Groundnut Seed Production Manual

International Crops Research Institute for the Semi-Arid Tropics

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Abstract

In spite of the involvement of public sector seed producing agencies in groundnut seed production, the varietal seed replacement rate in the crop in developing countries remains low. This restricts the full benefit of varietal improvement research reaching farmers. Thus, the productivity of the crop remains low in most of the developing countries. Low seed multiplication ratio, bulky nature of the produce, quick loss of seed viability, self pollinated nature of the crop and low profitability of the seed production system discourage private sector's involvement in commercial seed multiplication of this crop. This situation can improve only when farmers, non-governmental organizations, and public sector agencies participate more vigorously in seed production of this crop. This manual provides basic information about the crop, formal and informal seed production systems and processes, and crop husbandry to enable farmers and others to take up formal or informal seed production of improved varieties of groundnut.

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Introduction

Seed is the basic input in agriculture. The quality of seed used by farmers determines the status of agriculture they practice. However, for maximum gain in productivity in any crop, use of both improved varieties and improved integrated crop management practices are required. Not only do they contribute to increased productivity individually, but they also act synergistically.

Seed of improved varieties is a costly input; more so in the case of groundnut, where the non-availability of improved variety seed is a major constraint in most of the groundnut growing countries. With little interest of private sector in groundnut seed enterprise due to reasons such as low seed multiplication ratio, bulky nature of the produce, quick loss of seed viability, high cost of transportation, low profit margin, self pollinated nature of the crop, the task of making the seed of improved groundnut varieties available to farmers in required quantities and at the right price lies with the public sector seed agencies. Unfortunately, the public sector seed agencies have not been able to meet the demand of good quality seed of improved varieties of groundnut in many countries. There remains a large gap between the seed demand and seed supply resulting in low area coverage by the improved varieties in this crop. The problem is further accentuated by the low seed multiplication ratio in groundnut. The vertical seed replacement rate for groundnut in India during 1999-2000 was 6.15% (Tiwari, 2002). Unless enterprising and progressive farmers and NGOs come forward to take up formal/informal seed production, this situation is likely to remain unchanged. This manual aims to provide information on groundnut seed production practices and attendant crop husbandry as the seed crop requires a treatment different from that of a commercial crop.

Groundnut

Groundnut is the sixth most important oilseed crop in the world. It contains 48-50% oil and 26-28% protein, and is a rich source of dietary fiber, minerals, and vitamins. Groundnut is grown on 26.4 million ha worldwide with a total production of 37.1 million metric t and an average productivity of 1.4 metric t ha^{-1} (FAO, 2003). Over a 100 countries worldwide grow groundnut. Developing countries constitute 97% of the global area and 94% of the global production of this crop. The production of groundnut is concentrated in Asia

and Africa (56% and 40% of the global area and 68% and 25% of the global production, respectively).

Groundnut Plant and Seed

Cultivated groundnut (*Arachis hypogaea* L.) belongs to genus *Arachis* in subtribe *Stylosanthinae* of tribe *Aeschynomeneae* of family *Leguminosae* (Fig 1).

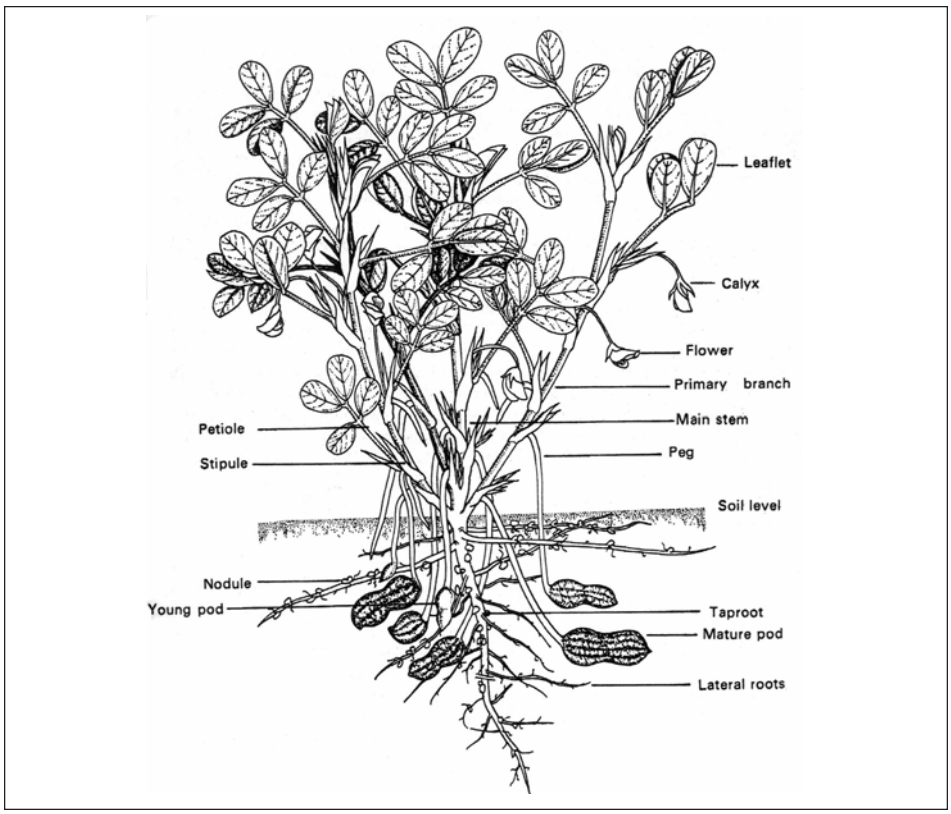


Fig 1. A stylized groundnut plant

It is a self-pollinated, tropical annual legume. At locations where bee activity is high, some cross-pollination can occur (Nigam et al., 1983). Cultivated groundnut has two subspecies, *hypogaea* and *fastigiata*, which in turn have two (var. *hypogaea* and var. *hirsuta*) and four (var. *fastigiata*, var. *vulgaris*, var. *peruviana*, and var. *aequatoriana*) botanical varieties. Each of these botanical varieties has different plant, pod, and seed characteristics (Krapovickas and Gregory, 1994). However, most of the commercially cultivated varieties belong to var. *hypogaea* (common name/market type:

virginia or runner), var. *fastigiata* (valencia), and var. *vulgaris* (spanish) botanical variety groups. The main characteristics of these three botanical varieties are described below.

Variety ***hypogaea***: No floral axes or branches on main stem; alternating pairs of vegetative and reproductive axes on branches (alternate branching); inflorescence simple; vegetative branches moderate to profuse; primary branches longer than main stem; growth habit spreading, intermediate, or erect; usually two seeds per pod; pod beak not very prominent; seed size medium (runner market type) to large (virginia market type); testa color generally tan (red, white, purple, or variegated also exist); cured seed dormancy moderate; maturity medium to late.

Variety ***fastigiata***: Floral axes on main stem; irregular pattern of vegetative and reproductive branches with reproductive branches predominating on branches (sequential branching); inflorescence usually simple; vegetative branches sparse; primary branches shorter than main stem; growth habit upright; two to four seeds per pod; pod beak absent, slight, or prominent; seed size small to medium; testa color tan, red, white, yellow, purple, or variegated; cured seed dormancy little.

Variety ***vulgaris***: Floral axes on main stem; irregular pattern of vegetative and reproductive branches with reproductive branches predominating on branches (sequential branching); inflorescence compound; vegetative branches moderate; primary branches shorter than main stem; growth habit upright; mostly two seeds per pod (three seeds are rare); beak absent or present; seed size small to medium; testa color tan, red, white, or purple; cured seed dormancy little.

Different growth habits and branching patterns in groundnut are shown in Appendix 1, Fig I and Fig II. New groundnut cultivars, resulting mostly from hybridization within and between subspecies, sometimes, have overlapping characteristics described above.

