Investing in indigenous Knowledge

GREEN

GREEN FOUNDATION

Investing in indigenous Knowledge

CONTENTS

Preface

The concept of genetic resource conservation has undergone several changes ever since awareness thereof was raised by the Convention on Biological Diversity. GREEN (Genetic Resource, Ecology, Energy and Nutrition) Foundation as a grassroots organisation has been working among the marginalised farmers of Karnataka and Tamil Nadu for the past decade in raising awareness and involving the farmers in conserving the subsistence crops that are fundamental to their food security. The work on seed conservation was logically extended to bring about synergy between indigenous systems of conservation and the agricultural diversity valued by farmers. It was not enough to simply conserve diversity, however; it was imperative to add value to it. In the process, farmers' knowledge pertaining to agricultural practices has played an important role. Indigenous communities' knowledgein this area has drawn the attention of the international scientific community. Indigenous knowledge and biodiversity have been considered two sides of the same coin. In different parts of the world efforts have been afoot to protect this knowledge through documentation and biodiversity registers. Community biodiversity registers, however, are seen as a double-edged sword. It has been acknowledged that no rights can be claimed on knowledge that is in the public domain. But at the same time there is ample scope for bio piracy by vested interests of knowledge that has been passed down over generations by oral tradition in indigenous communities.

While the debate over intellectual property rights and traditional knowledge continues, yet another important aspect of agriculture is calling the attention of those who care for the environment, the health of the soil, access to water, and the interests of producers and consumers. Organic farming is not new to the agrarian communities in countries such as India. However, knowledge that has been in

existence for over 2,000 years has been undermined by technological interventions such as the Green Revolution. Under the Green Revolution, productivity increased considerably in irrigated areas but at the cost of the environment. In the face of such damaging interventions, it is heartening to see that chemical-free farming continues to be practised based on the knowledge farmers have developed over centuries. Conservation of biodiversity is possible only with the revival of the knowledge that surrounds it. Farmers have identified and successfully cultivated plant species that can enrich the soil, are resistant to pests and diseases, and have enhanced nutritional content. The lives of farming communities to a large extent have been guided by local wisdom to maximise resources in a sustainable way. The indigenous farming practices are based on holistic worldviews. The main activities of GREEN Foundationwere initially to clarify concepts relating to this indigenous knowledge and document the experiential wisdom of farmers.

Normally when one refers to "innovation", only formal systems of innovation are recognised, namely those centred around universities, industrial research and development and laboratories. What is not so easily recognised is the innovation by artisans, farmers, tribals or other grassroots innovators. These informal innovators have contributed to a rich store of knowledge. To encourage the continued use of indigenous knowledge, it is necessary to scout, support and scale up the community efforts. The communities have a storehouse of knowledge about their flora and fauna – their habits, their habitats and the agroecosystems. As mentioned above, however, concerns have arisen over appropriation of the collective knowledge of communities into proprietary knowledge for commercial profit. The need of the hour is a policy that does not obstruct the advancement of the knowledge and that provides foradequate intellectual property protection. Unfortunately the existing systems of intellectual property rights are oriented around the concepts of private ownership and

individual innovations. The issue of protection can be looked at from two angles:protection may be granted from being appropriated by third parties, and protection also means preserving traditional knowledge against extinction. It has been well acknowledged that protection to encourage continued use of this knowledge also promotes self-respect and self-determination. As long as collective tradition is maintained by communities, it is possible to protect indigenous knowledge under mechanismslike geographical indications or sui generis systems of protection.

It is in this direction that GREEN Foundationhas contributed in bringing farmers together to place their knowledge as the basis of endogenous development. This book is one such effort to acknowledge the innovations by farmers towards sustainable farming systems.

Vanaja Ramprasad

Acknowledgment

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Abbreviations

CBOs	CBO community-based organisation
CSBN	Community Seed Bank Network
GF	GREEN Foundation
IARDF	Indian Agricultural and Rural Development Foundation
ISPWD-K	Indo - Swiss Participatory Watershed Development – Karnataka
NGO	non-governmentalorganisation
NORAD	Norwegian Agency for Development Cooperation
NRM	Natural resource management
PCI	participatory crop improvement
PTD	participatory technology development
SDC	Swiss Agency for Development and Cooperation

1 Sustainable Agricultural Practices

The debate surrounding sustainable practices of agriculture versus simply increasing yield has been simmering for some time now. Over time, there has been enough evidence to show that higher yields under modern industrial agriculture are achieved only at the cost of depleting resources or in response to external inputs. Modern farming has become highly complex, with gains in crop yield dependent upon abundant external inputs. There is the realisation that progress towards a self-sustaining, resource-conserving, energy-efficient, economically viable, socially acceptable and technologically sound system of agriculture is warranted. It is imperative to understand that traditional systems of farming can constitute the basis for the development of alternative agricultural production and management systems. In traditional systems, farmers have the ability to manage their time, labour and natural resources even under adverse conditions. There is a wisdom that is unique to their culture and has withstood the test of time.

Indigenous agricultural knowledge is a vital part of the process of making agriculture sustainable. Experimentation leads to an emergence of the best methods of sustainable agriculture. The attempt here is to compile indigenous knowledge in a usable form and disseminate it among farmers for their benefit. The dissemination may be done through training sessions, demonstrations, sanghas and meetings.

Ecological agriculture revolves around three important factors, namely soil, water and the seed. In nature, organic relationships are a pervasive phenomenon and everything is interconnected. The totality of the relationships between soil, water, flora and soil microbes

becomes the bedrock of organic and sustainable farming. Much of the understanding of these relationships is reflected in the traditional farming practices developed over centuries.

A quick review of the history and evolution of agriculture, and plants in particular, reveals that farmers have been breeders since time immemorial – way before scientific breeding began. They collected and selected different types of crops and seeds to meet their requirements for food, fodder, fuel and medicine. However, as civilisation progressed and science advanced, farmers' initiatives got sidelined due to over-emphasis on institutional development of breeding efforts. Undoubtedly, such concerted efforts were necessary to meet the growing demands of an ever-increasing population. But now the time has come to blend scientific advancements with sustainable practices – and that is where the participatory crop improvement (PCI) initiative becomes significant and relevant.

Policy makers around the world realised that mono-cropping systems were not only adversely affecting the sustainability of crop yields but also rapidly depleting agro-diversity, due to commercialisation of agriculture through the Green Revolution in the 1960s and 1970s. The formal system had undermined the role that farmers played in implementing any changes. Therefore, during the 1980s, several governments and institutions gave emphasis to "farmer-first workshops","learning by working with farmers"initiatives etc. These meetings, conferences, workshops and publications highlighted the relevance to agricultural research and extension activities of participatory approaches which could bring small-scale farmers and their concerns to the centrestage of the development agenda and sustainability concept.

Many of these initiatives can be classified as "participatory technology development" (PTD), where farmers or end users are actively involved. But the term "participatory crop improvement" will be used more often in subsequent chapters, since this publication's prime aim is to consolidate the breeding efforts by farmers.

The field of PCI is a wide one and the range of experiments / experiences, diverse. This is probably due to the multi-stakeholder nature of PC Iinitiatives, which involve agencies/institutions (universities, research institutions, extension agencies, non-governmental organisations (NGOs) etc.), farmers (producers, developers and users) and consumers/people in society. It should be noted that organisational initiatives to promote PCI have encountered several practical problems and different constraints to varying degrees in the implementation of PCI methodologies. Nevertheless, in the process of implementation, execution and association with farmer-breeders, the institutions, in general, and development agencies and

(NGOs), in particular, have produced phenomenal results on farmers' fields and simultaneously contributed to methodical innovations.

Conservation of agro-biodiversity involves ex-situ conservation and participatory management through on-farm research, with collection, multiplication, characterisation and evolution being the principal activities.

The introduction of hybrids and the technological package has considerably weakened farmers' control of key agricultural resources, particularly seeds. Seeds, which are important to food security, are increasingly no longer in the control of farmers but instead are in the hands of the private sector. In light of this, community-based and -managed agriculture has been defined by GREENFoundation as a strategy for organising collective and participatory efforts to initiate a vibrantand sustainable base for food security.

Keeping these developments in perspective, GREEN Foundation felt the need to bring together farmer-breeders and scientists in a three-day "Participatory Crop Improvement Workshop" from 30 November to 2 December 2002.The workshop was sponsored by the Norwegian Agency for Development Cooperation (NORAD) and Swiss Agency for Development and Cooperation (SDC)/Indo-Swiss Participatory Watershed Development – Karnataka (ISPWD-K).

This publication compiles not only the deliberations of the workshop but also the cumulative experiences of GREEN Foundation's initiatives in PCI, which were undertaken along with its partnerNGOs and participating farmer families.

2 Participatory Crop Improvement

Crop improvement starts with the quality of seeds that is determined by seed selection. Farmers can modify the natural selection process by the way they select seeds or cultivate crops. Early agriculturists selected and saved grains, tubers or roots that they liked most. The seeds chosen were the ones which were largest, tasted best, cooked fastest, did not easily shatter from plants without thorns yielded highest, showed the least insect and disease injury, etc. As a result, characteristics that enable the survival of plants in a natural environment, like early shattering of seeds, etc., disappeared from the plant population. As agriculture developed, plants became genetically more adapted to cultivation. Farmers selected healthy-looking seeds and seeds free of disease. Thus by repeated selection for the same characteristics over years and years farmers developed seeds with specific characteristics through the natural selection process alone.

A plant population that has developed over time as a result of such selection practices is called a farmer's variety, local variety orlandrace.

The seed is an important consideration in crop production. It has a direct effect on field performance, yield and productivity. Good-quality seeds are characterised by high germination, high vigour, low moisture content, genetic and physical purity, and are free from pests and diseases (AFSICH 1993).

Farmers have been using their own saved seeds for staple crops since time immemorial. Seed saving after every harvest is a common practice by farmers to ensure seed availability for the following season (Almekinders et al. 1994).

However, there is a general tendency by the formal seed sector to replacefarmers' seeds with formally released seeds. The formal seed sector has always assumed that farmers' seeds are poor in quality and that only it can provide farmers with good-quality seeds. This is evident in seed-related government policies wherein the government promotes the use of certified seeds to ensure high yield. Despite the efforts of the formal seed sector, however, farmers continue to use their own saved seeds since they are readily available, cost little to nothing, and are of assured quality. In fact, it is estimated that farmers' seeds meet 80% of the seed requirement in most developing countries (Almekinderset al. 1994; Fernandez and Zamora 1995).

The Green Revolution developed and promoted a package of agricultural technology which included high-yielding varieties and the use of chemical fertilisers and pesticides to achieve optimum production of these new varieties (Shiva 1991). The Green Revolution centralised agricultural research in the hands of scientists. Farmers gradually adopted the new technology and replaced traditional farming methods. The Green Revolution hada negative impact on farmers by changing the natural ecosystems and agricultural structures (Murakami 1991).

Since early times, farmers have been researching and improving their crops. Out of curiosity farmers have continually experimented either to solve a problem, to adopt or to introduce new technology to the local conditions and satisfy their interest and preferences (Simalenga 1995). However, the formalisation and centralisation of research have deprived farmers of their role as researchers in agriculture. They have become mere recipients of these new technologies and have lost control of their own knowledge and

varieties (Reijntjes et al. 1992). Hence, there is a need to move away from the conventional to the traditional farming system and bring back farmers' role as researchers, as they have contributed in improving subsistence crops like finger millet, paddy, sorghum, pearl millet and many varieties of vegetables.

PRACTICES AIDING PCI INITIATIVES FOR DIFFERENT CROPS

Finger Millet *(Eleusine coracana)*

Finger millet is a short, profusely tillering plant with finger-like terminal inflorescence bearing small reddish seeds. Maturity of the crop is between three and six months depending on the variety and growing conditions. The crop is adapted to fairly reliable rainfall conditions and has an extensive but shallow root system.

"A healthy mother alone can give birth to a healthy child; similarly only healthy soil can produce healthy crops." Mangamma of Mulbagal, Kolar district in Karnataka state, reiterates the importance of maintaining soil fertility each time a crop is to be cultivated. Basavaraj, a farmer from Tumkur district, says that applying the right kind and amount of inputs to the soil at the appropriate time is essential to obtain a good finger millet crop.

When the soil has rested through his period, weeds germinate with the first rain that occurs at the end of April. Tank silt is applied to the soil just before the rains begin and soon after, the land is ploughed thrice to incorporate weeds in the soil.

In the month of June, farmyard manure amounting to 24 cartloads per acre is broadcasted throughout the field before the seed is sown. The compost is ploughed to avoid oxidation. This compost is prepared carefully throughout the year by adding neem leaves and cake in May, flowers and leaves of PongamiainJune, and flowers of Madhuca species inSeptember; all these act as insect and pest repellent and as biomass. In some cases, 100kg of neem cake is broadcasted per acre before ploughing to enrich soil fertility and productivity.

SOWING

Seed Rate :

Broadcasting – 5kg/ac

Drill sowing – 4kg/ac

Transplanting – 3kg/ac

Spacing : Raw to row – 9inches
Plant to plant – 6 inches

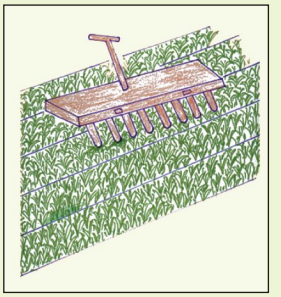
Farmers have nurtured the multicropping system for generations. The diversity in the small farms of the dryland regions has ensured food, fodder and fuel throughout the year. It is this model of cultivation that needs to be sustained to ensure food security in its broadest sense.

