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SEED PRODUCTION FOR SMALL FARMERS AND HOME GARDENERS

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Anyone who can successfully grow a crop is sufficiently equipped to save its seed. There is nothing that a farmer does not know about seed production. A seed germinates, grows, flowers and produces more seed! Seed is the beginning and the end of the growth cycle of a crop – something that every farmer is very familiar with.

INTRODUCTION

For millennia, ever since plants were domesticated, seeds have been inseparable from farming. Even now, in most rainfed areas, especially in small subsistence farms which are linked to local markets, seed production is still an integral part of farming activity. Not as a specialised activity, but seamlessly merged with the growing of crops and the totality of work and life on a farm.

All the agricultural bio-diversity that is our heritage has been maintained and developed in such farms and these unknown farmers are our real seed breeders – claiming no property rights, no royalties, no acknowledgement. The situation started changing when the first experts were brought in to 'improve' crops and make agriculture 'profitable' (improved for the profit of companies). Once these seeds were released and pushed on farmers, packaged with accompanying inputs, it was the beginning of the end of traditional agriculture and all its plant wealth.

Today only fragments of this wealth survive in remote or hilly areas or in backyard gardens which the agro-industry has not yet managed to invade. Governments around the world, who are the present 'official' custodians of seeds, choose to store them in vaults deep below the Arctic ice, protected by international laws, or in well-guarded national seed banks, nameless, homeless, numbered accessions in concentration camps, where no farmer dares or is allowed to set foot.

The industrial way of life now dominates and encompasses farming as well, which is slowly but inexorably being absorbed into the agro-industry business. Thus many of the essential inputs of farming, which used to be produced and recycled within the farm in a rhythmic manner, season after season, year after year, are now being purchased from companies and factories at very heavy cost. Of all the inputs required on a farm, the corporate grip over seeds is the most alarming because it threatens to hold farming hostage to big business interests.

If the integrity of farming is to be restored and preserved, it is crucial for farmers to regain and retain self-reliance in all inputs, especially seeds.

In areas where seed saving still survives as an integral part of traditional farming, it only needs to be honoured and safeguarded. In other areas where farmers have lost their connection with seeds, they need to win back their privileged role as seed breeders and custodians.

The first half of this booklet presents 'perspectives' while the second half introduces simple 'techniques' for seed production which are practical in the present-day context of farming. The booklet discusses the basics of seed saving, focusing on some vegetable crops and shows how the farmer can produce seeds good for sowing his/her next crop.

This booklet will be useful to farmers who have been alienated from the process of producing seeds and are eager to rediscover it. It will also serve as a guide to aspirant farmers who are rejecting the urban-industrial way of life and are turning to agriculture, so that right at the outset, seeds can be placed where they belong – at the heart of farming. It is a guide for anyone interested in starting seed conservation or production, beginning on a small scale with vegetables for a home garden.

SEED SAVING – THEN & NOW

Seed conservation/production today is compelled to be slightly different from seed saving in traditional agriculture because it has to adapt to greatly changed circumstances. The simple process of sowing a seed, letting it grow, flower and finally harvesting the seeds, now needs one additional step – *maintaining varietal purity*. While the job of maintaining varietal purity is an important task for a seed producer today, this was never so in traditional agriculture. Why?

Crop diversity in traditional agriculture was 'created' by a combination of natural and human influences. Varying geographical conditions, natural plant mutations and cross pollination are some of the natural factors that created diversification within species. The human element in crop variation came from intelligent selection by farmers, combined with historical events such as new varieties brought from other regions by travellers and migrating populations. This is how for instance thousands of rice varieties came into existence.

This stunning diversity was maintained for thousands of years. It was possible only because of the sheer vitality and extent of farming across the whole country. Wherever farms existed, crops were grown and seeds were routinely conserved. Each cluster of villages had its own unique varieties. Farmers all over the Indian subcontinent only continued to do what they typically did – grow crops and store the seeds – season after season. It was physical isolation by geographical separation that 'maintained' the unique qualities of varieties.