Groundnut seed is very delicate and is highly sensitive to different kinds of stresses before, during, and after harvest including storage. Different pod and seed parts are described in Fig 2.

Factors affecting yield and seed quality in groundnut include cultural practices, diseases, insect pests, weeds, drought, temperature, and curing and drying after harvest. Humidity also becomes important in storage for seed viability. Seed quality is established in the field and cannot be improved after harvest. Setting up of management plans and cultural practices that produce high quality seed is very important in the groundnut seed enterprise.

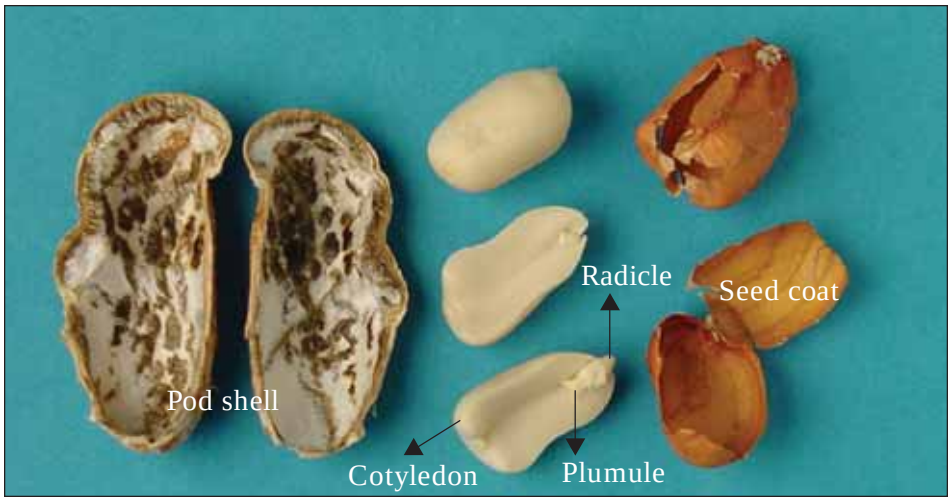


Fig 2. Different parts of groundnut pod and seed

Currently, the seed multiplication ratio in groundnut ranges between 1:5 and 1:10. Under assured growing conditions and high inputs, this multiplication ratio can be further increased. It is important to get a high pod yield in a seed crop to ensure lower seed prices for the farmers and more profit to seed growers.

Classes of Seed

In a formal seed production system, the following five classes of seed are recognized.

Nucleus seed: The Nucleus seed is produced from the basic seed stock, Nucleus seed, or Breeder seed available with the originating breeder or institution under the direct supervision of the originating or a sponsored plant breeder following the progeny row method. True to type (representing diagnostic characteristics of a released variety selected for Nucleus seed production) plants are selected individually from the space-planted basic seed stock (or Nucleus or Breeder seed plot). The number of selected plants will depend upon the quantity of Nucleus seed to be produced taking the multiplication ratio into account. These selected plants are studied for plant characteristics during the growing period in the field, and for pod and seed characteristics after harvest (See Appendix I). Only those plants which fully conform to the diagnostic characteristics of the variety under multiplication, are retained individually. In the following season, these plants are space-planted in progeny rows and each progeny is again studied carefully during pre- and post-harvest, for diagnostic

characteristics of the variety under multiplication. Any progeny deviating from these diagnostic characteristics is rejected. The selected progenies are then bulked to form Nucleus seed stock.

Breeder seed: Nucleus seed is used to produce the Breeder seed, which is done under the direct supervision of the originating or a sponsored plant breeder. It is used to increase the Foundation seed and is not available for general cultivation. Because of the low seed multiplication ratio in groundnut, two stages of Breeder seed production are permissible in India. The Nucleus seed is multiplied to obtain Breeder seed Stage I, which in turn is multiplied to obtain Breeder seed Stage II. However, it is essential to use only duly certified Breeder seed Stage I to produce Breeder seed Stage II. The Breeder seed crop is sown at normal recommended plant density.

Foundation seed: This is the offspring of Breeder seed or occasionally the progeny of Foundation seed. The breeder and originating institution help to maintain genetic purity and identity of the Foundation seed conforming to the standards prescribed for this class of seed.

Registered seed: This is the offspring of Foundation seed and is produced under agency regulations to maintain varietal purity and identity.

Certified seed: This is the offspring of Foundation, Registered or occasionally Certified seed and is available to farmers for general cultivation. Certified seed produced from Certified seed is not eligible for further seed increase under certification.

Seed of only notified varieties is eligible for certification. The agricultural universities, public and private sector seed producing agencies, authorized farmers' organizations, and registered individual farmers generally undertake Foundation, Registered, and Certified seed production programs. Each class of seeds has its own prescribed seed standards, which are to be met by the seed growers for certification.

In an informal seed sector, enterprising farmers and small seed traders produce/procure seed of varieties released in the public domain and sell it to the farming community as 'Truthful seed'. The selling of 'Truthful seed' is allowed legally in India, but its purity and quality is not assured. In leguminous crops, where seed multiplication ratio is low and seed is bulky (such as groundnut, chickpea, pigeonpea, and others), the informal seed sector plays a significant role in making the seed available to local farmers.

Seed Certification Standards

A regulatory authority sets the seed certification standards for various classes of seed of different crops in each country. These standards could vary depending on the local situations. Nucleus seed represents the highest degree of purity and stringent standards, which relax as the seed category moves down to Certified seed. Breeder seed does not have any prescribed certification standards. However, as per the Indian Minimum Seed Certification Standards, "*Breeder seed should be genetically so pure as to guarantee that in the subsequent generation i.e. certified Foundation seed conform to the prescribed standards*".

The following are some of the seed certification standards set by various regulatory authorities for groundnut in their jurisdiction.

Table 1. Seed certification standards for groundnut set by the Central Seed Certification Board, Ministry of Agriculture, Government of India

	Seed class	
Factor	Foundation	Certified
Pure seed (minimum)	96%	96%
Inert matter (maximum)	4%	4%
Off type plants (maximum) at the final inspection in the field	0.1%	0.2%
Other crop seed (maximum)	Nil	Nil
Weed seeds (maximum)	Nil	Nil
Germination of the hand-shelled kernels (minimum)	70%	70%
Moisture content (maximum)	9%	9%

(Source: Tunwar and Singh, 1988)

Table 2. Seed certification standards for groundnut in Vietnam

	Seed class	
Factor	Foundation	Certified
Pure seed (minimum)	96%	96%
Inert matter (maximum)	4%	4%
Weed seeds (maximum) (seeds kg^{-1})	0	5
Other crop seed (maximum)	0.1%	0.5%
Germination of the hand-shelled kernels (minimum)	70%	70%
Moisture content (maximum)	10%	10%

(Source: Ministry of Agriculture and Rural Development, 2002)

Table 3. Seed certification standards for groundnut set by the North Carolina Crop Improvement Association, North Carolina, USA

Factor	Seed class			
	Foundation	Registered	Certified-1	Certified-2
Pure seed (minimum)	100%	98%	98%	95%
Inert matter (maximum)	0	2%	2%	2%
Weed seeds[1] (maximum)	0.01%	0.01%	0.01%	0.01%
Restricted noxious weeds	None	None	None	1 seed/lb
Other crop seed other kinds[2] (maximum)	None	0.01%	0.02%	0.02%
Other varieties and offtypes (maximum)	0.04%	0.2%	0.5%	0.5%
Germination (minimum)[3]	85%	85%	85%	75%
Bottom screen size(minimum)	15/64"	15/64"	15/64"	15/64"

(1 = shall not exceed 5 per lb; 2 = not to exceed 2 per lb for Registered seed and 3 per lb for Certified seed; 3 = seed offered for public sale must germinate 85%)

Table 4. Seed certification standards for groundnut in Georgia, USA

Factor	Seed class		
	Foundation	Registered	Certified
Pure seed (minimum)	95%	95%	95%
Inert matter (maximum)	5%	5%	5%
Other varieties (maximum)	None	0.2%	0.2%
Other crops (maximum)	None	0.1%	0.2%
Noxious weeds	None	None	None
Conditioned seed germination (minimum)	75%	75%	75%

(Source: Baldwin and Lee, 1990)

In developing countries, where non-availability of seed continues to remain a major constraint to promoting improved groundnut cultivars among the farmers, it may be advisable to relax some of these standards to stimulate the seed production chain in the formal seed sector.