Table 1 : Year Round Supply of Food to Farming Family

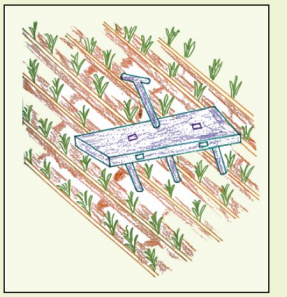
	January	August	September	November	December
Castor					
Beans					
Pearl Millet			 		
Mustard					
Niger					
Green Gram					
Field Bean					
Faxtail Millet				 	 
Little Millet				 	
Radish					
Pigeonpea					
Sorghum					 
Cowpea				 	

Fresh grain		Vegetable		Grain	
Dry grain		Fodder		Oil seeds	

Implements Used By Farmers For Inter Cultivation kunte



8 tynes kunte used on 2nd week after sowing for thinning operation



Plank used on the 6th week after sowing for 1st weeding

3 tynes kunte used on the 7th week after sowing for earthing up

Inter cultivation practices

The kunte is a bullock-drawn implement used by farmers for inter-cultivation operations. Two weeks after sowing, a kunte with eighttynes is passed through the field to maintain optimum plant population, remove weeds and aerate the soil. To aerate and for earthing up the soil further, the implement is drawn three weeks after sowing, which also helps to remove weeds and provide a congenial environment for the development of the crop. During the sixthweek a plank is run over the crops to avoid excess vegetative growth as this helps to produce a profusion of tillers. In six weeks all inter-cultivating operations are completed. Drawing three types of kunte helps in controlling the weed population at a later stage. Dead furrows are opened at 6ft intervals to facilitate infiltration of rainwater in the field. In the seventh week after sowing, drawing (donisaalu) broad furrows with the koorgehallu (tooth drill) helps to conserve water at regular intervals.

Crop rotation with finger millet

In central and southern parts of Karnataka finger millet is rotated with crops like castor, horse gram, pigeon pea, green gram, black gram and cow pea.

Table 2: Crop Rotation

YEAR	SEASON	CROP ROTATION	ADVANTAGE
I Year	Kharif	Castor and horse gram	- Minimum cost of cultivation - Enrichment of soil fertility - Suitable for drought conditions
II Year	Kharif and Rabi	Pigeon pea	- Mutiple harvest - No additional cultivation cost - Effective utilization of land
III Year	Kharfif	Greengram, blackgram, Cow pea	- Nitrogen fixation in soil Black gram Fodder availability for cattle - Double copping system in dry land conditions

Grain Yield :	
Spacing	: 14 inches row to row spacing with 3,69,500 plant/acre
Yield	: Rainfed : 20-25 quintal/hec Irrigated : 25-30 qt/hec
Spacing	: 12 inches row t row spacing with 1,35600
Plant / acre yield	: Rainfed : 32-34 qt/hec irrigated 36-380 qt/hec
Test weight :	
Organic ragi	: 95 measures = one quintal
Improved ragi	: 105 measures = quintal
Organic ragiflour	: 250 ragi flour = 400 gms ragi balls
Improvedragi flour	: 250 gms flour = 300 gms ragi balls

To overcome multiplication of the rhinoceros beetle which feeds on the young seedlings, well-decomposed compost that is enriched with hippe flowers (Madhucalatifolia), pongamia cake and neem cake is used. Neem flowers and pongamia flowers help in enriching the quality of compost and reduce soil-borne pests and diseases. Instead of direct application, farmyard manurein small heaps kept on the field for a week helps in controlling the beetle menace. The nutrients taken out in the cropping season are to be added back to the soil to sustain its fertility.

Basavarajhas been growing Doddaragi, a finger millet variety, for many years. The yield of six bags per acre has been the same even to this day;this stability, he says, is due to the application of well-decomposed organic matter to maintain the soil fertility.

Harvesting and cleaning of seeds :

Tillering compensates for low plant population but extensive tillering exacerbates the problem of uneven ripening of the heads, resulting in a large proportion of immature seeds at the time of harvesting. Having several rounds of handpicking of ripe earheads produces the highest yields of quality seed but is very labour-intensive. Cleaning, especially the winnowing operation, is very important to remove the immature seeds. Selecting seeds from the top half of healthy earheadscan ensure better performance in the next season.

- A suitable variety has to be selected according to the agro-climatic zone.
- The seed that has been selected for sowing (from the previous crop-seed storage retained in the end) is soaked for about 20 minutes in a solution of asafoetida and dried in the shade for 24 hours before sowing.
- Some farmers follow the tradition of checking germination during the Ugadi festival. Sowing is done during the last week of June or the first week of July, coinciding with the punarvasu and pushya rains are commonly called chikhasale and dodhasale rains.

Table 3: Pests of Finger millet

COMMON NAME	SCIENTIFIC NAME	DISTINCTIVE FEATURES	DAMAGING SYMPTOMS
White Stem Borer	*Saluria inficita*	White in colour	Cause dead heart or chaffy earheads. Attacks stem near the soil surface.
Earchead Caterpillar	*Heliothis armigera*	Pale brown in colour with green stripes	Attacks the Ragi earheads
Root Aphid	*Tetraneure nigribdominalis*	Very minute ana pole grenish in colour	Suck sap from roots at all stages ants around the collar region of infected plants Ants also carry Aphids to non-infected plants

Pest control methods used by the farmers :

A few larvae of the pest are collected and boiled with ghee (2,000ml). This mixture is diluted with 10l of water and sprayed onto the standing crop with a broom. This will infect the younger larvae and control the pest.

Another method of pest control applied by the farmers uses the odukai fruit. The fruit is cut into small pieces and soaked in water; later the solution is sprayed onto the standing crop. The pungent smell emitted by the solution repels pests.

Diseases of finger millet

Blast *(Pyriculariagressia)*

This is the most serious finger millet disease and occurs between September-October. It attacks the leaf, neck and earheadportions of the plant. Long grey spots appear on the leaves. During the flowering stage the neck is affected and turns black and usually breaks. The earhead is also attacked, resulting in poor grain development.

Sheath blight, leaf blight and foot rot *(Helminthosporiumnodulosum)*

Infection occurs in the leaves, leaf sheaths, nodes, internodes, crown and inflorescence. Small oval spots occur on the leaves, and larger ones on the leaf sheaths and internodes. Blackening of the collar area and rachis also occurs.

Crown rot or sclerotialroot rot *(Sclerotiumrolfsii)*

Plants attacked by this fungus show stunted growth and paleness. The infection occurs near the base of the plant, turning it soft and brown. Eventually the plant wilts, lodges and dries. Later, sclerotal bodies form on the lower portion of the stem which release an acid that destroys the stem tissue. Wet soil conditions favour the disease.

Seed treatment to control finger blast

According to farmers, the incidence of blast diseases in finger millet is caused by excessive humidity that permits the growth and development of the pathogen (Pyriculariagressia) known to cause neck and finger blast. Heavy rains during the grain maturity stage spread the disease indiscriminately.

Sannakaddiragi, a variety of finger millet, is basically susceptible to finger blast because of its open earhead. The pathogen infects the finger from the top during its maturity stage. If the pathogen enters into the mature seeds, it can survive in the seed for a long time and cause infection during growth. If these seeds are used for the next season, the crop will be affected.

. An experiment was conducted to study the effectiveness of different types of traditional seed treatment. For each treatment, the number of blast-affected earheads in a plot was counted. The lowest number of affected plants was recorded for asafoetida treatment, as compared to other methods. The effect in controlling blast infection may be attributed to disruptionof pathogen activity inside the seed when treated for 30 minutes. Asafoetida contains sulphur that is very effective against seed-borne diseases. Treatment with BD-500 was also found to be effective in controlling finger blast. Cow's urine and salt water treatments also had significant effect on seed-borne pathogens. Cow's urine treatment was very effective against leaf blast and finger blast as compared to the control treatment.

Evaluation of drought resistant varieties

A study was undertaken to observe the drought-resistant characteristics of the different finger millet varieties in the farmers' fields. Four landraces were selected, namely Karikaddi, Mandya Orissa, Sannakaddi and Chendhooragi.

Among the four varieties, Karikaddiragi showed the highest drought resistance of up to aperiod of 1.5 months. This variety's drought resistance may be attributed to its deep root system, thick sturdy stems and narrow upright leaves with tiny hairs. Hardy and hairy surfaces prevent the loss of water from plants under moisture stress conditions. Mandya Orissa ragi also recorded significant resistance to moisture stress. This variety completes its lifecycle before the drought period commences. Sannakaddiragi was moderately tolerant to drought conditions. After 15 days of moisture stress, the basal leaves dried up. Low leaf area indicates moderate tolerance to drought. It was noted that Chendhooragi had the lowest resistance to

drought conditions in a period of 20 days. Karikaddiragi was found to be a suitable variety under moisture stress conditions in red sandy loam soil.

Paddy *(Oryza sativa L.)*

Paddy is a strong tillering crop of 0.5 to 1.5m height, with the major tillers producing productive panicles of 15 to 40cm length and about 100-200 kernels. The development of early-maturing varieties has enabled the cultivation of two to three crops per year. The crop's self-pollinating nature facilitates seed multiplication.

There are three eco-geographical sub-species of paddy:

- Indica, which is cultivated in the humid tropics, has thin, long grains and is mostly adapted to short days.
- Japonica, which is cultivated in sub-tropical and temperate zones, has round to oval grains and possesses a low or no day length sensitivity.

- Javanica is cultivated in parts of Indonesia.

Other perennial rice species, found in West Africa, are Oryzaglaberrima and Oryzabreviligulta.

The tropical types require a growing season of three to six months at an optimal temperature of 32°C. Hence, tropical rice is seldom grown at higher altitudes. Irrigated rice is usually sown in nurseries, from which mature seedlings are transplanted to main fields, whereas upland rice is directly sown through either broadcasting or line sowing.

Seed drying

Drying of paddy seeds under extreme heat and cold hinders its vigour and germination capacity; hence partial shade drying is a desirable method. Before sowing, the seeds are soaked in water and the chaffy seeds are separated to ensure 100% germination. Good seeds supply carbohydrates to the developing radicle and plumule at seedling development stage.

Table 4: Pests of Paddy

COMMON NAME	SCIENTIFIC NAME	DISTINCTIVE FEATURES	DAMAGING SYMPTOMS
Stem Borer	*tryporyza incertulas*	Yellowish with one black spot on each wing and 1 inch in lenght	* Eggs are laid in masses on the leaf * Bores into the stem near the node and feed on the central shoot, resulting in 'dead hearts' and chaffy earheads
Caseworm	*Nymphula depunctalis*	Worms are slender green in colour and 1 inch in length	* Constructs tubular cases by cutting the leaf blades * Feeds on the green layer of the leaf resulting in dry parchment of the green material and ladder like appearance in the damaged area
leaf Roller	*Cnaphalocrocis medinalis*	Worms are very active and 3 to 4 inches in length	* Ralls the leaf tips and feeds on the green matter with in the roll * After the larva leaves the leaf looks similar to that of an affected
Green Jassids	*Nephotettix nigropictus and Nephotettix virescens*	Insects are small, green in colour and move sideways by hopping. Males have a prominent black spot an the wings	* The insects suck sap from the leaves, leaving small scrath like marks * Heavy infested leaf turns brown in colour * They also transmit Yellow Dwarf and Tungro virus
Brown Plant	*Nilaparvata iugens*	Insects are brown in colour and move by hopping	* Insects suck sap from the leaf and create damage similarly as Jassids
Hispa	*Dicadispa armigera*	Black beetle, fringed with numerous short spines	* Attacks young plants and disappears when plant matures * Removes green layer of the leaf leaving parallel white lines * Entire leaf dries under heavy infestation
Paddy Butterfly	*Melanitis ismene*	1 ½ inch long, light green in colour, with a rough body with 2 prominent horns	* It is a minor pest feeding on leaves only

Measures taken to control pests

1. Neem oil, diluted with water in a ratio of 1:25, is sprayed on the crop only in the mornings.
2. Plants can be dusted with woodash.
3. Stem borer egg masses entering the main field can be avoided by clipping off the top portion of the rice seedlings.
4. To control the brown plant hopper, a mixture of aloe vera leaf (gel) boiled in cow's urine can be sprayed on the paddy crop.
5. A solution of neem oil (250ml) and kerosene (1,000ml) mixed with Khadi soap (150g) can also be sprayed.
6. Garlic paste soaked in kerosene overnight and diluted with 200l of water can be sprayed onto the crop.
7. Maintaining wider rows to ensure good sunlight and air circulation reduces the incidence of pests.

Non-chemical pest management

Farmers rice fields were selected randomly through out the project area. Each rice field was divided into five plots to spray the herbal pest repellent. The different spraying treatments included (i) neem oil = pongam oil spray (ii) bitter leaves spray (iii) herbal spray (iv) control. Selected paddy varieties were sprayed as per the treatment at panicle emergence stage by observing the level of pest population.

Regular observations were recorded to standardize the treatment and it was observed that spraying of bitter leaves extract controls the paddy pests like; brown plant hopper, long horned grasshopper, stem borer and leaf eating caterpillars very effectively. The herbal spray developed by Puttaiah a farmer was also fund effective against stem borer and brown plant hopper. As compared to control plot that was affected by all the major pests these two methods were efficient in controlling paddy pests at both vegetative and reproductive stage. However, the oil spray effectively controlled the diseases like leaf blast, rust and rotting of nodal regions.

Diseases of Paddy

Blast : (Pyricularia oryzae)

This may occur on the leaves, at the nodes or in the neck region, and is most severe during the months of August to October. On the leaves, brown spots with grey centres occur when the leaf is resisting the attack. If infection occurs at the nodes, the stem blackens, dries up and breaks. In the case of neck blast, the neck shrivels and turns black, resulting in chaffed earheads.

Leaf Spot : (Helminthosporium Oryzae or Cerospora oryzae)

This is a fungal disease that appears as dark oval spots with a yellow ring on the leaves and dark brown spots on the grains. Itattacks germinating seeds, leaves, leaf sheaths and grains. C. oryzae results in linear spots rather than oval ones on the leaves.

