farmer's description of landraces**

Landrace name \_\_\_\_\_

Type within landrace characteristics \_\_\_\_\_

Name of farmers: \_\_\_\_\_

Name of collectors: \_\_\_\_\_

**Morphological**

Trait	Observation			
Maturity	Early	Medium	Late	
Plant height	Short	Medium	Tall	very tall
Tillering	None	1 or 2	Many	very many
Head compactness and shape	Curved	Bent	Erect	
Head size	Very small	Small	Medium	large
Plant color	Pigment	Tan		
Grain color	White	Yellow	Red	Brown
Glume color	Tan	Red	Purple	
Glume coverage	0-25	25-50	50-75	complete
Race				
Stem thickness	Thin	Average	Thick	
Leaf type	Thin, short	Thin, long	Thick, short	thick, long

**Agronomic**

Grain Yield	Low	Medium	High	
Fodder Yield	Low	Medium	High	

**Disease problems**

Problem	Susceptible	Resistance

**Insect problems**

Problem	Susceptible	Resistance

**Weed, storage pest, or bird problems**

Problem	Susceptible	Resistance

\*(adapted from Bramel-Cox and Christinck 1998)

## Stress reactions

	Sowing	Seedling	Heading	Maturing
Month				
Drought				
Water logging				

## End use

Local bread	Poor	Good
Injera	Poor	Good
Porridge	Poor	Good
Local beer	Poor	Good
Popping	Poor	Good

## Quality

Taste	Bitter	Sweet
Cooking time	Poor	Good
Threshing ease	Poor	Good
Dehulling	Poor	Good
Storability	Poor	Good

## Cultural practices

Planting time	_____
Number of weedings	_____
Harvest time	_____
Irrigated or rainfed	_____
Number of times irrigated	_____
Fertility requirements	_____
Intercropping or sole cropping	_____
Normal crop rotation	_____

### Source of seed

Own crop	_____
Number of years	_____
Before that	_____
Received from relative	_____
When	_____
Purchased from others	_____
When	_____
Given as gift	_____
When	_____
Relief Agency	_____
When	_____

## Seed selection and conservation practices

Timing of selection for seed	_____
Field prior to harvest	_____
Field at harvest	_____
Prior to threshing	_____
Save from bulk after threshing	_____
Harvest or production of seed stocks	_____
-in same field as crop	_____
-in separate area of field or	_____
separate field	_____
Any special cultural practices	_____
Thresh separately	_____
Drying procedures	_____
Selection criteria used for seed stock	_____
Selection criteria used for seed plant	_____