This massive geographical canvas – where crop diversity was naturally maintained –does not exist anymore. Today farmers, groups or individuals who wish to revive traditionally bred seeds are few and far between. They source seeds from all over and start building a collection. Such collections are urgently needed and most valuable, but they are still however, artificial responses to an emergency situation, like Noah's Ark. There is an inherent risk in such collections where several varieties of the same

species are confined to and grown in a relatively small area – the risk of cross pollination. This sounds paradoxical because cross pollination is a natural phenomenon and one of the causes of diversity in the first place. In the context of building and maintaining a seed collection today, ironically, this very force can also eliminate diversity. The desirable qualities of a crop variety can be lost by cross pollination if more than one variety is grown in a small area. Since our aim is to conserve varieties rather than lose them, it becomes unavoidable to introduce and follow, wherever necessary, practices to maintain purity of varieties.

SOURCING SEEDS

Any work of seed conservation/production has to begin with sourcing seeds. A collection could be specialised for one crop, e.g., a collection of rice varieties or it could be generalised – a collection of home garden varieties which would include a wide range of crops.

Backyard gardens, rainfed farms, remote regions and hilly areas are some of the places where seed treasures still exist and should be sourced via farmers' networks.

National Seed Banks are supposed to preserve this wealth. A closer look reveals that these banks do not preserve crop diversity per se, but are meant to provide plant material to specialist plant breeders for 'crop improvement'. Farmers do not come in the picture except as victims of officially released varieties. Wherever farmers collectives are active, attempts should be made to access these collections and make them available for field trials. After all, where did these varieties come from in the first place?

The focus while sourcing seeds should be on finding traditionally bred varieties. The term used today for traditionally bred seeds is OPEN POLLINATED, referring to the *natural* conditions in which these varieties originated. [1]

Open Pollinated seeds stand in contrast to seeds produced by modern methods such as HYBRIDISATION. Hybrid seeds are obtained by the *intentional* crossing of two plant varieties.

HYBRIDS AND TRADITIONAL SEEDS – THE DIFFERENCE

From the seed itself, it is not possible to distinguish between a hybrid and a traditional seed. As a rule, however, hybrid seeds come with a high price compared to open pollinated seeds.

When hybrid seeds are sown, the offspring are of a uniform type. But if the seeds produced by the offspring are sown, they will show variations. If the seeds from the offspring *do not* show variations, then it is just a fake hybrid with absolutely no justification for its premium price.

[1] We choose to use the term 'traditionally bred' varieties instead of 'open-pollinated'.

Even an authentic hybrid, for that matter, is a giant fraud, as some scientists have so convincingly argued.[2] Their contention is that hybridisation is a crafty method used by seed companies to make farmers captive purchasers of seeds. Hybrid seeds cannot be saved by farmers because variations show up in the second generation. In some hybrid crops, the parental lines are inbred to such an extent that they become sterile. This is the real agenda behind hybridisation – breeding for sterility – while the seeds are deceptively marketed under tall claims of hybrid vigour and improved yields. The same vigour claimed by hybrid methods can be obtained by essentially traditional methods of crop improvement, but this line of work is totally ignored because it empowers farmers to produce their own seed. Farmer's empowerment is the last thing that seed corporations are interested in.

Seeds of open pollinated varieties on the other hand have been and can continue to be kept by farmers. If the variety is stable, its qualities will continue to be expressed in successive generations. Technically this is known as 'breeding true to type' or 'breeding true'. Because open pollinated varieties 'breed true' anyone can save their seeds.

MAINTAINING VARIETAL PURITY – WHY?

If two varieties of a species, e.g., two kinds of lady's finger or two varieties of brinjal are grown together in a garden of say 500 sq metres or even larger, the challenge of maintaining varietal purity has to be faced. Wherever insects are observed on flowers of crops – bees of different kinds, wasps, butterflies, either foraging for nectar or for pollen, we can be fairly sure that they are at the same time transferring pollen from flower to flower. If this happens between flowers of a red, long lady's finger and green short lady's finger, the uniqueness of both is likely to disappear. If a bee transfers pollen between a hot chili and a sweet capsicum, both being varieties of the same species *Capsicum annum*, the capsicum is likely to lose its sweetness. In technical terms the resulting seeds will not 'breed true' or be 'true to type'.