Bacterial leaf Streak : (Xanthomonas translucens)

This bacterial disease results in linear yellow to orange lesions between the leaf veins. It often attacks crops where hispa and leaf rollers feed because the bacteria enter through the damaged tissue. High rates of nitrogen, rain and wind favour the disease.

Bacterial Leaf Blight : (Xanthomonas oryzae)

This results in linear yellow to straw-coloured lesions on the leaf margins, leaving a small green area in the centre. Leaf blight is a serious disease especially on heavily fertilised high-yielding varieties.

Udobatta : (Ephelis Oryzae)

This is an internal seed-borne infection, and symptoms occur during the flowering stage. The inflorescence is converted into a silvery-grey rod-like structure with sterile spikelets which appear to be glued together. Sometimes the upper surface of the bootleaf is covered with a greyish powdery fungal growth.

Tungro Virus :

This disease is transmitted by green jassids. It is characterised by slight stunting,reduced tilleringand light yellowto yellow-orange leaves. The virus has only recently been discovered in this area and is only a minor problem.

Disease control measures

- Any variety sown in the off-season will always manage to mature in the regular season and thereby avoiding diseases.
- If the sowing of the paddy is done all at the same time, pests and diseases can be controlled easily as they spread across the field. Spraying 2% of milk at the vegetative stage controls the blast disease.

Seed selection

Experience shows that seeds selected from the middle portion of the panicle/earhead are healthy and bold and have vigour. Seeds selected from organic plots perform better compared to chemically farmed seeds. Repetition of this selection process for five generations improves the quality and purity of seeds. Individual plants selected from a wider population which show resistance against abnormal climatic conditions can emerge as a high-profile variety.

Vegetables

Cross-pollinated vegetable seeds have been released as hybrids for commercial cultivation. It has beenshown in the recent past that this has led to monoculture of crops cultivated by farmers who have irrigation facilities. As a result, there is high erosion of the diversity of vegetable varieties. The practice of seed saving has been limited to vegetables of Indian origin. Saving seeds is a very satisfying experience; gathering seeds from our own garden gives a feeling of self-sufficiency and continuity. Having knowledge of saving seeds means being independent of private seed companies. Farmers develop strains that are particularly adapted to unique growing conditions and help in preservation of

Vegetable Nursery Technique

Soil is mixed with an equal quantity of sand and vermicompost before sowing the seeds and filled in a big, round pot. The vegetables are grown in these pots. Farmers have obtained excellent results with tomato, brinjal and chilly. This is one of the methods the farmers have adapted to grow vegetables in their gardens.

endangered varieties. While saving seeds from such varieties, it is essential to practise proper techniques, ensuring that the varieties remain pure. The task of seed saving is easy and yet it takes a bit of knowhow to do it well.

SEED MOTHER

Hombalamma is a 50-year-old woman farmer who owns five acres of farmland in Alappanadoddi village situated on the border of Karnataka and Tamil Nadu. The land here is undulating and in a dryland region. Having to feed a large family, Hombalamma works her land very effectively. She conserves many traditional finger millet varieties, as well as paddy, groundnut and a range of vegetables. Little millet occupies the eroded patches of the uneven land, while the plain areas are planted with other millets.

Hombalammais well versed in indigenous knowledge about the culture rooted in agricultural diversity. She is very enthusiastic about organic farming and is a hard worker. She is undoubtedly a key figure in the efforts of GREEN Foundation to promote agricultural diversity. During a seed mela(seed fair) held inThallyin Tamil Nadu, she was honoured as "BeejaMatha" (Seed Mother) for her invaluable contribution and dedication towards conserving germplasm of local varieties.

Home Gardens

Home gardens are areas for sustainable agricultural practice that leads to the preservation of a rich source of biological diversity. As home gardens meet various food needs of a farming family, they tend

to contain high levels of species diversity as well as variations within species, which may be disappearing from large-scale agricultural systems and from the wild. Home gardens are tended under principles of organic nutrient management to promote consumption of healthy foods.

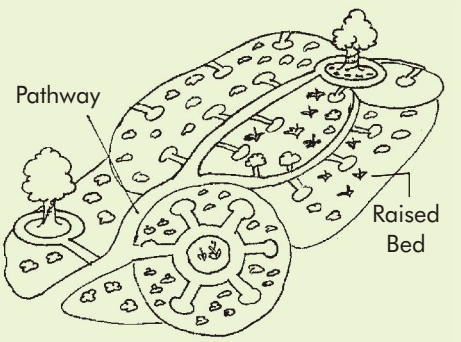
Most rural households greatly benefit from having a garden in their backyards. The vegetables grown here provide variety in the diet, increase nutritional levels and fill gaps in the food supply during lean periods. Some of the crops grown here may also meet household needs for medicines, spices and fuel at a very low cost. Surplus vegetables and spices can provide a supplementary income to the family.

CASE STUDY

Chinnamma of Dasarahallyin Karnataka has made efforts togrow vegetables for neighbouring markets. She has been fortunate to own a piece of land near a tank and hence enjoys the benefit of irrigation throughout the year. Following a mixed cropping system, the vegetable beds are prepared very meticulously with manure a fortnight before the sowing. Different varieties of greens are mixed and broadcasted in the 3"x3" beds. The seeds are mixed with a spade or by hand to place them at optimum depth. Coriander takes nine days to germinate while the other greens like amaranthus, chakotha and harive take five to six days. Chinnamma feels mixing the greens gives her the option of a continuous harvest through the season, which supplies vegetables for home consumption as well as to a limited market which earns her some income. She also raises a nursery of chillies, brinjal and tomatoes (Solanum species), and later transplants them to the main field. Inter-row planting is a unique practice followed by Chinnamma. Onion and garlic bulbs are planted in between two rows of chillies and lady's finger. The practice also helps in avoiding pests. Chinnamma's family works with her, so there is no need to hire outside labour.

Permaculture – Permanent home garden design

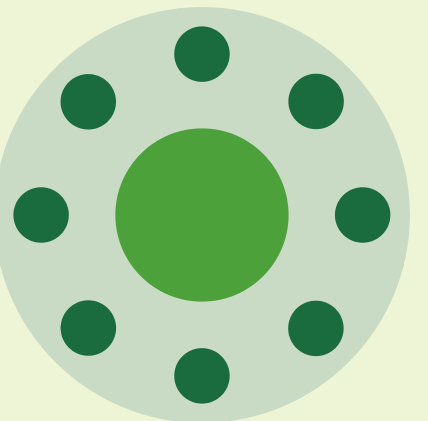
The permaculture gardening technique is a new way of sustaining and enriching life without environmental and social degradation. It is about designing sustainable human settlements where microclimate plants, animals, soil and water management and human needs are interconnected and productive to communities.



Permaculture is usually practised where the gardening area is limited. Raised beds are designed before planting. Systematic planning is necessary so that vegetables can be sown according to their height to avoid shade on subsequent plants. Vegetables which respond well to light are grown towards the east and those that respond poorly are grown towards the west.

Circular method planting method

This is the intensive cultivation of fruit trees, done in order to increase plant population and productivity per unit area.A pit of 5 feet in diameter and 2 feet in depth is dug. Around the centre, pits of 1-foot



diameter and depth are dug. Each of these is planted with banana and papaya trees alternately. The central pit is watered once every 10 days and mulching material is applied here as well. This leads to the efficient use of irrigation water and mulch.

Practices for quality vegetable seed production

- Selection of disease-free plants for seed collection is of primary importance.
- Crop rotation techniques are very effective in controlling the diseases of vegetables.
- Cultivationof marigold as a trap crop in chilli and tomato fields will effectively control the fruit borer pest.
- A spray of nucleo poly virus (NPV) with boric acid, blue powder and jiggery prevents the incidence of vegetable pests.
- Considerable usage of farmyard manure (FYM), sand and vermicompost before sowing will help in conferring immunity against pests and diseases. FYM provides 23 nutrients and vermicompost acts as a growth promoter or hormonal supplement.
- A combination of cow dung and cow's urine acts as root hormone for many vegetable crops.

Drying and Storage

Seeds are living entities. Even when theyare in a dormant state, proper care is necessary to maintain the life within. After gathering, seeds should bethoroughly dried ina warm, dry place with good air circulation, or in a good dehydrator. The temperature should never exceed 95°F. If a seed breaks instead of bends, this indicates that it is suitably dry. After drying, it is essential that the seeds are stored in a cool, dry place, away from direct sunlight and in airtight jars. The

extent of care determines seed viability. Even a seed stored under the most ideal conditions does not remain viable forever though. If the seeds are stored for an extended period of time, it is important to check that they still have a good rate of germination.

To test for germination, some 50-100 seeds (depending on seed size) are placed on a wet paper towel. The seeds are laid on one half of the paper towel and the other half is folded over the seeds. The rolled-up towel is put in a plastic bag and placed in a warm location.

An alternative test for germination isto sow 50-100 seeds line by line in a plastic tray filled with sand.The seeds are watered everyday while placed under the shade with minimum light.

The number of days to germination depends on seed size.A germination rate of above80% is acceptable.

Pumpkin (Cucurbita maxima)

Pumpkin is characterised by hairy long vines and broad leaves; Fresh seeds germinate well. Pumpkin is a monoceous crop (both male and female flowers) and is cross-pollinated mainly by insects.

Hand pollination

Pollinating pumpkin by hand gives pure seeds (true to type). The method followed is by selecting pumpkin flowers that will bloom onthe following day and not the ones that arealready open. These flowers are a bit tight at the tip and are yellow in colour. In male flowers the vine that connects the blossom is thin and straight, while in female flowers the vine shows a small swelling that looks likean immature fruit. After selection, the flowers have to be bagged

with waterproof material and masking tape to avoid cross-pollination. The same plant is visited again the next morning and the female flower is unbagged and the pollen of the male flower is rubbed onto the receptive part of the female. After pollination the female flower is bagged and marked with red tape around the vine for identification. The flower is put under observation and when the fruit initiates, the bag is taken off for the development of the fruit.

Seed extraction

The fruit is allowed to ripen on the vine until it gets soft and the colour changes to deep yellow before seeds are collected. The seeds are scooped into a glass or plastic container and left to ferment for threedays. After fermentation good seeds sink to the bottom while the chaffy seeds float on the top and can be poured off. The good seeds are washed,strained and dried under the shade.

Brinjal *(Solanum melangena)*

Brinjalis self-pollinating but can be cross-pollinated by insects. It is essential to maintain an isolation distance of 50 feet to separate the varieties;alternatively, plants can be caged using polyester bags. The matured fruits are collected and the pulp bearing seeds isextracted intoa container filled with water. Two to three washings are sufficient to separate the seeds fromthe pulp; the seeds are then dried under the shade.

Lady's finger *(Ablemoscnusesculentus)*

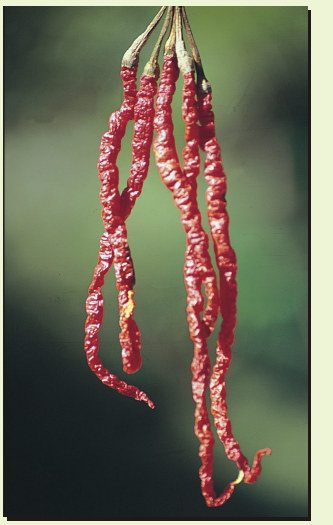
Lady's finger is mainly self-pollinated but can also be cross-pollinated by insects. To avoid cross-pollination, plump buds with a

light green striped appearance are secured using bags. The bags are removed after three days and the vegetable is tagged for identification. Fruits that are still green but fully mature canbe harvested and left to dry until they split open, after which the seeds are collected.

Tomato (Lycopersi only copersicum)

Even though tomato is a self-pollinating crop, cross-pollination is possible between varieties. Varietal purification is achieved by maintaining an isolation distance of 20-50 feet. Matured fruits are collected and cut open horizontally, and the gelatinous pulp from each section is scooped into a container and left to ferment. After fourdays a foul-smelling fungal mould will develop on the top. The fungus eats away the gelatinous coat surrounding the seeds. The contents are emptied from the container into a strainer and held under running water. After washing, the strainer is flipped over to empty the seeds onto a paper towel. The process that destroys the germination inhibitor and seed-borne diseases will have been triggered mainly through the fungus.

Chilli (Capsicum annum)



Even though peppers are self-pollinating, there may be considerable cross-pollination by insects. To keep the varieties pure, it is essential to maintain an isolation distance of 500feet. The fruits are allowed to turn red and fully ripen on the plant. Soft fruits are gathered and cutopen; the seeds are removed and left to dry fully before they are stored. Some fruits develop black spots, whichare an indication of the Anthracnose disease, which is seed-borne. Hence seeds from diseased fruit are not saved. Any plant which shows signs of Anthracnose isrogued out.

Chilli cropscan also be affected by Muruda disease, which is caused by a virus. The vectors of this virus are whiteflies and aphids.Diseased plants show signs of stunted growth and curling of leaves.

Disease Control measures

Seeds are collected from deep red-coloured fruits (fully matured) from disease-resistant plants. The seeds are soaked in butter milk for a week before sowing. At flowering stage (45 days after sowing), butter milk diluted with water is sprayed on the plant.

Vegetable Seed Selection

- Carrot, radish: Select the seeds from the health plant that has produced roots profusely.
- Select fruits of tomato, brinjal, and chilli from healthy plants.

Pest Control

- Spraying asafetida solution at the early stage of pod formation can control pod and fruit borer.
- Garlic extract also controls the pest infection by its bad obour.

- Beetroot, carrot, radish: 1/3 part of tubers should be cut, since tubers are strong and contain reserve foods, produce healthy and pure seeds.
- Cauliflower: Healthy fruits can be selected for seeds and preserved for following year's sowing.

Soil Nutrition

To reduce the pathogenic effect and supply nutrition to the soil, a mixture of neem leaves, pongamia and ekka mixed with soil can be placed in the irrigation furrows in the fields.