Monitoring and Inspection

The Nucleus seed and Breeder seed do not come under the purview of a seed certification scheme. As such, there is no prescribed monitoring/inspection procedure for them. However, the breeder responsible for Nucleus seed

production should ensure full conformity to diagnostic characteristics of the variety under Nucleus seed production and the highest purity standards of the seed. The breeder responsible for Breeder seed production should carry out a thorough inspection of the crop before and after flowering and at harvest to eliminate any unhealthy, abnormal and off-type plant. This will ensure genetic purity of the Breeder seed, which in the next generation would conform to the standards of Foundation class of seed.

Monitoring/inspection is mandatory for certification of other classes of seed (Foundation, Registered, and Certified). A duly authorized seed certification agency of a State organizes the field and post-harvest inspections by a team of technically qualified personnel. A seed analysis report and results of a grow-out test, wherever prescribed, are taken into account before issuance of a certificate by the seed certificating agency.

Important Considerations in Cultural Management of a Seed Production Crop of Groundnut

A seed crop requires more care and attention than a food crop. A healthy crop (Fig 3) meeting the prescribed standards of seed certification is essential for a successful seed production program.

Season for seed production: In many countries, there is only one season suitable for groundnut cultivation in a year. However, in major groundnut growing areas in India and southeast Asia at least two groundnut crops can be grown in a year. In such a situation, it would be better to grow a groundnut seed

Fig 3. A healthy groundnut seed crop sown on raised beds at ICRISAT Center, Patancheru, India

crop in a season where productivity and seed quality would be high. In India, crop season × seed germination of the produce interactions have been reported in the past. Generally, the produce of the postrainy (Oct/Nov-April/May) season, when high temperatures prevail at the time of maturity, is reported to have lower germination. However, in a study at 30 locations in Tamil Nadu, Natarajan (1996) did not find any germination difference between the *kharif* (rainy season, June/July-Sept/Oct) and *rabi* (postrainy) season produce of groundnut variety VRI 2. If proper field drying and curing procedures are followed (avoiding direct exposure of the pods to the sun when field drying), the germination of the produce will not be affected.

Selection and care of parental seed: The class of parental seed will depend on the class of seed one has opted to produce. It is essential that the appropriate class of certified parental seed is used to produce the desired class of certified seed. The parental seed should be obtained from the authorized sources and the attached certification seed labels should be preserved till the next seed crop is certified. The seed procured for sowing should be stored in a cool and dry place. The seed bags should be handled carefully. Rough handling and dropping of bags on the floor can damage the seed radicle (protruding part of the seed which gives rise to the primary root) resulting in seed decay, poor germination, and abnormal seedling growth. If the seed is not treated with fungicide and insecticide, it should be treated with them just 1 or 2 days prior to sowing. The seed treatment with recommended fungicide and insecticide should be carried out gently so as to avoid injury to seed radicle. Seed treatment ensures good germination and establishment of healthy seedlings, which leads to higher productivity in the crop. The seed rate depends on the recommended plant spacing for the region and 100-seed weight of the variety under multiplication. It could vary from 80 kg ha^{-1} to 150 kg ha^{-1} under Indian conditions.

Selection of field: A healthy field, free from soil borne diseases and insect pests and weeds, is essential for a seed production program. The field should be leveled and well drained and should preferably have sandy loam soil. It should also have irrigation facilities. Unless supplementary irrigation is available, seed production under rainfed conditions should be avoided.

Do not select a field in which groundnut was grown in the past two seasons. This will avoid contamination of the seed crop from volunteer plants of previous crops. If this is impossible to follow, the variety under seed multiplication should be the same as was grown in the previous seasons with equivalent or higher class of certified seed.

However, it is not advisable to grow groundnut after groundnut in the same field as it could lead to build up of diseases and insect pests in the soil. The field should also have easy accessibility for monitoring/inspections.

Isolation distance: In general, natural cross pollination in groundnut is almost absent. However, at locations where bee activity is intense, depending on the variety and season, natural cross pollination can occur. Therefore, it is essential to have adequate isolation distance between varieties in seed production fields to help prevent contamination with pollen from other varieties and mechanical mixtures. In Florida and Georgia, the isolation distance for Certified seed is a minimum 15 m between two groundnut plots. For Foundation seed in Georgia (0.25 – 6.16% natural cross pollination), the minimum isolation distance required is 30 m. In India where natural cross pollination is almost negligible, an isolation distance of 3 m between varieties is required for all classes of Certified seeds. Isolation distance should be determined for each location, season, and variety depending upon the extent of natural cross pollination. It would be advisable to carry out natural cross pollination studies periodically, particularly with newly released varieties, to make necessary adjustments in isolation distance, if required.

Land preparation and sowing of the crop: The land should be well prepared to give a fine tilth required by the groundnut crop. Although, groundnut is sown on flat beds in many countries, it is preferable to grow the crop on raised beds as they permit ease of field operations, better water management, and avoid compaction of seedbeds. The recommended plant spacing and sowing depth should be followed to raise the crop. However, only one seed per hill should be sown so as to permit easy rouging, if needed. The crop should be sown at the optimum time and followed with irrigation to ensure uniform and better crop establishment. A field with uneven crop emergence may fail to qualify for seed certification.

Nutrients application: Groundnut does well in soils which are rich in organic matter. The fertilizer doses would depend on the results of soil tests and the productivity levels targeted for the crop. They could vary from field to field. In addition to major nutrients N, P, and K, calcium (Ca) is a critical nutrient in producing high quality groundnut seed. There must be enough Ca in the top 8-12 cm of soil after the peg enters it. Characteristics of Ca deficiency include a dark plumule, slow germination and emergence, low seedling survival, poor growth, and a weakened plant. In tests, seed germination averaged 92% when the Ca level was greater than 420 ppm but decreased to 52% when the Ca level decreased to 200 ppm. It is important to maintain

near to neutral soil pH levels (as high or low levels may create either deficiency or toxicity of micro-nutrients) and Ca to K ratios of less than 3 to 1. Excessive K in the podding zone interferes with Ca uptake and results in pod rot and pops (unfilled pods). Regardless of soil tests, it is advisable to apply 150-200 kg ha^{-1} Ca to small-seeded varieties and 300-400 kg ha^{-1} to large-seeded varieties at the time of peak flowering. The gypsum/lime (depending upon soil pH) should be applied as side placement followed by light inter-cultivation to mix it with soil and remove weeds. It is also important to monitor Mg, B, and Zn levels closely in seed production fields. They can interfere with the availability of other nutrients and their toxicity or deficiency can affect plant growth and production.