This worry of cross pollination causing loss of desired qualities of a crop variety, of course, does not apply to a farmer who has no intention to grow many varieties of a single species, but merely wants to revert to a traditionally bred variety and save its seed for next season. It is only a matter concerning those who want to grow more than one variety of the same crop (e.g., small fruited brinjal and large fruited brinjal or a red lady's finger together with a green one and white one).

Techniques to maintain varietal purity are not at all impossible to learn. The rest of this booklet will demonstrate how it can be done, with very little resources. But if it is an added burden to farmers who are already overworked, it would be simplest for individual farmers to grow and save seeds of one variety per crop (species), so that it just has to be grown and seeds harvested, in the traditional way.

There are also some crops which are naturally closed to cross pollination or where the percentage of cross pollination is very low. In such cases two

[2]Jean Pierre Berlan

or more varieties can be grown for seed purposes without much worry about cross pollination.

Anyone who has a look at official standards for seed production will immediately be discouraged. Seed production is made to appear as if no one other than a huge scientific establishment, with mega funding, can produce good quality seeds. This is totally incorrect. Every farmer is a natural seed producer. Even with the additional job of maintaining varietal purity it is still highly achievable for any farmer, small grower or even city gardeners to produce seeds which are qualitatively excellent.

NOTE FOR READERS:

The next section contains a few technical terms, which the reader needs to know if s/he wishes to make intelligent choices from among the various methods found to be suitable to keep seed varieties pure or if the reader wishes to understand why a particular method is recommended over others. If however the reader finds the information too technical and is interested merely to know the most appropriate (tried and tested) method to be followed, s/he can skip to the next section on Methods for Different Crops and simply follow the step-by-step instructions.

UNDERSTANDING POLLINATION

A seed is a dormant plant embryo with a supply of stored food for its initial growth.
Seeds are the result of a reproductive process of plants, in which flowers play a lead role.

By just looking at a flower and remembering school botany, it is possible to tell that flowers have female parts and male parts. Fertilization takes place when pollen from the anthers (the male -pollen producing part) is transferred to the stigma (the female receptive part). This process is called pollination. The deposited pollen (male sperm) fuses with the ovules (female egg) to form the embryo, which then develops into a seed.

From the seed savers perspective, the task of maintaining purity of varieties involves making sure that the pollen from the male part of a particular variety reaches only the female part of the same variety. Pollen from another variety should be entirely excluded.

Depending on the nature of the crop and its pollination habit, the seed producer has to either CONTROL POLLINATION or PREVENT CROSS POLLINATION.

Exactly which approach, is suitable for which crop, can be known by understanding its pollination habit. The clues to understanding pollination habits lie in the structure of the flower.

<u>Observing Flowers</u>

There are three basic 'living' arrangements in plants for male and female elements.

1) Male and female both occur within the same flower. This type of flower is known as a PERFECT FLOWER or hermaphrodite.
   Examples: brinjal, tomato, lady's finger

2) Male and female occur on separate flowers on the same plant. These are IMPERFECT FLOWERS or more precisely MONOECIOUS or 'one house', meaning that both male and female occur on separate flowers on the same plant body.
   Examples : pumpkin, cucumber, gourds, maize

3) Male and female occur on separate plants. Such flowers are also Imperfect but are clearly defined by the term DIOECIOUS meaning 'two houses'.
   Examples: papaya, potol or pointed gourd, tendli/kovakkai or ivy gourd.

Put in a simple way, there are roughly three kinds of 'living arrangements'; those in which male and female occupy:

1) one room
2) one house, but separate rooms
3) two separate houses.

(***PHOTOS SHOWING FLOWERS OF BRINJAL/TOMATO, PUMPKIN, PAPAYA***)

With these three expressions of Perfect and Imperfect flowers which are either Monoecious or Dioecious, there are four pollination patterns, under which most crops fit. Many other variations exist in nature, but we need to focus only on categories relevant for the seed saver.

Strictly Cross-Pollinating – Imperfect Flowers

If flowers are imperfect, monoecious (separate rooms, one house) or dioecious (separate houses), it is obvious that some external agent (either wind or insects) is absolutely necessary to transfer the pollen from the male flower to the female flower, or in the case of dioecious plants, from the male plant to the female plant. These plants are called strictly allogamous.