Seed Treatment

1 Treating seeds with a mixture of cow dung and cow's urine (a 7-month-old pregnant cow's urine is best) will enhance root growth and germination and prevent disease at an early stage.

2 Soaking seeds of lady's finger and beans in water overnight (12 hours) before sowing leads to early germination and vigorous growth.

3 To prevent decaying of seedlings at germination stage, vegetable seeds can be soaked for two hours in a solution of two teaspoonfuls of ash and 1l of water.

Sorghum *(Sorghum biclour (L,) Moech)*

Sorghum is an annual erect plant which grows up to 4m in heightand has a dry or juicy stem, a hairy sheath covering part of the internodes and alternate flat leaf blades. The terminal inflorescence is a compact, semi-compact or loose panicle. The fruit is usually caryopis. The plant is usually photosensitive, but insensitive types are commonly cultivated. The traditional varieties are tall and late-maturing. The crop is largely self-fertilised but also cross-pollinated upto 10%. Sorghum grows intensively in the Raichur, Gulbarga, Koppal, Bijapur, Dharwad and Bidar districts of Karnataka.

Foundation Seeds Selection

Criteria like long earhead, freedom from disease and pests, normal plant, drought resistance etc. are considered during seed selection. The seeds selected by the mass selection method are called foundation seeds. Sorghum flowering starts from top to bottom; seven days are required to complete the flowering in the earhead. Seeds selected from the top half portion of the earhead have better quality and vigour. Spraying of vermiwashat the grain development stage increases the quality of the seeds. (A spray of 1 part vermiwash + 10 parts water + 1 part cow's urine increases the seed strength.)

During storage, the seeds are stored with husk to prevent insect attacks. To avoid insect eggs on the bag of seeds, the bag is dried sufficiently and cleaned before it is stored.

Monsoon sorghum Varieties

Gidda Jala: A highly drought-resistant variety, rich in taste and fodder quality. Ideal intercropping system is giddajala + groundnut.

Ekkernaljala: 70-day-duration variety, grows to a height of 10 feet and yields fodder the quality of which is moderate;and the size of seed is bold and prominent. This variety is suitable for intercropping with niger, castor and red gram.

Sajjagirijala: 5.5 months' duration, 10-12ft height, good fodder yield. Suitable for rabi season.

Gattitenejala: Good for roti making, compact earhead and good fodder quality.

Maldandi: Good for food and fodder.

Puleyeshodha: White, round, stiff earhead, good market value, and sweet fodder.

Halle jala: Native of Koppal region in Karnataka. Suitable variety for monsoon season, good fodder yield and highly drought-resistant.

Cropping system:

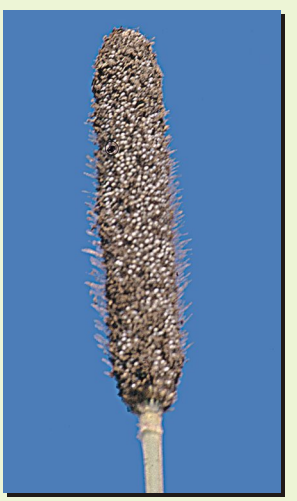
Inter Crop: 4:1 sorghum:safflower.

Mixed crop: Safflower, agase, green gram, math beam, niger, sesamum, castor.

Crop protection: Sorghum leaf extract controls the stem borer and leaf-eating caterpillars of sorghum.

Farmers Cultivation Practices

- Sowing of sorghum in early June prevents shoot fly infection.
- Generally varieties with good grain production and fodder-yielding capacity are popular among the farmers.
- Mixed cropping with legume crops like green gram, cowpea, black gram etc. helps improve yield by improving soil fertility.
- Crop rotation and use of FYM/green manure help to deliver better yields and prevent disease outbreaks.
- A spray of cow's urine, asafetida and soap/detergent in a 5:1:1 combination before flowering helps to control insect damage.



Pearl Millet (Pennisetum americanum (L.)

Pearl millet is an annual erect plant that grows up to 4m in height and has solid round or oval stems and slightly swollen nodes. The leaves are arranged alternately along the stem. The inflorescence is a terminal spike-like panicle carrying large numbers of small round seeds. The crop is cross-pollinated and takes three to four months to mature.

Seeds selection:

Fertilisation of the flower takes place from the top to the base of the earhead. Hence, the first fertilised seeds formed at the top half of the earhead are healthy, bold and pure seeds. Selection of these seeds will improve the crop yield in the subsequent season. Bagging of earheads at the flowering stage is practised to get true-to-type seeds.

Seed selection is based on the following criteria: drought resistance; short duration; tall growth for fodder; compact earhead; resistance to pests and diseases; and good cooking quality.

Seeds storage method

Farmers in the northern part of Karnataka dig out a pit and fill it with earhead husk at the bottom, and paste the side walls with a mixture of ash, cow dung, termite hill soil and neem leaves. Ash is spread at the second layer and the grains are filled in the pit. The top layer is covered with ash, neem leaves and paddy straw. For one quintal of grains,two baskets of ash are required.

Cropping system

Intercrop: Cluster beam + pearl millet; pigeon pea + pearl millet + sorghum.

Pigeon pea (Cajanus cajan (L) Millsp.)

Pigeon pea is also known as red gram or arhardahr. The pea is primarily used as dhal while its tender green seeds are consumed as vegetables, crushed dry seeds as animal feed, and leaves as fodder. Pigeon pea is perennialmostprimitive of all pulses and evolved as a backyard crop. It is a rainfed crop and suitable for intercropping with cereals and millets. On undulatingslopy lands, it reduces soil erosion and serves as

live fence or as green manure and has immense potential in agroforestry systems.

Pest Management Practices

The following methods are used to control the Helicoverpa (pod borer) pest:

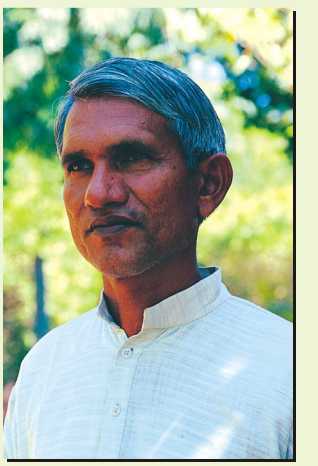
- A mixture of 100ml cow's urine + 20g asafetida + Khadi soap with 20l of water not only serves as a pest control agent but also encourages flower production.
- 10kg of seeds are ground, mixed in 10l of water and soaked overnight. This mixture, when sprayed at the flowering initiation stage, will effectively control the pod borer.
- Bird perches with water pots can be placed randomly in the field to attract birds, which will pick the pod borer larvae and control the pest population.
- Marigold act as a trap crop in controlling fruit borer
- NucleoPolyhydrosis Virus (NPV): A mixture of 1ml NPV, 1l water, 200ml Robin Blue and 1g/l jiggery can control the pest and is safe for farmers, crops, soil and the environment.

Seed treatment

A solution of rhizobium culture with jiggery is prepared.The seeds are mixed thoroughly with this solution and dried under the shade before sowing. The rhizobium treatment helps enrich soil fertility by symbiotically fixing the atmospheric nitrogen in root nodules. This treatment reduces the need for application of nitrogenous fertiliser to the crop.

3 Farmer Breeders and their Contributions

Farmers are highly knowledgeable and have been experimenting in the fields of crop improvement, pest management and other aspects of agriculture. In providing an overview of farmers' experiences and contributions,this chapter gives a deeper insight into their extensive knowledge and achievements. A few farmers are featured here for their valuable contribution as innovators and for their deep inquiry into crop production and management.



Sundaram Verma an innovative farmer from Rajasthan, was a teacher by profession but later took an interest in agriculture in 1971. The Indian Agriculture Research Institute (IARI) selected him for an agriculture training course and he trained under international agricultural scientists. Through this training he learnt about dry farming technologies. In spite of the extreme climatic conditions in Rajasthan, with dry temperatures rising to 50°C in summer and 20°C during winter, and annual rainfall ranging from just 10cm to 20cm, he has proved to be a role model for many other farmers.

Seeing his interest in farming, agricultural scientists from the IARI actively guided him. During that time he was able to acquire knowledge on selecting plants that are resistant to pests, disease

and drought conditions. With his existing knowledge of water conservation, he also learnt the technique of efficient use of rainwater in situ. Under his guidance the local forestry department planted trees suitable for drought conditions. The experimentation with dry farming was carried out on 0.1lhectar.success was achieved in growing trees by applyingonly one liter of water at the time of planting. Eucalyptus was grown initially and later other types of trees were planted.

Further, Vermasucceeded in water conservation by adopting two techniques.The firstmethod involves breaking the capillary pores where groundwater stagnates at a depth of 20cm; planting the trees and crops at this depth ensures availability of groundwater and enables the roots to extract water and the plant to grow profusely. Plants sown in the early monsoon spread roots only on the top layer;they survive as long as moisture is available, but during dry periods these roots die due to lack of moisture. Breaking the capillary water movement helps ensure survival of the plant. The second method entails

Crop improvement experiments

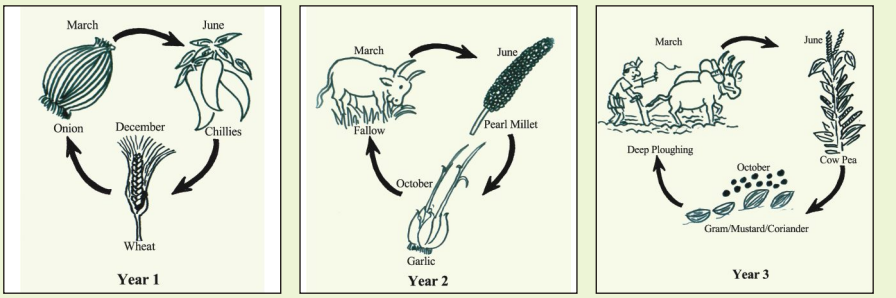
Crop improvements with interested farmers were conducted on Verma 's farm. Experiments were carried out by selected number of varieties that were resistant against drought, pests and diseases. Since climatic severe bring new pests and disease, farmer has to be aware of the problems on his farm .During experimentation, plants were labeled according to the pest and disease resistance and Pest - affected plants. Observations were recorded about the plants geographical area, yield, height, and

branches. In the first year selection of about 50 to100 plants that are pest, disease and drought resistant from different locations were sown in a plot: for second-generation crops selection of susceptible plants with resistant plants were interspaced. In the second year, studying the transport of infection form diseased plants to resistant plants, the best plants that had not been infected with the pathogen were selected. Selecting the best plants continuously for up to three years ensures that healthy plants are pest, disease and drought resistant forever.

It is a well-known fact that crop rotation practices reduce the cost of cultivation by adapting traditional low input management. According to Verma, creating awareness among consumers about naturally grown food is important. Farmers maintain the quality of the produce and sustain the farm yield through proper crop management. Crop rotation is done not only to control pests and diseases but also to overcome market competition against fluctuating prices.

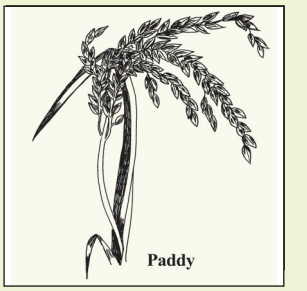
Vermapractisedcrop rotation for three years in Rajasthan. Seven crops were grown onthe same piece of land, and latter only one crop was grown so as to decrease pest and disease attacks. Since root depth differs from plant to plant, nutrients are utilised from different layers of the soil. Rotation also ensures that failure due to market and climatic changes can be avoided. Through proper crop rotation, farmers do not need to import inputs from outside. Crops that are rotated include vegetables like onions, garlic and chillies; pulses like red gram, green gram and Bengal gram; cereals and millets like wheat, pearl millet and barley; and spices like coriander and oilseeds. According to farmers with experience in crop rotation, sowing of castor in the month of May and horse gram between July and August, for example, has a very specific impact on the soil. Castor draws water and nutrients from the deeper layer of the soil while horse gram adds leaf residue to the soil. During second year

red gram is sown in the month of May. Spraying of dung slurry on the crop helps prevent cattle grazing and also supplies nutrients to the crop. Mulching the field avoids moisture loss and maintains the soil structure.



Method : The farm is divided into three parts. In the first part, cereals and millets (rice, wheat, sorghum, pearl millet) are sown; in the second part, oilseeds (safflower, sesamum, groundnut, castor, sunflower) and pulses (red gram, Bengal gram, cowpea, soyabean, horse gram, green gram, black gram); and in the third part, spices and vegetables (garlic, onion, coriander, lettuce, chilli, tomatoes, lady's finger, brinjal). In the first year, underground crops like onion, potato, beetroot and carrot are sown in the month of May; vegetables like chillies and tomato are sown above the ground in June; and sorghum and pearl millet are sown in October. Before sowing, the farmer takes into account the market fluctuations in order to be ensured of a stable and continuous income from the produce. Availability of water before sowing is also taken into consideration. In the second year, the land is left fallow from March to June, while cows are left to graze and to fertilise the soil with urine and dung; in June rice, wheat and pearl millet are sown; followed in October by spices, garlic and onion. In the third year, in the month of March the land is ploughed deep and exposed to sunlight so as to control pests and soil-borne diseases. Only in the month of June are pulses and spices again sown.

Basavaraj Santhe Shivara from Hassan district in Karnataka is a pioneer farmer who conducted a seed selection experiment with the Mungasari wetland paddy variety. Mungasari yielded only 20-24qt/acre in the first generation. Basavaraj adapted the indigenous crop improvement practice learnt from innovator farmers and agricultural scientists. In the first year of cultivation, healthy panicles with bold seeds were collected through the mass selection technique. Apart from mass selection, he enriched the soil with organic and green manure. The role of trace elements was well emphasised by him. Even though trace elements are required only in small quantities, they play an important role in the physiology of seed formation. Hence, integrated nutrient supply can be achieved by applying well-decomposed manure, green manures and concentrated nutrient material like neem cake, pongam cake and groundnut cake. By practising mass selection of healthy earheads over five years, he has achieved yields of up to 30-35qt/acre and ensured that panicles are free from chaffy seeds, with each panicle carrying 250-300 seeds. Fertility of the soil has enhanced the branches of panicles. This is red-coloured grain of a nutritious and tasty variety. Basavaraj is aware of the consequences of intensive inorganic agriculture and maintains his farm with his own seed and soil management practices.