Water management: Appropriate water management is essential to achieve early germination, uniform plant establishment, and high productivity in the crop. If soil moisture is insufficient, the field should be irrigated before or soon after sowing to ensure uniform and rapid crop emergence. A light soil moisture stress during the vegetative phase (up to 3-4 weeks after sowing) does not affect yield but it can reduce vine growth enough to minimize diseases later. However, moisture stress during flowering can delay or inhibit flower formation. After flowering, peg penetration requires adequate moisture. Once active pegging and pod formation have begun (about 50-60 days after sowing), the pegging zone (the top 8-12 cm of soil) should be kept moist. This can be achieved by applying frequent but small amount of irrigation. The presence of moisture in the podding zone improves Ca uptake, which is essential for proper pod and seed development. A lack of water in this zone during pod addition and development results in more pops, more one-seeded pods, a less mature crop, and a lower Ca content in the seed, which in turn affects germination and seed quality. Water deprivation can reduce germination by 40%, particularly in virginia types.

Too much water also causes problems by promoting excessive vine growth, diseases, peg deterioration, and non-uniform maturity late in the season. Irrigation or rainwater should not be allowed to stagnate in the field.

Weed management: A seed production field should be weed free as weeds not only affect productivity and other field operations but also interfere with roguing and field inspections by the monitoring team. Further, the presence of weed seeds in produce may disqualify it for certification.

Plant Protection: Diseases and insect pests affect crop productivity and the quality of produce (poor pod filling, low shelling outturn, small seed size, shriveled seed, seed discoloration, seed damage, low germination etc). They

also interfere with recording of proper field observations. Recommended plant protection measures against diseases and insect pests should be regularly followed during the cropping season.

Roguing: Minimum two (preferably three) roguings should be carried out before harvest to remove off-type groundnut plants in the seed production field. At the seedling stage, weak, distorted, variegated, diseased, and out of the row alignment seedlings should be removed and destroyed. At the flowering stage, variants, not conforming to flower morphology, branching pattern, growth habit, and other diagnostic characteristics of the variety under seed multiplication should be removed from the field. Similarly, at the podding stage, based on peg morphology and other vegetative characters, the remaining off-types including late flowering plants should be removed. The last roguing is done on the harvested plants to remove plants with diseased pods and off-types based on pod and seed characteristics.

Harvesting: The timing of harvesting is very critical as it can significantly affect the economic yield and the quality of seeds. Both pre-mature harvesting and over maturity can be harmful. When the crop is mature, the leaves start yellowing. The mature pods become reticulated and within it, seed is separated from the shell of the pod and the inside of the shell becomes dark in color (Fig 2). The crop should be harvested when 70-75% (sometime this percentage can be slightly lower in the case of alternate branching types) of the pods are mature. A few representative plants in the field should be uprooted and their pods should be studied to determine the optimum time for harvesting.

After harvest, the plants should be left in rows for final roguing. Any off-type plant (based on pod and seed characteristics) and plants with diseased pods should be removed. Gleanings (left over pods in the soil) from seed production plots should not be mixed with certified seed.

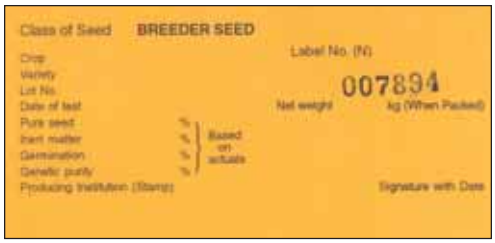
Drying and Curing: Initial curing of plants and pods is usually done by allowing them to dry in windrows under ambient temperature conditions. At the time of harvest, groundnut pods generally contain 35-60% moisture. Until the moisture is reduced to < 10%, the pods are prone to mould attacks. Plants are allowed to remain in the windrows until whole pod moisture drops down to 18-20% for mechanical threshing and to 15% for hand threshing. In places where high temperatures prevail at the time of harvest (postrainy season crop in India), direct exposure of pods to the sun should be avoided. This can be achieved by arranging the harvested plants in circular heaps with pods facing inside (Fig 4).

Fig 4. Drying and curing of groundnut plants and pods in a circular heap with pods facing inside in a farmer's field in India

If a thresher is used to strip pods, it should be thoroughly cleaned before use for each variety. All the possibilities of mechanical admixing at the time of threshing should be eliminated. After threshing, the pods should be dried in a bin by forcing low humidity air to evaporate the excess moisture. Or else, they could be dried in the shade (but it would take longer). Exposure to high temperatures (above 45^0C) may affect the seed quality. The moisture content in unshelled groundnut should be brought down to 8% (in case of seed 6%) for storage. Only sound, mature, clean, and well-filled pods should be selected for seed.

Packaging and Storage: Except for the lot size, there are no specifications on packaging of groundnut seed pods in India. The cleaned and well-dried seed pod produce should be packaged in polythene-lined gunny bags with appropriate certification tags. Each bag should be properly stitched along with a seed tag (issued by the seed certification agency) and sealed. The details printed on different seed tags used in India are given in Fig 5. The color of the tag for Breeder seed is golden yellow, for Foundation seed white, and for Certified seed, azure blue. The seed producer should maintain a proper record of use of seed tags.

Groundnut stores better in pods than in seeds. It is known to loose seed viability quickly if stored improperly. The storage temperature should be low. In general, the lower the temperature, the longer the expected storage life. Temperatures below 13°C inactivate most insects and arrest growth and influence of other seed quality deteriorating factors. The relative humidity



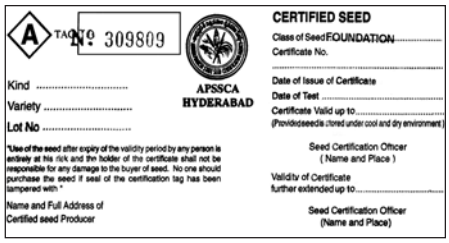
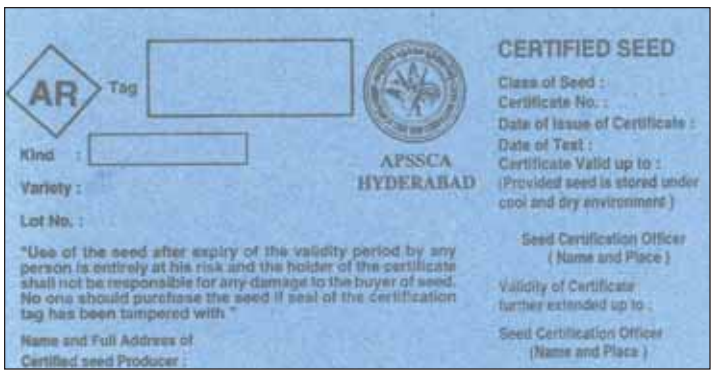


Fig 5. *a. A Breeder seed tag* *b. A Foundation seed tag*



c. A Certified seed tag

(RH) should be between 65% and 70%. Mould growth is encouraged at higher RH levels. However, at RH below 65%, the groundnut pods loose weight and the seeds become brittle and split during handling. The RH, rather than seed moisture content *per se,* is the key criterion for many physiological events and microfloral associations during seed storage. If proper storage conditions (low temperature and low humidity) are not available, well dried, unshelled groundnut should be packaged in polythene-lined bags, and fused calcium chloride @ 250 g 20 kg pods^{-1} in a wide- mouthed bottle covered with thin muslin cloth should be placed in the center. The bags should be stored in a ventilated, clean, and dry store in such a way that the mouth of the bottle is upward in direction (Basu and Reddy,1989). The bags should be placed over wooden planks to avoid dampness from below and should not be stacked too high. In case of pest outbreak in storage, fumigation with Celphos (tablets) should be carried out strictly following the recommended procedure. It is important to follow proper sanitation in seed stores.

Groundnut seed should not be carried over more than a year if it is to be sold as certified seed.

Shelling: Shelling of groundnut pods for seed should preferably be done manually. Manual shelling can avoid damage and splitting of seeds, which can

happen in mechanical shelling. At the time of shelling, any seed, which is infected, damaged, or does not conform to shape, size, and color of the variety under seed production, should be removed. The seeds should be treated with appropriate fungicides and insecticides before sowing.