Examples: Dioescious plants: Papaya , pointed gourd (potol), ivy gourd (tendli/)
Monoecious plants: Maize, pumpkins, gourds and most other cucurbits – cucumber, gourds, pumpkin etc.

In this situation a seed producer who, for instance, is simultaneously growing a long bottle gourd and a round bottle gourd has to make sure that pollen from the long bottle gourd does not reach the female flower of the round bottle gourd and vice versa. This can be achieved only if the seed saver plays the role of the insect, so that pollination is strictly controlled. The method is called Hand Pollination (Described in detail

later). It is used for pumpkin, bottle gourd, snake gourd, sponge gourd and ridge gourd.

There are other cucurbits which have very small flowers and do not lend themselves easily to Hand Pollination. For such plants Time Isolation or Space Isolation is the only possibility.
Examples: Cucumber and bitter gourd.

Time Isolation means sowing varieties with a time interval of 30 days or more (depending on the duration of the crop), so that that the flowering of different varieties does not coincide. Within the constraints of season, if time isolation is possible, it is a recommended method. But there should be absolutely no overlapping of flowering.

Maize is an exceptional member of the grass family which has imperfect flowers. Most other grasses – all the other cereals – have perfect flowers. The male inflorescence of maize appears on the top of the plant, while the female inflorescence is the silk that is seen above the emerging cob. Pollination in maize is a combination of wind and bee activity. Different varieties of maize are best grown in a staggered way, making sure that one variety begins flowering only after the other has completed flowering.

Dioecious plant varieties are also best isolated in space or time. Papaya is Dioecious with male and female on separate plants. As the plants are very tall, Hand Pollination is difficult, though not altogether impossible. Every year a different variety can be grown. Papaya is pollinated by night flying moths which apparently fly long distances. This makes space and time isolation a little unreliable, but still preferable.

Space isolation is also a possibility. Ideal isolation distances are hard to judge, because bees forage within a range of 0.3 to 3 km in the tropics. Isolation distances vary between regions and no general rule is reliable. After a little experience and observation, it is surely possible to judge ideal isolation distances for a specific location.

If varieties can be distributed over villages, this is the best way to maintain purity and is the closest to the traditional way.

Strictly Self-Pollinating – Perfect Flowers

When flowers are perfect (male +female on same flower), self pollination is one possibility, but there are very few plants which are strictly self pollinating. Such plants are called autogamous.

Examples : Basella or Malabar spinach (*Basella rubra*, *Basella alba*), lettuce.

Because autogamous plants are almost entirely self pollinating, varieties generally do not cross and therefore nothing additional needs to be done to keep them pure. They can be grown next to each other and usually they do not cross pollinate. But even in autogamous plants, there are some chances of cross pollination. For instance: In temperate climates, tomato has autogamous tendencies, but in tropical climates, they cross pollinate quite easily. Even lettuce, which is considered autogamous in

colder climates does cross pollinate in warmer regions, but to a small extent.

Self Pollinating + Insects and Wind – Perfect Flowers

A large majority of the crops we grow have perfect flowers with a capacity to self fertilize, but are also open to cross pollination by insects or wind. These are called allogamous plants.

Examples: brinjal, tomato, chili, capsicum, beans, pulses and other legumes, lady's finger. Bees are is quite active on brinjal. Chilli, capsicum and tomato are also cross pollinated by bees, to some extent. In some beans such as Lima beans (*P.lunatus*), *Apis cerrana* is very active. Rice is also in this category. It is largely self pollinating with 0-3% chance of cross pollination by insects or wind.

Since these plants are basically self pollinating but welcome cross pollination, something has to be done to prevent the mixing of varieties by insect activity. Usually the method for plants of the Solanaceae family (tomatoes, chillies, capsicum, brinjal) is to use mosquito netting to prevent insect activity and consequent cross pollination. Details follow.

Mosquito netting is also possible for Lady's Finger but since the plants are often quite tall, netting is not very practical. Instead the flowers can either be bagged or tied with a twine. Details follow.

Other methods that can be used:
Time Isolation
Space Isolation

Strictly Cross Pollinating – Perfect Flowers

There are some plants with perfect flowers (male and female on the same flower) but which absolutely need insects or wind to move the pollen either within the flower or between two flowers. Such plants are strictly allogamous.