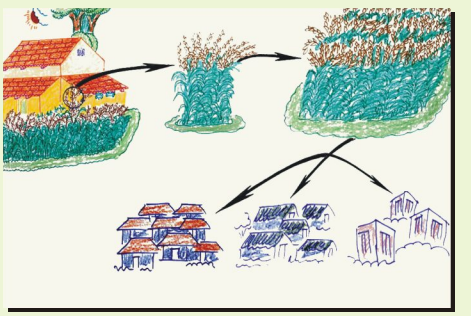

Paddy

Nursery : To Nursery: To prepare a seedbed, soil has to be mixed with compost and land has to be tilled twice or thrice. The seeds are soaked overnight and spread on the seedbed. Seedlings are sprayed with cow's urine and biodynamic manure solutions. 25-

day-old seedlings are transplanted to the main field after being dipped in cow's urine.

Inter-cultivation: 15 days after transplanting, vermicompost is applied at the base of the plant. Spraying a mixture of 1l tender coconut + 1l milk + 10l water at the time of flag emergence ensures synchrony in the formation of healthy earheads. Basavaraj's achievement in growing finger millet has been well acknowledged by the farmers in Hassan.

Lingamadaiah ownseightacres of land on which he cultivates paddy, finger millet, horse gram, mango, sapota, banana etc.



During his participation in an international farmers' meet in 1994, he had the opportunity of exchanging local varieties and also obtained a Philippine rice landrace MS-05. The farmers and scientists who donated this variety directed him to grow it under organic conditions, as the variety was adaptable to natural conditions. Only 12 seedlings germinated while the others failed. He transplanted the tillers from these 12plants and maintained the population. Based on criteria like uniform panicles, medium plant height, lodging resistance and synchrony in flowering, he selected earheads, then dried them separately and stored them for the following season.

During the next season he sowed 1kg of seeds and followed the mass selection technique for further purification. Seed bulk was raised to 35kg in the second year. This paddy was cultivated under a tank-fed irrigation system. In the third generation the yield was 36qt per acre.

Other farmers demanded this variety due to its quick adaptability to the local conditions, low water requirement, resistance to pestsand diseases, and lodging resistance. Farmers who grew this variety under chemical farming conditions observed pests and diseases, while the experience was different under organic farming conditions. This variety came to be known as "Mysore Mallige" in the course of time and has presently spread across Karnataka.

Mysore Mallige has the following characteristics:

- Medium height
- Lodging resistance
- High tillering capacity
- Sturdy stem
- 110 measures (seru) of grain weight equal to 1 quintal
- Husking: 20% (80kg rice/qt of paddy)
- Resistance to pests and diseases
- Low water requirement
- Rich taste
- Grows under minimum manuring conditions
- Resistance to grain shattering
- Suitable fordelayed sowing
- 120 to 130 days' duration
- Very low chaffiness.

Mahalingeswar Bhat, an experienced farmer, has worked towards synchronisation of different varieties of paddy differing in maturity. At vegetative stage he cuts the top portion of the crop to achieve synchrony in the maturity. This technique allows farmers to harvest the crop at the same time though it is made up of different varieties. He conserves short-duration paddy varieties likeHekantatavaya, Thekkunpunja, H4 of Sri Lanka, local paddy, Bharathiand PTB Basmathi, and long-duration varieties like Jathisuggi, Theskantaveg, Thekanpunga and PTB 19.

Other farming practices adopted by him are presented below:

- A variety with relatively short duration should be selected to make effective use of water during the rainy season.
- The seeds for the next sowing have to be taken from the top half portion of the earhead since these seeds are big and strong.
- Filling of grains lasts for a week. The source-sink relationship will be very effective in the seeds from the top portion of the earhead.
- Hot sunny days during the flag leaf emergence stage and grain filling stage contribute to good seed filling.
- Use of green manures or neem cake will help prevent severe infection of diseases and pests.
- A spray of 2% milk will effectively control riceblast disease.
- If all the farmers of a particular region take up sowing/transplanting at the same time, this will reduce the intensity of diseases.
- Maintenance of a thin layer of water in irrigated rice will effectively control weeds.

4 Indigenous Knowledge and agricultural Practices

Indigenous knowledge is now much sought after in the present context of globalisation. While the vast biodiversity of the Third World is claimed as a heritage that belongs to all humanity, the knowledge on how to use the diversity is in the hands of the indigenous communities who have nurtured it. Scientists trained in the Western paradigm look upon bio resources as raw material to be exploited, while indigenous communities' use of these resources is very sustainable. Farmers' knowledge on seeds and the associated agricultural activities continues to be put into practice despite modern technological interventions and there is a need to preserve this valuable knowledge.

Prior to sowing, for example, the farmers follow several practices to achieve the optimum healthy plant population in the field. A detailed description of some popular practices in the areas of seed treatment, seed drying and seed storage is provided below. These practices were experimented in selected farmer's fields and extended to wider area (Table 6 and 7).

Seed Treatment

The quality of the seed is very important in obtaining good germination and optimum plant stand. To ensure good seed quality, seed treatment is a must.

Seed treatment has the following objectives:

1. Prevents the spread of plant diseases such as soil-borne and storage fungus.
2. Protects against seed rot and seedling blight.
3. Improves germination and activates the embryo.
4. Controls soil insects.

5. Avoids germination failure in sowing and risks involved in re-sowing.

Some of the seed treatment methods followed by farmers are outlined below :

- Treating wetland paddy, dryland paddy and finger millet with diluted cow's urine (1:10) decreases the risk of germination failure as well as seedling mortality. It also prevents seed-borne diseases like neck blast in finger millet and blast in paddy.
- Treating seeds in salt water increases the vigour of seedlings and reduces seed-borne fungal diseases.
- Soaking paddy in milk and water in a ratio of 1:5 for half an hour prevents yellowing of leaves and leaf spot disease.
- Soaking vegetable seeds in a solution of ash (2 spoonfuls) and water (1l)will prevent rot at the sprouting stage.
- Soaking seeds in baje (aromatic plant) solution diluted in water for half an hour before drying and sprouting them prevents fungal diseases.
- Bougainvillea extract treatment: 200g of bougainvillea leaves are soaked in 1l of water overnight. The extract is then diluted with water at a ratio of 1:5, and this is used to treat seeds. It is very useful in controlling storage fungus.
- Hot water treatment: Water is heated to 55°C. Long-stored seeds are treated with this for 10-15 minutes. It controls seed-borne pathogens and also enhances germination.
- Salt water treatment: An egg is placed in water until it sinks to the bottom and rests horizontally – the horizontal position indicates that the egg is not rotten and can be used for the purpose of testing the density of salt concentration in water. The egg is then removed and salt is stirred into the water until it dissolves. The egg is once again immersed to test the density of the salt concentration. Salt continues to be added into the water until only a quarter of the egg is found to be visible on the surface. This is the standard salt concentration used for seed treatment. Seeds are soaked in this preparation for a period of 30 minutes and then removed, washed twice and thoroughly dried until the moisture is absorbed. Saltwater treatment is found to be effective (especially for paddy seeds) in separating healthy seeds from chaffy ones; protecting againststorage fungus; activating the embryo and

enhancing germination; and preventing seed-borne diseases at seedling stage.

- Salt water treatment: An egg is placed in water until it sinks to the bottom and rests horizontally – the horizontal position indicates that the egg is not rotten and can be used for the purpose of testing the density of salt concentration in water. The egg is then removed and salt is stirred into the water until it dissolves. The egg is once again immersed to test the density of the salt concentration. Salt continues to be added into the water until only a quarter of the egg is found to be visible on the surface. This is the standard salt concentration used for seed treatment. Seeds are soaked in this preparation for a period of 30 minutes and then removed, washed twice and thoroughly dried until the moisture is absorbed. Saltwater treatment is found to be effective (especially for paddy seeds) in separating healthy seeds from chaffy ones; protecting against storage fungus; activating the embryo and enhancing germination; and preventing seed-borne diseases at seedling stage.

Upland paddy/dryland paddy varieties are very unique in their performance as they can withstand high water stress conditions. The following describes in some detail a seed treatment method that has been followed by farmers down the centuries. This method enables the seedlings to withstand stress conditions in the early growth stages and import disease resistance. The procedure also enables quick germination of seeds.

Seed Treatment with Cow's Urine in different dilution ratios.

Table 5 : Finger millet

Name of the Variety	Germination Percentage		
	Control	1:6	1:10
Tamil Nadu Ragi	60%	60%	68%
Konakamibina Ragi	68%	84%	88%

(Finger millet seeds were treated with cow urine in different concentration i.e., 1:6, and 1:10 dilution with water for 15 minutes. Then was thoroughly washed with clean water).

The cow's urine treatment with 1:10 concentration was found very suitable to treat seeds of finger millet for good germination and seedling vigor So farmers suggested treating the finger millet with cows urine at 1:10 dilution.

Materials required

Bamboo basket, paddy straw, dry farmyard manure or compost, green leaves of Dalbergiapaniculata (pachadi), weight (boulder) and hot water.

Procedure

Cover the bottom of the bamboo basket with a thick layer of paddy straw. Spread the dry farmyardmanure/compost over this. Place the branches of Dalbergiapaniculata over the FYM layer. Spread theseeds on these leaves up to the brim of the basket. Then cover the seeds with Dalbergiapaniculata, spread compost over the leaves and finally cover with paddy straw. Cover the sides of the basket so that an airtight (anaerobic) condition is created inside.Place a weight (boulder stone) to create pressure on the seeds. Pour water that has been heated toabout 50-60°C on top of this, so that it percolates to the bottom. This is done to ensure that the seeds are completely soaked. The hot water soaking should be done twice a day, in the morning and evening, for three days. On the fourth day separate the materials covering the seeds. The seeds will have completely germinated on the third day. Ensure that there are no hump formations on the seeds. Carefully broadcast the germinated seeds on dank soil and from the fifth day onwards, completely drain off the water.

Benefits

This method of alternate wet and dry treatments ensures that the seedlings can withstand water stress conditions for 20-25 days. The yield will be almost on par with that under transplanted conditions.

Drawbacks

Careless handling of the germinated seedlings (on the fourth day) can cause damage. After the broadcasting of seeds, if water stagnation continues for more than 5-6 days, the seedlings will not survive (especially in the depressions in the land created by footsteps).

Scientific reasons

Abscisic acid (ABA) plays a major role in the induction of drought tolerance and dormancy in seeds, seedlings and plants. Exposure to high temperatures (hot water in this case) and water stress conditions provoke the synthesis of ABA hormone. At the same time, moisture, anaerobicity, high carbon-dioxide concentrations and pressure exerted induce the synthesis of gibberillicacid (GA), which ultimately activates the process of quick germination.

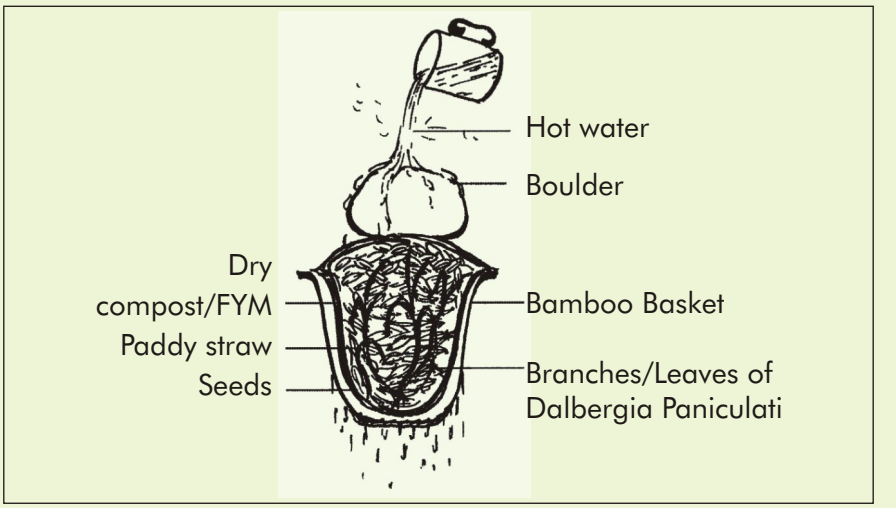
During germination, when the GA concentration increases, the ABA levels have to be reduced, but alternate exposure to dry and wet conditions maintains a balance of ABA, which in later stages imparts drought tolerance to the seedlings. Hot water treatment, anaerobicity and the strong medicinal effects of Dalbergiapaniculata prevent many seed-borne diseases.

Source : Narayana Avarepattim Thally

Pre-sowing treatment of dryland paddy seeds for the induction of drought tolerance, quick germination and disease avoidance figure

Indigenous Knowledge in pre-sowing and Post harvest Technology of Seeds

Prior to sowing the farmers follow several practices to achieve the optimum healthy plant population in the field. In this back drop a



detailed documentation of the farmer's popular practices in areas of pre-sowing , seed drying, seed treatment and seed storage are described below. These practices were experimented in select farmers fields and extended to wider areas.(Table 6and Table 7)

Seed Drying

Once seeds are selected, the seeds are dried and prepared fr either sowing or storing. Measures that farmers suggested for drying seeds are described here.

- The seeds are extracted after the vegetables are thoroughly washed and dried.
- Once seeds are selected, they are dried and prepared for either sowing or storing. The measures that farmers have suggested for drying seeds are described here:
- The seedsare dried on a mat or a piece of cloth. If exposed to mud, seeds will become prone to disease.