Seed Systems in India

Formal seed system

The system of official release of crop varieties in India was formalized in 1964 with the establishment of the Central Variety Release Committee (CVRC) at the national level and the State Variety Release Committee (SVRC) at the state level in various states. The Government of India enacted the Seeds Act in 1966, which was implemented in 1968, after framing the Seed Rules (Yadav and Singhal, 2003). In 1969, the functions of CVRC were taken over by the then newly constituted Central Seed Committee (CSC), who advises the Central and State governments on matters arising from implementation of the Seeds Act. The Central Seed Sub-Committee on crop standards, notification, and release of varieties, appointed by the CSC, scrutinizes identification and release proposals forwarded by the Variety Identification Committee constituted by ICAR during the annual crop workshops. It recommends varieties to CSC for their release at the national or state level and notification. The State level varietal system of testing and release is almost identical to that of the Central system. The State Seed Sub-Committee can release a variety at the State level, but only the CSC can issue a notification of such releases. Only notified varieties can be certified under the formal seed production program.

As per the Seed Rule of 1988, varieties of foreign origin may get provisional notification after one year of testing at 15-20 locations in a season. For regular notification however, two additional years of testing is required.

As per the Seeds Act, certification (pre-marketing seed control) of seed is not essential as the Act states, “Any person selling, keeping for sale, offering to sale, bartering or otherwise supplying any seed of any notified kind or variety, may, if he desires to have such seed certified by Certification Agency, apply to the Certification Agency for the grant of a certificate for the purpose”. However, for seed quality law enforcement (marketing control), labeling in the prescribed manner is essential. The person whose name appears on the mark or label is responsible for accuracy of the information required to appear on the mark or label.

The Indian seed program largely adheres to the limited generation system for seed multiplication: i. Breeder seed, ii. certified seed (Foundation seed and Certified seed). Seed certification agency notified under the Indian Seeds Act or any certification agency established in any foreign country, provided the certification agency has been recognized by the Government of India through notification in the Official Gazette, can certify the Foundation and Certified seeds.

Breeder seed production: The availability of Breeder seed in required quantities is essential to promote and sustain the seed production chain to popularize newly released and notified varieties among the farmers. Seed corporations, cooperative societies, and related organizations with the State Department of Agriculture can place their indent for Breeder seed requirement with the Seed Division, Department of Agriculture, Ministry of Agriculture and Cooperation, Government of India. Private seed companies and individuals can submit their requirements to the Seed Association of India who consolidate the requirements and place the indent with the Seed Division. These indents are then screened and complied variety-wise, state-wise, agency-wise and sent to the Deputy Director General (Crops), Indian Council of Agricultural Research (ICAR). The Deputy Director General (Crops), ICAR sends these consolidated indents to Project Coordinators of the respective crops for making arrangements for the production of Breeder seed. The assignment for production of Breeder seed is discussed in annual crop workshops of ICAR and then allotted to different research institutions/centers for production. Each participating center keeps the Project Coordinator and the Seed Division informed of the progress in Breeder seed production by sending information in prescribed Breeder seed production (BSP) proformas as described below.

BSP proforma No.	Content	Issued by
1	Allocation of Breeder seed production (only notified varieties)	Project Coordinator of the crop concerned
2	Schedule of production and expected availability of Breeder seed	Producing breeder
3	Monitoring team report	Submitted by producing breeder
4	Variety-wise Breeder seed production – Final report	Submitted by producing breeder
5	Supply of Breeder seed to seed producing agencies identified by the Seed Division	Submitted by producing breeder

(Adapted from Shanmugam, 2003)

Although the Breeder seed does not come under the purview of seed certification, a multidisciplinary team consisting of a plant breeder, a plant pathologist, an entomologist, and a scientist from the National Groundnut Research Centre, Junagadh, form the monitoring/inspection team for Breeder seed production. One representative each from the National Seed Corporation and the State Seed Corporation is also invited to join the team. At least two inspections from flowering to harvesting period are prescribed. The monitoring team generally inspects the Breeder seed crop 2-3 weeks before harvest to certify the conformity of the crop to diagnostic characteristics of the variety under multiplication and other prescribed standards of crop husbandry and isolation distance. Due to low seed multiplication ratio, sometimes two stages of Breeder seed multiplication (Stage 1 and Stage 2) are permissible for groundnut.

Foundation and Certified seed production: Foundation seed is generally produced at their own farms by the seed producing agencies. Like Breeder seed, two stages of Foundation seed multiplication are also permissible in groundnut. The Certified seed is generally produced in farmers' fields. The Foundation seed producing agencies identify farmers and enter into an agreement with them to produce Certified seed. These fields are regularly inspected by the seed producing agencies, who are responsible for getting the produce certified by the State Seed Certification Agency.

An individual farmer can also produce Foundation and Certified seed at his/her farm by obtaining the appropriate class of parent seed (Breeder or Foundation seed) from authorized sources, maintaining the prescribed field and crop standards and getting the field inspected and produce certified by the State Seed Certification Agency. Farmers should retain the original tags of parent seed until all the inspections by the Seed Certification Agency are completed.

Informal seed systems

The yearly requirement of Certified seed of groundnut in India is 1.5 million metric t. The public sector seed producing agencies meet only a small fraction (0.065 million metric t) of this requirement (Tiwari, 2002). Because of non-availability of seed of newly released varieties in required quantities, the old varieties such as TMV 2, J 11, JL 24, AK 12-24, and others continue to dominate the varietal scene in groundnut farming in India. Most of the farmers either save their own seed for the next season or buy it from local markets, which often sell nondescript or mixed seed; thus resulting in low

productivity of the crop. Unless farmers, NGOs, and the private sector come forward in a big way, the demand for Certified seed of groundnut will remain unfulfilled. As a consequence, crop productivity will remain low due to non-realization of full returns on the investment made in groundnut improvement research.

Groundnut scientists and policy makers have suggested several schemes to promote the informal seed sector to overcome the shortage of good quality seed and hasten the diffusion of improved varieties of groundnut among the farming community. Some of these schemes in India include:

1. Seed village program: Under this program interested farmers are provided with Foundation seed and technical guidance by public sector seed producing agencies/ state agricultural universities/NGOs to undertake seed production at the village level. The seed farmers are free to sell their seed to other farmers within or outside the village. From their experience with farmer participatory groundnut seed production in Tamil Nadu, Vijayalakshmi et al. (2003) reported a considerable shortening of the 'seed route', farmers' increased confidence in seed production and distribution systems, and their increased willingness to participate in farmer-led research.

2. 'Beej Swavlamban Yojna' (A Scheme for Building Self Reliance in Seed): Under this scheme each farmer is provided with small quantity of Foundation seed and the seed plots are supervised by agricultural officers. A part of the resultant seed is recycled to maintain the seed production chain, and the remainder is used to raise a commercial crop. A similar self-sustaining scheme in groundnut (Fig 6) is suggested by Deshmukh et al. (2001).

3. Contract seed production: As local seed traders are the major source of groundnut seed, they could promote quality seed production through contract farming of improved varieties with selected farmers. However, both farmers and traders need to be educated in the technical aspects of groundnut seed production, processing, and storage.