Example : sunflowers, many of the brassicacaea, such as radish.

If any plant is strictly allogamous, the seed saver has to use time isolation to prevent cross pollination.

Some varieties of radish have an interesting pollination habit. The flowers are perfect but there is a time lapse between the emergence of the male and the female parts on a flower. This implies that pollen from other plants is a necessity for fertilization to take place. It is not possible to Hand Pollinate radish because the flowers are too small. Isolation with mosquito netting is also ruled out because radish is self incompatible. The only way to keep different varieties of radish pure is by isolating them in time.

Sunflowers are also perfect flowers. Some varieties tolerate self pollination but need bees to do the job. As the anthers start releasing pollen you can use your fingers to brush the pollen on to the stigmas. It is also possible to collect pollen, from the anthers of many plants of the

same variety, into a paper cup and dust it over the flowers of another plant of the same variety. Like this the seeds will have a wider genetic base. Before and after pollination, the flower head needs to be covered with a cloth/large paper bag, to be absolutely sure that no bee can land on it with pollen from another variety.

METHODS FOR SPECIFIC CROPS

This section is illustrates four basic methods which can be used to maintain varietal purity of most popular vegetable crops. These methods are adapted for small farmers and gardeners to produce pure seeds at a minimum cost. They are a little time consuming and need meticulous work, but are worthwhile, as they empower small growers, to convert their farms and homes into valuable seed wealth centres.

1) Brinjal, chili, tomato, capsicum – Isolation with mosquito netting
2) Lady's finger – Isolation using string
3) Pumpkin – Hand Pollination using string
4) Sponge Gourd – Hand Pollination using paper bags

Brinjal, Chili, Tomato, Capsicum

Brinjal, Chili, Tomato and Capsicum, all have a capacity to self pollinate, but they also attract insects. When growing many varieties of brinjal or chili (or tomato or capsicum) together, insect activity has to be excluded to prevent cross pollination between different varieties

(PHOTOS SHOWING MOSQUITO NETTING)

For small scale seed production, ordinary nylon mosquito nets of size 6 x 3 ft which are easily available can be used. They are strung to vertical poles and draped over a part of the bed where the plants are the most vigorous. The net has to be installed just prior to flowering. If there has been a slight delay and flowering has already started, the fertilized flowers should be removed. The net has to be firmly fixed on the sides using branches or logs or anything else, as long as insects are prevented from entering. As the fruits set and ripen they can be harvested for seed extraction. The mosquito nets can be removed and stored for the next crop.

Small quantities of seeds can also be produced in pots covered by a mosquito net. When the plants grow too tall, they have to be pruned back. This is ideal for city gardeners with very little space.

For tomatoes, if seeds are needed in very small quantities, just for next year's garden, one or two flowering stalks can be covered with a cloth bag. This is very simple to make with a draw string at one end so that it can be drawn close and tied, gently but close enough to keep insects away. When the fruits have started forming, the stalk can be marked with a string and the bag can be removed so that the fruits have space to grow.

Large scale seed producers put up isolation tunnels over long beds. Usually it is a skeletal structure of bendable GI wire, partially dug into the ground on both sides of the bed (of approximately 3 ft width and as long

as desired). This structure is covered with long lengths of mosquito netting which are stitched together and fastened at the base with stretched elastic.

Qualitatively, there is no difference between the seeds produced in tunnels and those produced in individual mosquito nets. To go one step further in the direction of crop improvement, you can select the best plants and cover them with a specially tailored net of 75 cm height x 60 cm length x60 cm breadth. With this the seeds produced are not only pure but also improved by selection.

Lady's Finger

Lady's Finger, like Brinjal, tomato and other vegetables of the Solanaceous family, has perfect flowers, with male and female elements in the same flower and capable of self pollination. But it does to a considerable extent attract bees which mix pollen between varieties. In principle, the lady's finger varieties can be isolated by mosquito netting, but practically this is difficult because the plants outgrow the nets. Instead each flower can be tied with a piece of twine.

(PHOTOS SHOWING ISOLATION WITH STRING FOR LADYS FINGER)

With this method, it is possible to grow many varieties, side by side, without any worry of losing purity.