- Direct sunlight between 11 am and 2 pm is avoided, as this will reduce the sprouting strength of the seed.
- Pulses such as redgram, cowpea, greengram, blackgram and field bean are dried after being smeared with castor oil.
- Gourds are allowed to dry on the plant.

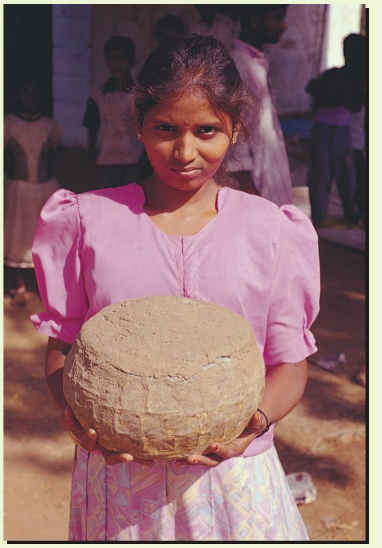
If aseed cracks when pressed between two fingers, it indicates that the seed has been properly dried.

Table 6: Farmers seed processing techniques

Techniques of farmer	Farmers logic (Probable Scientific explanation)
Well-composed sheep/goat manure can be mixed with paddy seeds and soaked over night in gunny bags by placing weight on them	Promotes uniform germination due to growth regulatory affect of manure.
Sunflower seeds are soaked in sour butter milk before sowing	Better germination and acts as growth promoter
Passing wooden plank in paddy field 60 days after drill sowing paddy (locally called "Hodtha" operation) and 35 days after sowing in finger millet	▪ Operation stimulates profuse tillering ▪ Makes seedlings to dip in the and diseases standing water there by killing pests
Use of high speed rate under drill sown paddy	Serves to maintain desired plant population even after inter-cultivation and pest damage
Sowing seeds of finger millet mixed with FYM	▪ Helps crop to tolerate moisture stress at early stage, ▪ Promotes tillering ▪ Ensures better moisture and nutrient supply
Dipping of finger millet seedling in cow dung and red earth while planting	▪ Seedling tolerate moisture stress ▪ High potassium in red earth and cow dung ensure adequate nutrient in the initial stages

Table 7

Techniques of farmer	Farmers logic (Probable Scientific explanation)
Horsegram stored in empty common salt bags or storing in gunny bag dipped in salt solution	Insect damage is reduced. Salt prevent hatching of storage pests eggs and also acts as a preservative
Neem leaves are in pulse bags for storage	Controls storage pests. Neem leaves effect hatching of storage pests eggs
Redgram coating with red earth, soaked overnight and drying in shade	▪ Reduces insect damage and facilitates milling ▪ Wetting and drying process loosens husk from kernel and red earth act as physical barrier to the storage pests
Bunching local small onion and hanging to the roof	Enhances shelf life. Hanging prevents rodents damage, the optimum temperature and air circulation near the roof has a curing effect
Mixing of wood ash for storing pulses	Controls storage pests. The fine powder of ash acts as a physical barrier and also blocks respiration system of storage pests
Mixing neem and eucalyptus leaves to store food	Controls storage pests, acts as insect repellent
Bamboo grain storage structure plastered with cow dung slurry covered with a layer of dried leaves of lakki at the bottom to store paddy and sorghum	▪ Reduces storage insect pests of paddy and prolongs storage life ▪ Cow dung slurry acts as disinfectant while lakki (vitex nrgundo) act as an insect repellent and pasting with cow dung makes with structure semi Impervious to external atmosphere
Storing of sorghum seeds along with husk	▪ Reduces storage insect pests and prolongs storage life ▪ The husk acts as a physical barrier and also blacks respiration system of storage pests
Mixing red chilies with red gram	Reduces storage pests and prolongs storage life. The pungency of red chillies prevents the insect activity



Seeds Storage

To keep their seeds clean and free from pests during storage, farmers follow some common practices. Seeds are commonly stored in earthen pots, bamboo baskets or similar containers made from natural materials, rather than in sacks. The storage area for the seeds must be free from moisture, have good air circulation and be frequently checked for pests. Often earheads and fruits of vegetables are tied and hung in a smoky area, e.g., the kitchen. Some materials like dried neem leaves, lakki leaves (Vitexnegundo), adusoge leaves (Adathodavasika), baje (Acorouscalamus), red chillies, limestone dust and ash are effective in controlling storage pests.

Indigenous Seed Storage Methods

- 15-20 red chillies strewn through a sack of rice can prevent pest attacks.
- The ash of paddy husk is mixed with jowar, paddy or wheat to prevent seed borers.
- Crushed limestone mixed with seeds protects from pests.
- Seeds rubbed with boiled castor oil or castor seed powder and thoroughly dried in the sun are less susceptible to pest attacks.
- Smearingseeds with red earth and soakingthem in cow's urinebefore drying and storage keeps the seeds free from pests.
- Wheat, jowar and paddy earheads tied together and hung remain free from pests for a long period of time.
- Seeds of pulses are stored in an earthen pot with sand or finger millet on the top and bottom layers, and the pot is sealed with straw and cowdung to keep the seeds free from pests.

- Paddy is mixed with the powder of Vitexnegundo to protect against most pests during storage.
- Dried leaves of wild tobacco keep pests away from stored paddy. The leaves are mixed in a proportion of 2%.
- Leaves of neem, Vitexnegundo and pongamia are placed between bags of rice or maize to protect the grain from pests for 6-12 months.
- Sorghum seed stored with husk is effective in controlling storage pests.
- Neem leaves mixed with sorghum seeds are kept in a storage structure prepared out of lakki sticks pasted with cowdung and covered by paddy straw.
- Mixing neem leaves, ash and dry chillies controls storage pests of redgram.

Storage pests

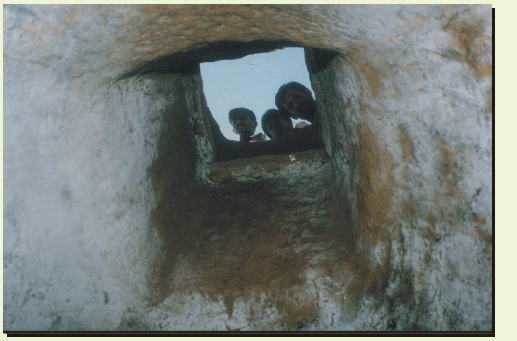
Often grains are stored after a harvest before they are used either as grain or as seed material. There are certain insects that attack the grainsduring the storage period, causing great loss to the farmer.

Rice weevil (Sitophilus oryzae)
The rice weevil is the most destructive for stored grain. It is a small black beetle with reddish or yellowish spots on its back, and can fly. The beetle feeds on whole grain rather than broken grain or flour. It sometimeseven attacks the grain in fields before harvest. The larva of the beetle feeds within the seeds.
Saw-toothed grain beetle (Oryzaephilus surinimensis)
This is a slender and flat brown beetle with tooth-like projections. Both larvae and adults feed on grain and flour. This pest feeds on seeds which are damaged by other insects.

Pulse beetle (Callosobruchus chinensis)
This beetle is of a reddish colour and the hind portion of its body is square in shape. Its eggs are oval-shaped and found glued to the grains. It feeds on pulses such as cowpea, grams and field bean in the fields as well as in storage.
Lesser Grain Borer: (Rhizopertha dominica)
This is a small and slender dark brown or black insect with a cylindrical form. The adult feeds on whole grain while the grub feeds on the flour.
Angousmois Grain Math or Paddy moth: (Sitatoga cerealella)
This insect is a pest of paddy, maize, wheat and other grains. It is a small, yellowish brown, satiny moth that feeds on the grain in the field as well as in storage. The larva feeds within the whole grain and leaves a smooth round hole from where it will emerge.
Rice Math: (Corcyra cephhalonica)
This moth is slightly larger than the paddy moth and is greyish brown in colour. The insect prefers broken and milled grain. The caterpillar is creamy white and is concealed in a silken case, from where it feeds.

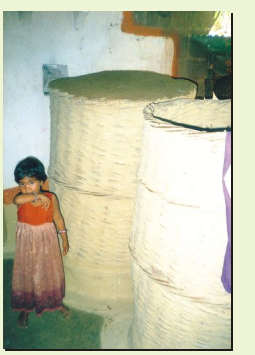
Methods of seed storage

Traditionally, seed is stored in many ways. It may be stored underground or in large mud vessels.



HAGEVU is a popular underground storage structure in regions where finger millet is grown. The structure is egg-shaped and has a round opening, large enough for one person to descend into the pit. The inner walls are smeared with cow dung and then covered with paddy husk. The size of the hagevu depends on the size of the land cultivated by the farmer. This method of storage is advantageous and the grain stored becomes red and sturdy. It can be used to store large quantities of grain without taking up space, as it is located underground. Once built, the structure remains useful for the next two or three generations. However, it has some drawbacks too. Excessive ground moisture sometimes makes the grain germinate. The grain may also become mixedwith loose soil. The colour of the grain often changes to black, making it unappealing as food. People who are not experienced in using this method of storage are prone to asphyxiation when they enter the pit.

KANAJA is a surface storage device. The bin is usually kept in a space in the front portion of a house. Sometimes, one room of the house is used as a storage bin for cereals, especially finger millet and paddy. With this method of storage, however, the grain is prone to fungal infections and changes in colour.



TOMBE is another surface storage method. It is a bamboo structure 8 feet high and 3 feet wide with a tapering mouth, and grain is stored within. Grain stored in this way is susceptible to termite attacks if not monitored properly.

Often farmers directly dry their seeds on their rooftops. This is especially common in the eastern dry regions of Karnataka. Sometimes. Seeds are

exposed alternatively to sunlight and dew for a fortnight. The seed is then packed into sacks and stored. Farmers say that seed dried in this way is resistant to pests and diseases.

MOODE is a container made of ropes of paddy straw, kodo millet straw and some fibrous weeds. The top and the base of the container are lined with ragi husk and the grain is filled in. This method is usually used to store pulses and grains, and the container can last for two years. However, the moode cannot be opened to monitor the grain and cannot be used twice.

MUD STORAGE DEVICES are common. Vade, gudana and madakesaalu are some of the types available. Earthen pots of varying sizes are also used. The mouth of the device is sealed with clay and dung. A small opening at the base allows the grain to be taken out whenever required.

Standardization of Traditional Seed Storage System

The case of field bean (Dholicos Lab Lab)

Field bean serves as a major subsidiary food crop. It is predominantly grown as an intercrop with finger millet and groundnut inrainfed regions. It occupies an important place in the daily food habits of the rural poor. Hence farm families have adopted different traditional storage methods to safeguard the life of the pulse till the next sowing

The storage methods employed vary across regions. According to a preliminary survey conducted in different regions of the project area, farmers were not following any standardised storage methods. Some of the methods adopted by the farmers in different regions were: (1) smearing pulse seeds with red earth; (2) sand mix; (3) finger millet mix; (4) kodo millet mix; (5) castor seed crystal mix; (6) castor oil smearing cooling smoke fumigation with smoke (7) container constructed with a wild grass (kasihullu);

An experiment was undertaken to compare the various storage methods, with a view to selecting the most effective methods and standardising their use across the different regions. The storage methods selected for experimentation were as follows:

1. Finger millet, sand, castor seed crystals and kodo millet were mixed with the field beans in equal quantities and stored in earthen pots.

2. Mude, a traditional storage structure constructed with the kasihullu wild grass.

3. A bag of seeds was placed at the doorstep for it to be regularly stepped on.

4. Seeds were also mixed with castor oil and stored in earthen pots.

To compare the different storage and treatment methods, a control treatment was maintained. This experiment was replicated at six villages.

After treatment, the seeds were kept undisturbed for four months. At the time of sowing (July), the seeds were examined for their viability and signs of pest attacks. Twenty-five seeds were randomly selected out of the total sample.The number of pest-affected seeds was counted, and the same set of seeds was subjected to the germination test.

Based on the results of the experiment, the farmers finally accepted the seed storage methods of castor oil smearing, finger millet mixing and stepping.

TABLE 8 Effects of Storage Methods On Pest And Germination Percent-Age Of Field Bean

Treatment	Observation / Effects	Germination
Mixed with finger millet	Disturb the feeding habits of storage pest through the slippery nature	100%
Mixed with Castor oil	- Regulated pests egg laying and multiplication. - Odour of oil acts as repellent - Cooling nature of oil affects the pests	100%
Stepping	- Walking on it disturb the feeding habit in storage pest	100%
Kodo millet mix	Disturb the feeding habits of storage pestd through repellent nature	100%
Mixed with sand	- Cool environment disturb the pest - Facilities free exchange of gases that hinder the pest for seed feeding activity.	50%
Stored with grass (Kasi hullu	- Strong smell of the grass acts as a repellent - Scorch effects avoid pest	100%

Experimentation with bio-repellents

The rice moth (Corcyra cephalonica), locally known as akkihooji, is the most common storage pest on rice. It is a small moth, pale greyish-brown in colour and capable of attackingwhole grains as well as milled grains. The caterpillar feeds on the grains and its entire life cycle will be on the stored grains. To check this pest menace, an experiment was conducted using plant-based bio-repellents.

Methodology

Five sets of seed sample infested by the pest were put in five separate cloth bags. One sample was kept separately as the control and the other four samples were treated with different bio-repellents. The bio-repellentswere made from the leaves of various plants (see below), which had been dried under the sun for days and finely powdered before they were mixed with the grains. One more set of infested grains was stored separately in an airtight glass jar as the second control. The sets of seeds used in the experiment were thus as follows:

TABLE 9	
Control 1	Infested grains in acloth bag
Control 2	Infested grains in aglass jar (airtight)
Treatment 1	Infested grains in the glass jar (air tight) + neem leaves (Azadiractavasica)
Treatment 2	Infested grains in the glass jar (air tight) + adathoda leaves (Adathodavasica)
Treatment 3	Infested grains in the glass jar (air tight) + gonde
Treatment 4	Infested grains in the glass jar (air tight) + neem + adathoda + gonde

Observations

One month after the treatment, no storage pests were observed in any of the cloth bags. Very interestingly, the control sample stored in the glass jar contained the rice moth.