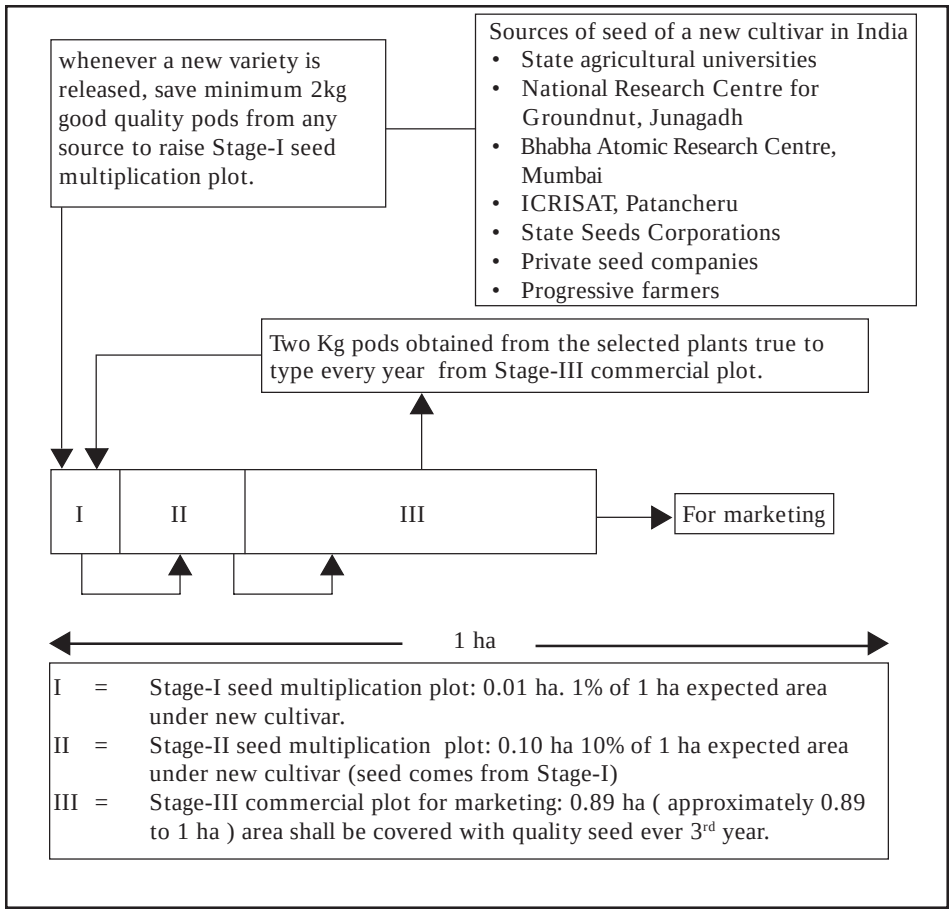


Fig 6. The PDKV method of groundnut seed production

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Appendix

Groundnut Varietal Descriptions: Diagnostic Characteristics

A. Morphological traits

1. Growth habit (See Fig I)
2. Branching pattern (See Fig II)
3. Plant height and breadth (mm)
4. Stem pigmentation
    i. Present
    ii. Absent
5. Stem surface
    i. Glabrous
    ii. Sub-glabrous
    iii. Moderately hairy
    iv. Very hairy
    v. Woolly
6. No. of primary and secondary branches
7. Leaf character
    i. Size (small, medium or large)
    ii. Shape (See Fig III)
    iii. Color
    iv. Hairiness of young leaflets
8. Flower color
    i. Standard petal (See Fig IV)
    ii. Standard petal markings
9. Peg pigmentation
    i. Present
    ii. Absent
10. Pod characters
    i. Pod beak (See Fig V)
    ii. Pod constriction (See Fig VI)
    iii. Pod reticulation (See Fig VII)
    iv. Pod ridge (See Fig VIII)
    v. Seeds/pod (See Fig IX)
    vi. Pod length (mm)
    vii. Pod breadth (mm)
    viii. Shelling percentage

11. Seed characters

i. Seed length (mm)
ii. Seed breadth (mm)
iii. 100-seed mass (g)/ Seed size (See Fig XII)
iv. Seed color (See Fig X)
v. Seed shape (See Fig XI)