Pumpkin *(Cucurbita moschata)*

Pumpkin has separate male and female flowers on the same plant. Bees, especially *Apis cerrana,* are the main pollinators for pumpkin, who crowd to the flowers to gorge on the abundant nectar. If more than one variety of pumpkin (*C.moschata*) is grown, bees are sure to mix up the pollen. The seed saver therefore has to take the place of the bee and become the pollinator instead.

(PHOTOS OF HAND POLLINATION OF PUMPKIN)

Pumpkins are usually very large vines, often spreading over 100 sq ft. If you are growing more than one variety, it is better to grow them apart, preferably in opposite corners of the garden. If different varieties are grown too close, the branches intermingle and it very difficult to identify which male flower belongs to which variety.

This method of hand pollination with string, is ideal for Pumpkin, or any other member of the Cucurbitaceae family, with large flowers. Bottle gourd (Lagenaria siceraria) can also be hand pollinated using string to tie the flowers.

Sponge Gourd

Many Cucurbits have small flowers. Sponge Gourd, Bitter gourd, Snake gourd, Ridge gourd, cucumber all have small flowers, which makes it very difficult to tie with string. For all these, using paper bags, in the way shown here for sponge gourd, is preferable.

(PHOTOS SHOWING HAND POLLINATION OF SPONGE GOURD WITH PAPER BAG)

Maintaining purity of cucumber and bitter gourd is very challenging because the flowers are very tiny and hardly visible before blooming. Besides, many of the flowers drop off before fertilization. Paper bag Hand Pollination is likely to succeed for the first female flowers that emerge as they usually always set fruit and are also easier to locate on a young plant.

In order to avoid inbreeding and keep a wide genetic base, it is wise to fertilize each female flower with three male flowers, preferably from different plants of the same variety. This is a general rule that applies to Hand Pollination of all Cucurbitaceae.

SEED PROCESSING & STORAGE

Traditional practices pertaining to seed processing and storage are rich, especially in rainfed areas. They deserve to be rediscovered and reintroduced.

There are however a few good seed processing techniques, which are not usually considered traditional, such as fermentation of tomato seeds. Seeds which are covered with a gel, especially tomato, are best fermented before being dried. Cucumber, melon and pumpkin seeds actually benefit from fermentation, before drying. The process is simple. Scoop out the tomato seeds along with the pulp that surrounds them and put it in a glass bottle. After two days, a white film appears on the surface. Pour the seeds together with the gel into a large strainer /sieve and rinse it out. Fermentation separates the pulp from the seeds and the rinsed out seeds emerge totally clean. Fermentation assists in quick germination and the clean seeds are less prone to fungal attacks during storage. The procedure is the same for cleaning any seed covered with a gelatinous pulp.

For seed drying, the morning sun is considered best, followed by shade drying. Common sense and a bit of practice is enough to set a seed drying standard for oneself.

Seeds essentially need to be protected from insects, from fungus due to humidity, and high temperatures. Various traditional methods make sure that all these conditions are met. Seed treatment with cow urine and wood ash works wonders to keep away insects and fungus. Storage in clay pots provides coolness. Hundreds of methods are known to farmers who have not yet lost their traditional knowledge base.

Seed storage is best adapted to the culture of a household. In modern households, domestic refrigerators work very well for long term storage, especially in areas with an unsuitable hot humid climate. In hot humid conditions, seeds kept in a refrigerator last seven or eight times longer than seeds stored outside. In cooler, drier areas, seeds remain viable much longer at ambient temperatures and there is no need for refrigeration.

A very low cost, small scale, seed bank can be successfully created in a kitchen cupboard to store 100 or more varieties, in small quantities, for up to a year. This can be done using 'origami' paper bags and boxes made by folding recycled A4 size paper.

*(**PHOTO SHOWING SEED CUPBOARD WITH ORIGAMI BOXES AND PACKETS**)*

CONCLUSION

A home based seed collection is highly do-able. Combined with seed sharing and exchange, it is a very meaningful activity, well within the capabilities of any farmer or gardener. For individuals concerned about the insecure food situation, this is one way to take direct action to preserve traditional agriculture: Start a home garden. Conserve and share seeds.

'Become the change you want to see' – Mahatma Gandhi

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