After this observation, a few adult moths were introduced into all the samples to study the effectiveness of the bio-repellents. The results obtained after a month of storage are described in the following conclusions.

Conclusions

1. All the bio-repellentshave a very strong odour that drives awaythe storage pests.
2. Moisture content and aeration, along with the repellents, play a major role in the control of storage pests in paddy.
3. The grains stored in cloth bags did not contain any moths under dry conditions.
4. This experiment led to the conclusion that the above bio-repellentsare effective in controlling the storage pests.

5 Farmers Participation In Seeds Purification

The introduction of high-yielding varieties (HYV) and hybrids in India under the Green Revolution has resulted in the extinction of numerous land races and local varieties. They are now considered to be uneconomical and unsuitable to the present market conditions. Small-scale farmers in marginal environments now grow a mixture of crop varieties as an insurance against biotic and abiotic stress of the crop.

The modification of genetic characteristics for the improvement of crops with the involvement of farmers and breeders is referred to as participatory plant breeding. There are many participatory crop improvement programmes which involve farmers to different degrees in breeding, identification of improved cultivars or upgrading landraces. The approaches were carried out in two steps:

1. **Selection**
2. **Purification**

Since the aim is to improve the local traditional varieties, it is appropriate to first undertake participatory varietal selection (PVS). An advantage of PVS is that it identifies materials that can be accessible and rapidly adapted by marginal farmers.

PVS programme to identify farmer-preferred cultivators has four phases

1. Identifying farmer needs in relation to cultivars

2. Searching for suitable material to test with farmers

3. Conducting experiments on the acceptability of the material in farmers' fields

4. Once it is accepted, the farmer-preferred cultivar is disseminated more widely.

After studying the local adaptability, yield performance and several other characteristics for two years, three varieties of finger millet and paddy were selected for production for food and the market. The selection was based on the interest and participation of the farmers. The factors considered by the farmers in selecting the crops were drought tolerance, medium duration, capability to withstand environmental variations, pests and disease, non-shattering, high tillering, uniform maturity, and high yield with low inputs (Table 10).

Seed Purification, The First Step in Plant Breeding

Farmers have developed landraces over many generations through selection, without direct input by the formal sector. Landraces have evolved continuously by natural selection, as well as criteria preferred by the farmers. Because of the diversity of planting environments, landraces co-adapt to various biotic and abiotic stresses. Hence, these landraces are essential for food security and income stability, particularly in marginal environments. Strengthening community-level management of plant genetic resources is essential to the success of in-situ conservation and development and also for facilitating the sharing of benefits derived from the utilisation of these resources. Empowering farmers would help promote food security.

Table 10 : Details of farmer preferences in Finger Millet Land Races.

Farmer	Variety	Village	Fovourable Characters	Non- Favourable Characters
Munithimmaih	Doddathene Ragi	Kariannanadaddi	* Tall growing * Drought resistant * Bold grains * Resistant pest * Compact earhead with minimum * Non shattering * Good fodder	* Low tillering * Medium sized earhead * Heavy lodging * Neck breaking of ear head
Chikkamadamma	Mandya Orissa	Achubalam	* Multiple branching and tillering * Drought resistant * Medium sized earhead * Non shattering * Completely devoid of pest and disease * Good straw yield * Suitable for marginal land	* Less yield * Thick stem * Bending of flag leaf
Mutturaj	Beli bunduga	Belalam	* High tillering * Multiple branching of Fingers * Big sized earhead * Minimum husk * Non shattering * Good response in marginal lands * High yielding	* Lodging type * Minor incidents of diseases * Germination of diseases when undue rains interfere harvest in the field

Participatory research conducted by GREEN Foundation revealed that farmers' knowledge is central to revitalising the cultivation of landraces. Collaborative research showed that for a typical crop grown in marginal and unpredictable environments, such as finger millet and rainfed paddy, it is possible to exploit genetic differences for specific adaptation to marginal environments and improve yields without additional external inputs.

Finger millet Pochakaddi ragi

Participatory research appraisal was conducted to select a landrace. Pichakaddiragi, a finger millet variety, was selected on a collaborative basis for purification. Pichakaddiragi is a local cultivar that has been sustained in the farmers' fields for the past few decades. Farmers have cultivated this landrace over the years mainly because it performs well under rainfed conditions. It is also drought-resistant and well suited for marginal environments. It grows to a height of 80-100cm erect, with 2-4 tillers per plant. The crop matures in 135-150 days and gives a grain yield in the range of 18-25qt/hec. Another reason farmers prefer to grow this landrace is its good straw-yielding ability, which is an essential requirement for feeding their livestock. The farmers opined that one bundle of Pichakad- diragistraw is equal to two bundles of straw from an improved variety (indaf 5).Pichakaddiragi straw is much liked by

livestock due to its palatability, which is lacking in other improved varieties of finger millet. According to women farmers, one measure of Pichakaddiragi flour is equal to two measures of improved variety ragi used in preparation of foodstuff (ragi balls, for example).

At the time when GREEN Foundation interacted with the farmers in a bid to improve their livelihood, they were confronted with a poor crop. The crop was in a state of poor growth, with a single stem devoid of productive tillers, and a variety of interspersed plants of other crops clouding the identity of the crop pichakaddiragi. There appeared to be no morphological or seed markers either. Some experienced farmers did identify the landrace but it was difficult to get a common diagnostic feature.

Therefore an approach to purification of the Pichakaddiragi landrace was designed with the participation of a few farmers. The approach utilised the indigenous knowledgeof farmers who were identified based on the Foundation's previous experience working on other initiatives in these areas.

The farmers' selection criteria for Pichakaddiragiwere:

- Darkbrown rings at the internodal region and pale pink stem
- 3-4 culm branching character
- As the plant matures, the top finger curves inwards
- Fine-textured straw (leaves and stem surfaces) and high straw yield
- 3-4 earheads per plant
- Dark brown first shape earheads with rough-textured and thick grain arrangement on fingers
- Unsynchronised maturity character
- Lodging resistance and non-shattering of grains
- Bulkiness of flour on cooking.

As a pilot study with restricted infrastructure, it was decided that two farmers from adjoining villages would participate in the purification of Pichakaddiragi. Since it was necessary to access the problem on ground realities as existing in site villages, the farmers were allowed to grow the crop in their plots following their ownpractices. Thus cultural practices, dates of sowing and harvest were left to be determined by the farmers, representing gender equity. ThePichakaddiragiseeds were collected from five traditional farmers and denoted as seed sources.However, it turned out, on farmers' evaluation, that one of the sources was in fact another finger millet variety, Mandya Orissa ragi. Thus only four seed sources raised in the two farmers' fields all were mixed and skewed, indicating that the farmers had exercised their judgment objectively with care. The variation between the seed sources was highly significant for all traits. It was clear that the Pichakaddiragi seeds collected from the four sources were impure. At the same time, the variation among selection depths showed significance for the important traits, which confirmed the careful observation and independent selection of the farmers. The pilot study has confirmed that the a priori grounds mentioned earlier of the problem of seed mixtures of Pichakaddiragi were real. To improve the yield performance, farmers' indigenous knowledge plays a vital role.

The seeds selected on a participatory basis in the first generation were raised in one farmer's field for seed bulking. Experienced farmers were invited to purify the variety in the second generation also. To study the significance of the planting method, line sowing, broadcasting and transplanting methods were followed. The results from the second generation revealed that farmer-purified seeds of Pichakaddiragi raised under transplanted conditions performed well in terms of grain yield, straw yield, genetic uniformity and suitability to low-input management conditions. Thus it can be seen that varietal improvement involving farmers isan optimal method of crop improvement and maintenance of genetic diversity in farmers' fields.

Rainfedpaddy (Belinellu)

The diversity ofrainfed paddy varieties in the Thally region of Tamil Nadu is eroding. Due to the introduction of modern varieties and intensive farming practices,traditional paddy landraces have become rare. To revitalise the cultivation of rainfed paddy in the area, theBelinellu variety was selected for improvement through farmers' involvement. Belinellu is a landrace predominantly grown by the farmers of Thally under rainfed conditions. It has traditionally been the leading cultivar among the paddy varieties in this region mainly due to its drought-resistant, pest- and disease-resistant and non-lodging characteristics.It grows to a height of 91-110cm and has a tillering ability ranging from 3-6 per plant. It is a long-duration (130-145 days) variety and its grain yield ability ranges from 20-25qt/hec.

Belinellu seeds were collected from five different farmers and raised onthree farmers' fields. At the time of grain maturity, five experienced farmers were involved in mass selection. Plants were tagged and observations recorded according to farmers' selections. On analysis of the data, it was noted that grain yield and straw yield were higher in the farmer-selected plants as compared to non-selected plants. Seeds purified by the farmers were raised for bulking in the second generation. To test the suitability of the crop, line sowing, broadcasting and transplanting methods were adopted. Performance was evaluated on a collaborative basis in the second generation. Farmers viewed positively the uniformity and yield characteristics of the variety. Seeds obtained during the second mass selection were grown in different regions to study the suitability of the farmer-selected variety in five farmers' fields. Belinellu in its purified form yielded considerably well even during low rainfall conditions and in marginal environments.

6 Crop protection

Pests and diseases in farms have been a problem ever since the cultivation of crops began. There are numerous pests and diseases that attack crops in the fields as well as during storage periods. Some pests are specific to certain crops, while others attack a wide variety of crops. The solution for pest control recommended by government institutions and private industryis chemical pesticides. However, these chemicals have caused much harm and led to the degradation of the environment and ecosystems. The best solutions lie instead with the farmers themselves, who have all the knowledge and experience required to deal with the problem in an effective and natural way. It is important for a farmer to diagnose a pest or disease attacking the crop at an early stage so it can be treated before the damage crosses the economic injury threshold.

The use of chemical pesticides for the control of pests and diseases not only damages the environment butis also harmful to human health. Such pesticidesare known to cause cancer and birth and genetic defects. Further, these pesticides are also expensive and cannot be afforded by resource-poor farmers. Realising these hazards and drawbacks, farmers have used naturally available materials to control plant pests and diseases.

These natural pest repellents are based on simple principles such as the use of bitter leaves and bad odours that repel insects. Some of the formulations are made of ingredients that are poisonous to insect pests. A few of the pest repellents currently in use are described in this chapter.

Pests and diseases may be prevented from reaching the stage of serious infestation by some simple techniques. Farmers' strategies to control pests include the following:

Farmers strategies to control pests.

- Treating seeds with organic solutions like cow's urine, milk, asafoetida etc.will control pests and diseases at an early stage.
- Lighting lamps in a paddy field at night can check the stem borer.
- Fallow ploughing during summer destroys insect eggs and infant insects.
- Planting certain crops together in the same field is an effective way to curb pest attacks:
- If mustard and finger millet are sown together, the ladybird beetle that is attracted to the mustard helps control aphids that attack the finger millet crop.
- Sunflower, intercropped with cotton, prevents leaf eater infestation in the cotton.
- Groundnut and wheat grown together prevent the fruit borer.
- Castor grown with cotton, tobacco and chillies prevents major pests.
- Castor grown with Dolichosbiflorus (horsegram) prevents aphids.
- Dolichosbiflorus grown sparely along with groundnut will reduce aphid attackson the groundnut.
- Dolichosbiflorus intercropped with jowarchecks the stem borer.
- Growing tomato with a carrot crop repels carrot flies.
- Coriander grown around vegetable patches prevents major pests.

Poochimarundhu :

This is a herbal pesticide made out of leaves and other natural materials. Each of the ingredients – 1kg each of lantana leaves, calotropis, neem seeds, lakki (Vitexnegundo) and aloe vera – is ground to extract juice and these are stored separately in earthen pots for a week.The separate juices are mixed together. It is later filtered, diluted with water at a ratio of 1:6 and sprayed on the crop. Poochimarundhu can be used for all crops and is known to prevent a wide variety of pests on field crops, vegetables and plantation crops. It is effective against the coconut mite when applied at the immature stage of coconut formation.

Lakki *(Vitex negunda)* extract

Crushed leaves of V. negundo are mixed with a solution of cow's urine and water in a 1:1 ratio. This mixture controls aphid infestation in wetland paddy varieties like basumati and kulloankar.

Cow's Urine Solution :

A solution of cow's urine and water in a ratio of 1:4 used at 15-day intervals effectively controls leaf blast in finger millet during the growth stage.

Vermi Wash Spray :

Vermiwash spray plays a dual role; it acts as a fertiliser as well as a pesticide. An increase in both the quality and quantity of produce in fruit and vegetable cropscan be observed with its use. Vermiwash mixed with cow's urine and water (1:1:6) effectively controls the caterpillars and aphids in vegetable crops.

Bitter leaves extract :

Leaves like neem, wild neem, pongamia, yak, erythrina and custard apple are immersed in 10l of cow's urine in a mud pot which is then sealed. After about 15-20 days, the solution is diluted in a 1:5 ratio and sprayed on vegetables once in 10 days. It prevents flies and minor pests. The bad odour repels insects and the solution is poisonous to them.

Neem leaf extract :

Neem leaves are crushed and mixed with water in a ratio of 1:1 to form a paste. This effectively checks the stem borer and fruit borer.

Wood Ash :

Wood ash sprinkled on vegetable plants prevents pests like mites, whiteflies and aphids, and cures some diseases also.