B. Quality traits

1. Oil (%)

2. Protein (%)

3. Oleic / Linoleic (O/L) fatty acid ratio

C. Reaction to biotic stresses

1. Foliar diseases

2. Soil borne diseases

3. Virus diseases

4. Insect pests

D. Reaction to abiotic stresses

1. Drought

2. Others

E. Post-harvest seed dormancy

1. Present (specify duration)

2. Absent

F. Growing season and area of adaptation

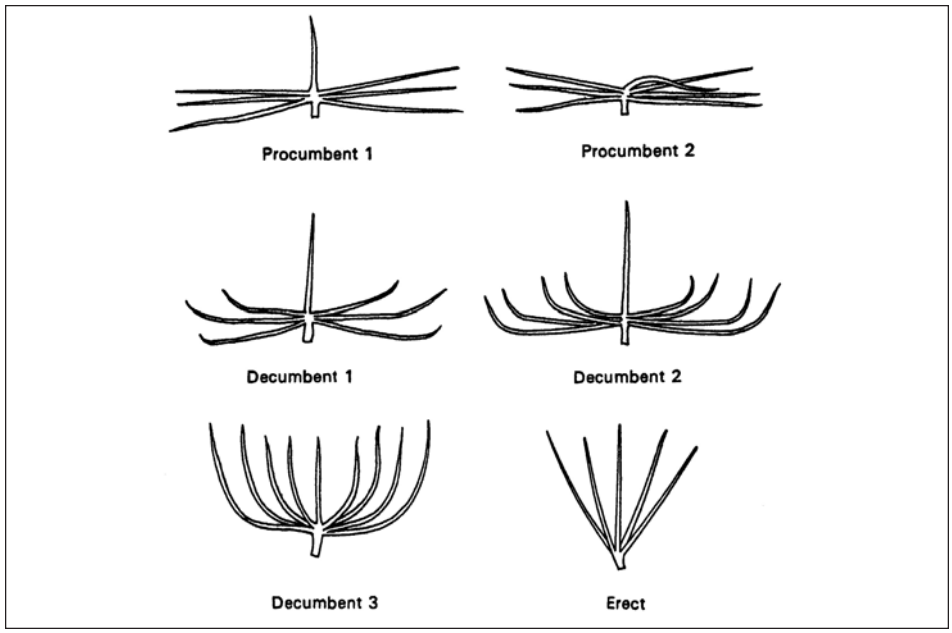

Fig I. Growth habits in groundnut

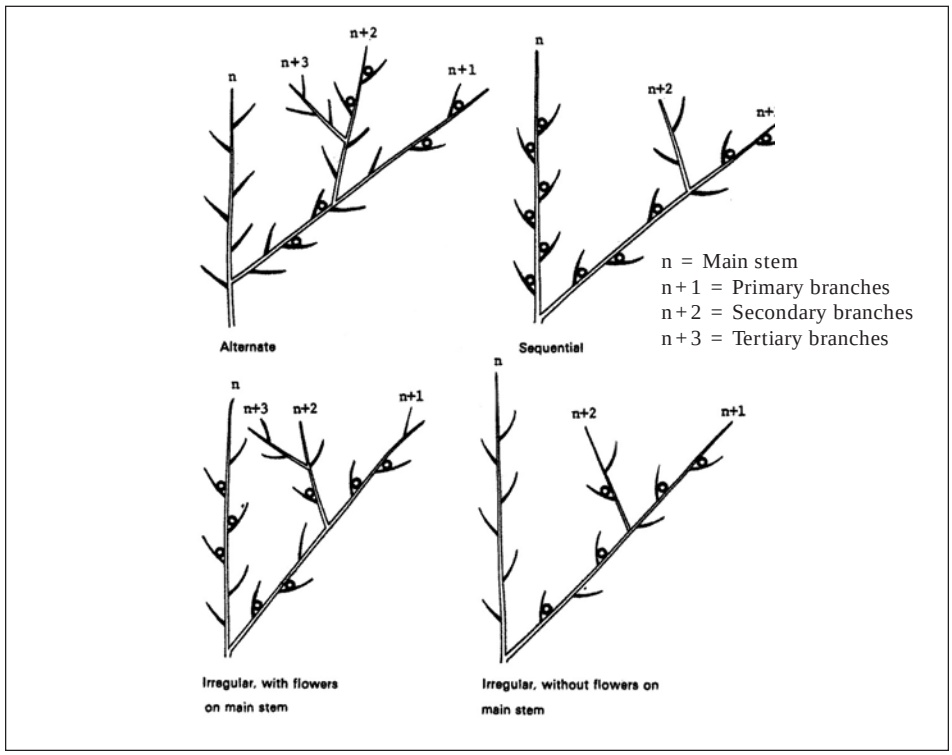

Fig II. Branching patterns in groundnut

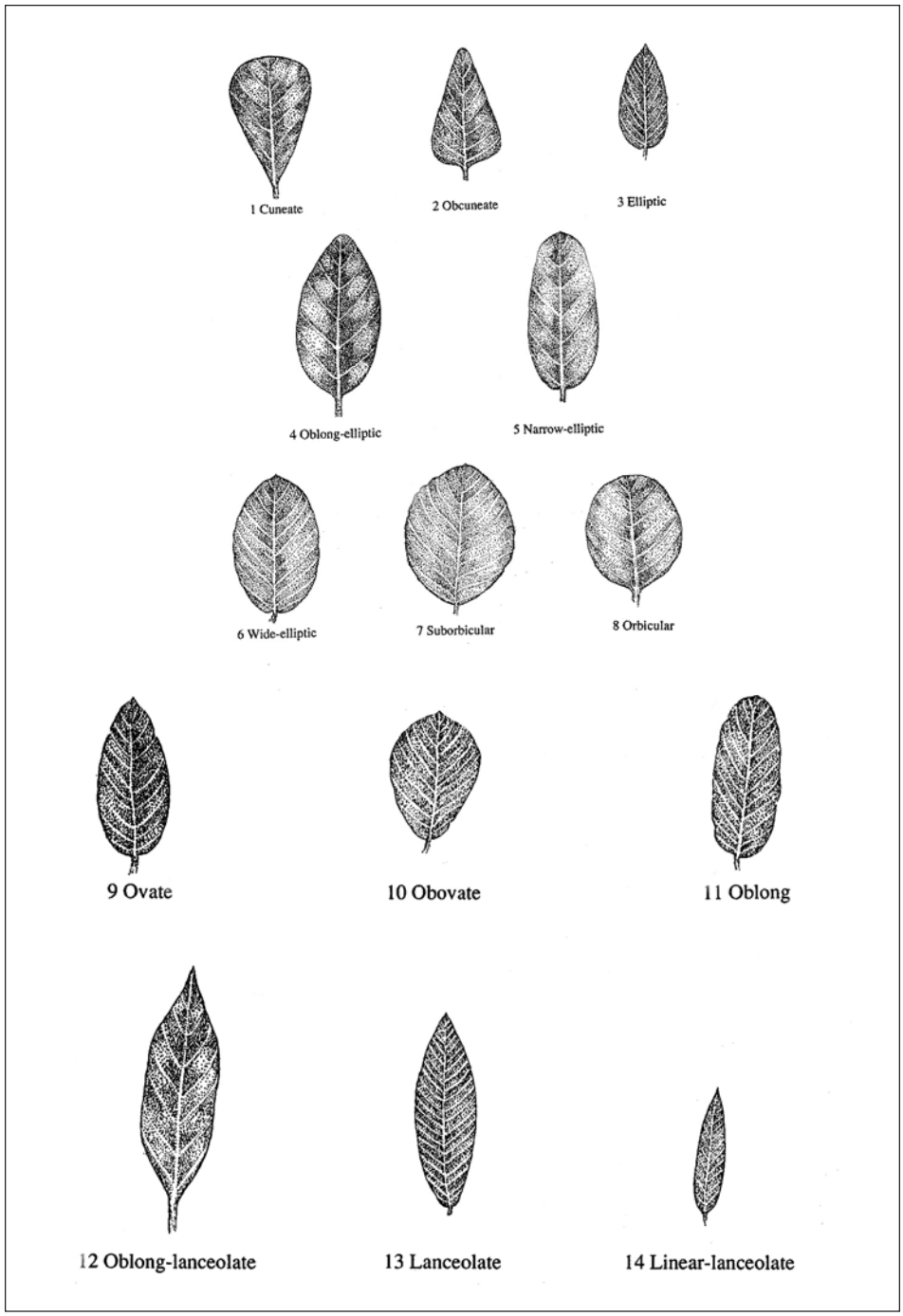

Fig III. Leaf shapes

(Source Fig I – III, IBPGR and ICRISAT, 1992).

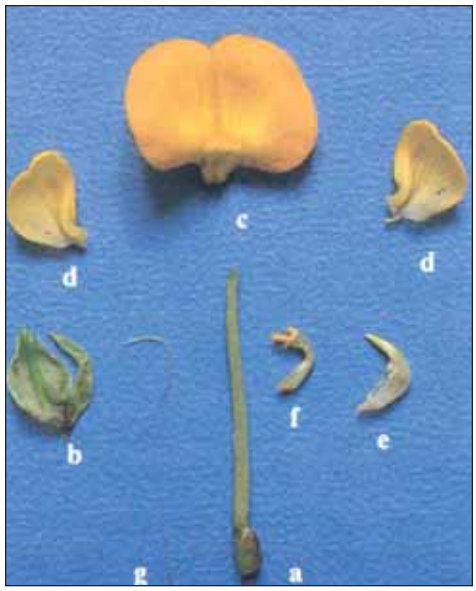

Fig IV. A dissected groundnut flower showing (a) hypanthium, (b) single and fused sepals, (c) standard, (d) wings, (e) keel, (f) stamens, and (g) style and stigma

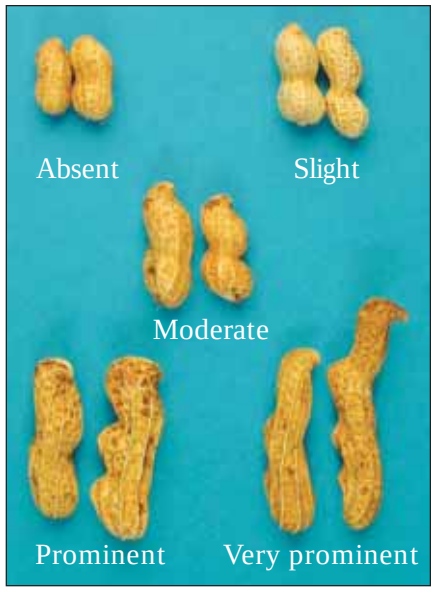

Fig V. Pod beak

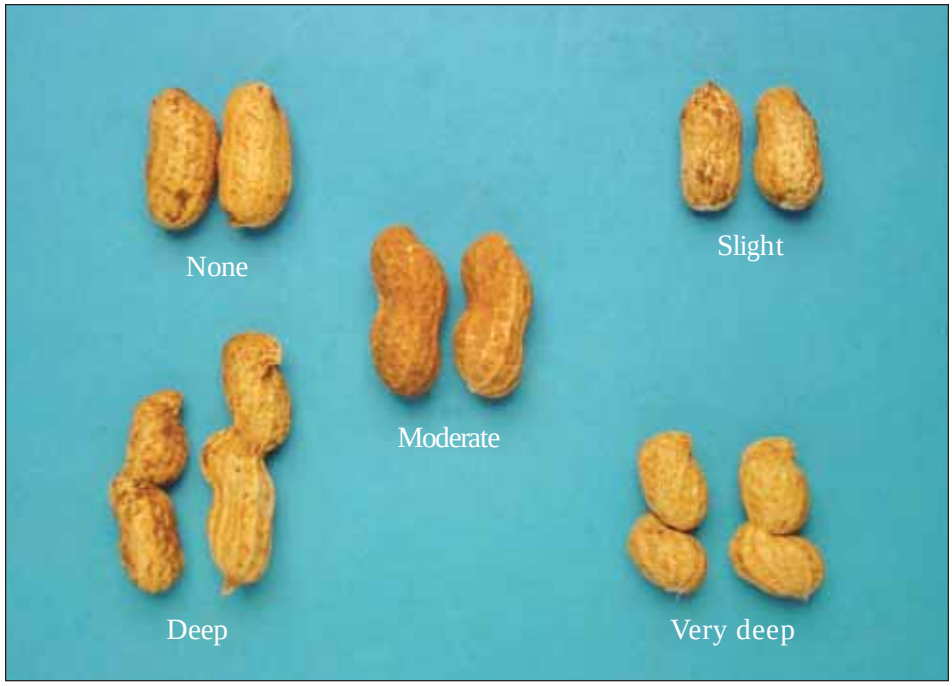

Fig VII. Pod constriction

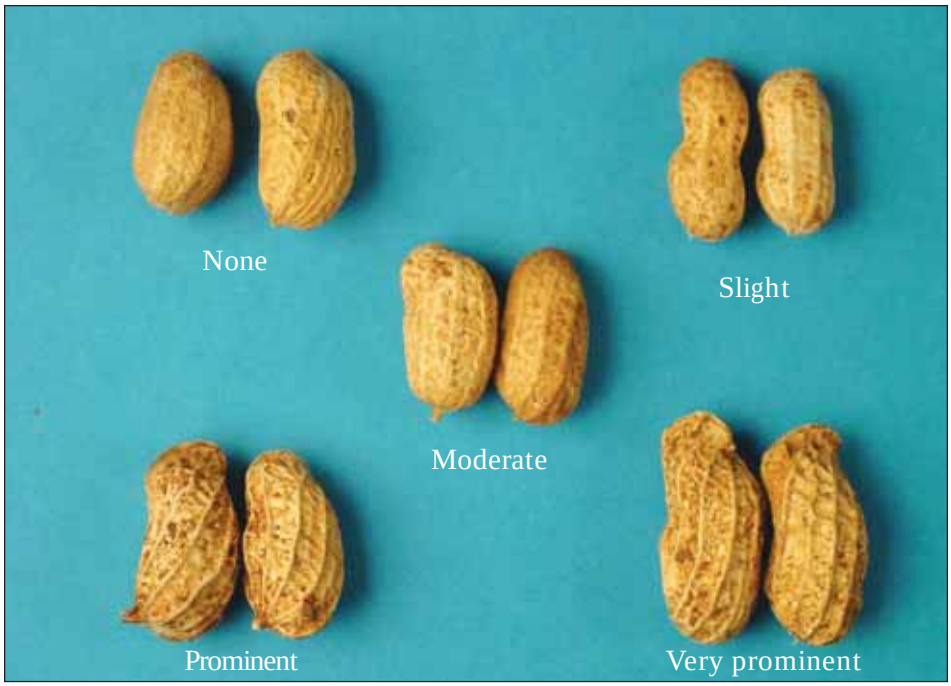

Fig VII. Pod reticulation

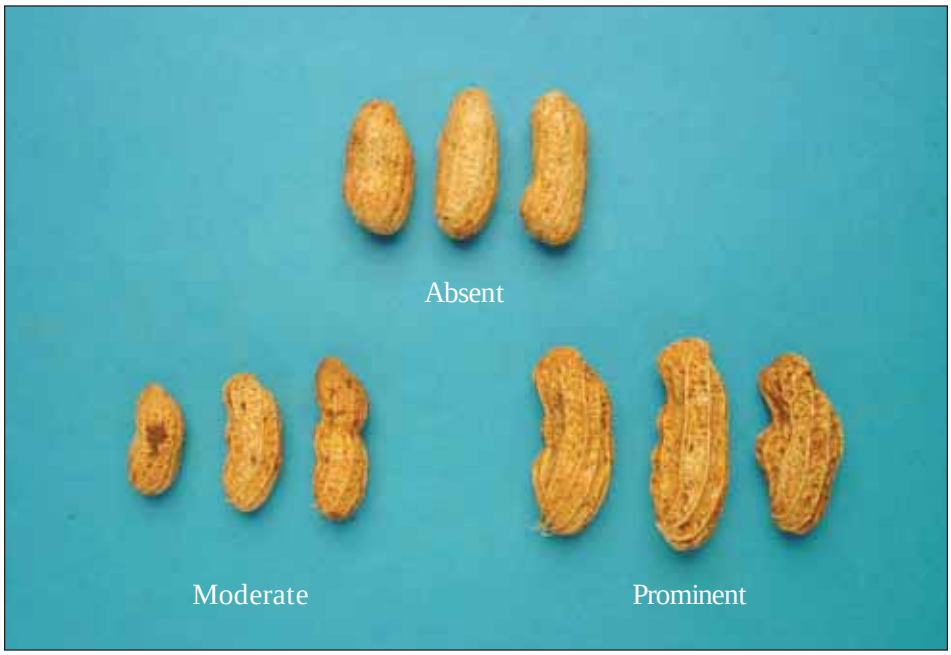

Fig VIII. Pod ridge

Fig IX. 1-4 seeds per pod

Fig X. Seed color

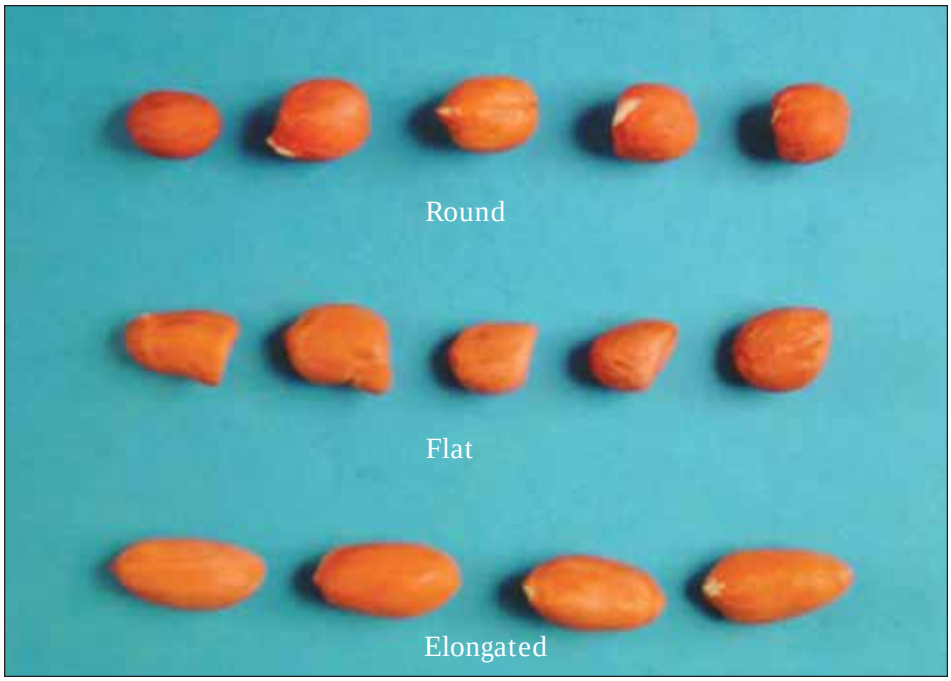

Fig XI. Seed shape

Fig XII Seed size

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political, international organization for science-based agricultural development. ICRISAT conducts research on sorghum, pearl millet, chickpea, pigeonpea and groundnut – crops that support the livelihoods of the poorest of the poor in the semi-arid tropics encompassing 48 countries. ICRISAT also shares information and knowledge through capacity building, publications and ICTs. Established in 1972, it is one of 15 Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

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