Garlic – Chilly extract :

Equal proportions of green chilli and garlic are ground together to prepare an extract. This is then mixed with water in aproportion of 1:100 and sprinkled over crops. It effectively controls jassids and

Pest Repellent Spray – Farmer Innovation

Plants used: ½kg of Sundesoppu *(Solanum indica),* 1kg of Yettikai *(Strichunsnuxvamica),* ¼kg of Urigpatti wild species, ½kg of Urigalisoppu and 2 strips of Lolesara (aloe vera).

All the ingredients are tied together in a cloth and immersed in 3l of cow's urine for 10 days. The solution is then diluted and sprayed on affected plants. This formulation is a good pesticide against small caterpillars and borers in field crops, particularly field bean and castor. Ithas been used by farmers and found to be effective.

Conserve trees to control pest and diseases on your farm.

Neem *(Azadirachtaindica)*

Pongamia *(PongamiaPinnata)*

Custard apple *(Annona squamosa)*

Kapu *(CalotropisProcera)*

Lakki *(Vitexnegundo)*

Adusoge *(Adathodavacica)*

Tobacco *(Nicotinatobacum)*

Marigold *(Tejituserecta)*

Lolesara *(aloe vera)*

Kaadusonde *(Solanum indicum)*

Hiremaddingagidda *(Withaniasominifera)*

Seemeyennegida *(Ipomia fistula)*

Datturi *(Dattura metal)*

Tumbe *(Lucas aspera)*

MukkadkaKasaraka

Yetti *(Strycnusnuxvamica)*

Vishamadhari *(Clerodendruminnermis)*

On -Farm trails: Experiments of Pest Repellant on Wetland Paddy.

Godavari IsukaVadlu (Orange Red Scented) is a wetland paddy variety from Andhra Pradesh. A small sample of this variety was multiplied at the Green Foundation's conservation centre and given to Singhe Gowda, a farmer from Herandyappanahalli village in Karnataka. During the month of September, the leaf roller pest was observed due to heavy rainfall. The pest repellent formulation was tried in Singhe Gowda's field as described below:

Step 1: The crop was brushed with a broom made of lantana (the odour was sufficient to drive away pests), and nearly 25% of the pests

fell onto the plot where water stagnated. After a week the stagnated water was drained off and again the crop was brushed with the broom. Again water was allowed in and 500ml of kerosene was mixed into it for uniform spread and allowed to stagnate for a day. Then the water was drained off along with the pests.

Step 2: 200ml of neem oil and 200ml of pongamia oil together with a pinch of Khadi soap diluted in a bucket full of water was sprayed. This formulation was effective against the brown plant hopper, stem borer and leaf roller pests.

Step 3: 500g of neem cake and 2kg of pongamia cake was powdered and spread in the field. The whole process relieved the crop from the pest attack and the plants looked healthy.

Table 11: Details of plant based pest and disease repellants tested in farmers field.

Trial crop	Target pest	Plant used	Useful part	Method of Preparation	Dosage	Result
Tomato chilly Brinjal Beans	All Major pests	Lpomea fistula Agave spp. Pongamiapinnata Argemone mixicana Annona squamosa	Leaves and stem	1 kg of fresh leaves of each of the plants are shredded and soaked in a large pot of cows urine, and allowed to stand for at least 10 days, then filtered	The filtrate is diluted in a ratio of 1:6 with water, and sprayed	Effective against all major vegetable pests, like eater and root damage.
Brinjal	Root aphids, fruit and shoot borer, Epilaehna beetle and other major pests	Neem pongamia	Seeds	1\2 kg cakes of each are soaked overnight in enough water to submerge them.(this quantity is sufficient for an area of 50 sq. meters)	The soaked cake should be broad casted and mixed well with the soil in early morning	Gives good yield and reduces the population of all major brinjal pests.(80-90% effective)
Brinjal	Brown hairy caterpillar	Custard Apple Neem	Leaves Seeds	1kg of fresh custard apple leaves and neem cake are soaked in 2.5lt. of cow's urine overnight, then filtered.	The filtrate is diluted with water in a ratio of 1:3 and sprayed on foliage.	Effective in control ling the pest in a day.
Brinjal	Epilaehna beetle	Custard Apple Neem	Leaves Cake	1 kg of fresh custard apple leaves and ½ kg of Neem cake are soaked in 3 lts of cow's urine overnight.	The filtrate is diluted with 8 lts of water and sprayed	Very effective against Epilachna beetle; also controls grub and Adult

Tomato Radish Brinjal Paddy	Curty leaf Disease Diamond Black moth Fruit borer Leaf roller	Garlic Chilly	Clove Fruit	100 gms of garlic cloves are crushed, soaked in kerosene, and left overnight.100gms of green chillies are ground, soaked in ½ lts. Of water, and left overnight. Both solution are filtered and mixed. 30gms of soap powder is added and thoroughly mixed.	The solution is diluted with water in a ratio of 1:5 and sprayed.	The results are satisfactory; 50-70% effective.
Cabbage Diamond	Cabbage Semilooper, Back moth	Marking nut	Seeds	A handful of marking nut seeds are crushed and soaked in water overnight. The mixture is boiled until it halves in volume and then filtered.	The filtrate is diluted with water in ratio of 1:10 and sprayed.	Effective against Cabbage looper, but fails to control diamond back moth and plant lice.
cabbage Tomato	Diamond Backmoth, Plant lice Aphids	Tobacco	Leaves	250 gms of dried tobacco leaves are boiled in 4 lts of water for 30 mins, allowed to cool, and filtered.	The filtrate is diluted with an equal part of water and 30gms of bar soap is added and sprayed	All diamond back moth and all diamond back die within one day. Very effective against aphids also.

Table 12: Formulations of Pest Repellant tested against Pests and Diseases :

Crops	Pests	Formulations	Results
Wet land paddy, basumathi and kullankar	Aphids	Crushed leaves of Vitex negundo mixed with cow's urine & water in the ratio 1:1 and sprayed	Aphids controlled
Wetland paddy, Ratnachudi	Seedling martality	Neem oil mixed with water in a ration of <1:10>	Effective
Wetland Paddy, Kullankar	Damage caused to roots mecklast	Manure tea solution mixed with water in the ratio 1:1	Effective
Coconut Tree	Rhinoceros Beetle	Slurry + Decayed Snake Gourd used are pesticide for the same fruit, controlled rhizoceros beetle due to the pungent smell	Very Effective
Cusumber	Decay of leaves	vermi-wash & Cow's urine in the ration 2:1 was sprayed twice in one month.	Effective
Brinjal	Mealy bug attack at the initial stage	Cow's Urine mixed with water in the ration 2:1 was drenched.	Very Effective
Pomegranate Brinjal	Fruit bore Stem borer	Neem leves crushed and mixed with water in ratio <1:1> and sprayed.	Very Effective
Brinjal	Leaf spot	Wood ash was sprikled	Very Effective
Tomatoes	Drying of leaves due to viral attack	Wood ash was sprikled	Very Effective
Tomatoes and Beans	Bacterial and viral attack	Liquid manure in the from of dilute liquid solution <1:10>	Very Effective

Redgram	Podborer, Aphids and Miters.	Green chilies 4-5 + garlic 2 tubers + water mixed and crushed and sprayed 4 times once in 15 days in the ratio of 1:2.	Control of Aphids and Mites
Wetland paddy, Ratnachudi	Seedling martality	Neem oil mixed with water in a ration of <1:10>	Control of Aphids and Mites
Brinjal	Fruit borer	100 gms of green cillies are ground and soaked in ½ ltr. of water. 100 gms of garlic cloves are crushed finely and soaked in kerosene over night. the solution was filtered and mixed. to these 30 gms of soap powder was added and stirred. Dilute the solutoin in the ratio of 1:5 and spray.	Very Effective
Finger millet (guttakindala Ragi and toor Ragi)	Aphids	Yetti kai (Strychnus Nuxvomica) Fruits were crushed and mixed with water in the ration 1:5 The filtrater was sprayed.	Very Effective

Table 13: Formulations tested against certain pests and diseases of the conservation center

Crops	Pests & Diseases	Formulations	Results
Red gram	Pod borer, aphids and mites	Chilly power + Garlic solution + Kerosene + Soap, diluted in water	Control of aphids and mites
Red gram	Pod borer, aphids and mites	Chilly power + lime	Control of aphids and mites
Red gram	Pod borer, aphids and mites	Chilly power + lime + Salt	Control of aphids and mites
Red gram	Pod borer, aphids and mites	Erythrina leaf extract + Lime water	Competed control fo aphids and slight control of pod borer
Red gram	Pod borer, aphids and mites	Neem cake + Soap water	Competed control fo aphids and slight control of pod borer
Sopota, Lemon, Redgram, Chillies and Tomato	Pod borer, aphids and mites Flower drop	Neem cake + Soap water Vermiwash in weter	Competed control fo aphids and slight Very effective
Tomato, Brinjal, Chillies, Red gram.	Bacterial wilt, leaf blight, leaf spot, yellow vein mosaic, root knot	Bio dung solution*	Very effective
Tomato, Brinjal, Chillies, Red gram.	Bacterial wilt, leaf blight, leaf spot, yellow vein mosaic, root knot	Manure Tea solution**	Very effective

** Solution contains leaves of Glyricidia, Cherry, Lantana, Red gram, Leon Adusoge, Terminalia, Neem, Pongamia, etc,. soaked in bio gas slurry and water for one month. The treatment were conducted for different set of plants separately.*

7 Crop Nutrition

Maintaining soil fertility and productivity on a sustainable basis is of primary importance for continuous agricultural production. To enhance soil health, it is necessary to augment and regulate the content and quality of humus. Often, the nutrition that is essential for healthy plant growth is not completely available from the soil and has to be supplemented externally. However, indiscriminate use of chemical fertilisers destroys the environment and is highly expensive. Using natural materials like biomass, compost, biofertilisers, liquid manure and biogas slurry is healthier for the environment and for consumers.

The different methods described below for supplying nutrients to crops were developed using the knowledge of farmers. The materials used are entirely organic and easily available on the farm. The manures may either be applied to the soil or may be sprayed onto the plants at different growth stages.

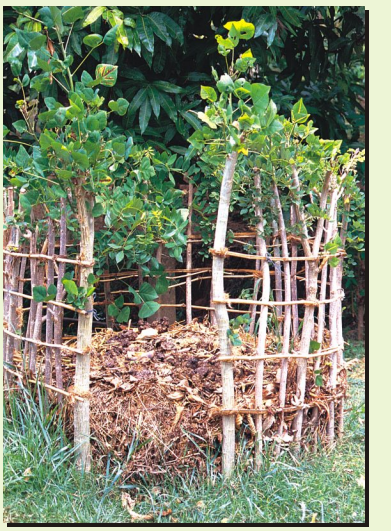
Methods of Compost Preparation

Basket Compost :

This method of composting converts green leaf material into rich manures using the processof decomposition.

Planting cuttings of gliricidia, erythrina and tapioca trees of about 5-6 feet tall in a shady area witha radius of 3 feet forms a "basket". This enclosure is then filled with leaves, both green and dry, and other agricultural wastes. The material is covered with a layer of mud and sprinkled with water every 15 days. After 40-45

days, earthworms are introduced into the partially decomposed material. The compost will be ready after 90 days.



Vermicompost : (an improved method)

Vermicompost is another rich manure obtained through the action of earthworms on organic material. Leaves and other plant residues are allowed to decompose in a tank or converted pit for about five days, after which earthworms are introduced.

In the usual method of making vermicompost, water is used to maintain the moisture level.In the improved method, a hole is drilled at the base of the tank to drain out excess water. This liquid can be used as growth promoter for vegetables and fruit trees. The vermicompost is ready for use after three months. The compost provides all essential nutrients and improves the quality and yield of a wide range of crops.

Chamber Compost :

Under this method of composting, crop residues, fruit and vegetable wastes, weeds, tree wastes, cowdung, biogas slurry, water etc. are placed in layers in a chamber and allowed to decompose for three months.

Three chambers are made out of stonewalls builtwith a slight space in between each slab for good aeration, which facilitates microbial activity and decomposition. In one of the chambers, the organic waste is spread at the base, upon which a thin layer of cow dung slurry and soil is added. This process is repeated till the

chamber is filled. After one month the partially decomposed material is shifted to the second chamber while the first chamber is filled as before. After the second month the material from the second chamber is shifted to the third chamber. This process ensures, after three months, continued production of compost every month.

Farmers Method of Nutrient Management

a) **Pongamia seed powder :** At the time of sowing, the seeds are mixed with pongamia seed powder at a ratio of 1:2. The powder acts as a good manure and controls soil-borne pests and diseases. It supplies nitrogen at the seedling development stage of the crop.

b) **Ow's Urine :** Sand that has been soaked with cow's urinefor three days can be used as organic urea supplying nitrogen to paddy, finger millet and other field crops.

c) **Goat manure :** Goat manure can be dried and mixed with finger millet at the time of sowing as it acts as a good manure.

Growth Promoters

Growth promoters are used for vegetable and fruit bearing plants to enhance their size, productivity and also to prevent flower drop. Cow dung and leaves of different plants are the main source in preparing these growth promoters. Others include the liquid manure like vermin-wash, manure tea etc.

Method of Preparation :

Growth promoters are used for vegetable and fruit-bearing plants to enhance their size and productivity and also to prevent flower drop. One common type of growth promoter is made using cow dung and the leaves of different plants.

The leaves of leguminous plants and other plants together with chaff are immersed in a tank of water mixed with two basketfuls of cowdung, and the tank is covered. The mixture should be stirred frequently. After about 25 days when bubbles stop appearing on the surface, the growth promoter is ready.

Other forms of growth promoter include liquid manure, vermiwash, manure tea etc.

Liquid Manure :

A bucketful of leaves of erythrina, gliricidia, lantana and tapioca mixed with 5% of cowdung and 100% water is allowed to decay in acement tank for 20 days until the pungent smell disappears and small bubbles appear on the surface, which indicate that the manure is ready to be used. This liquid manure can be used to enhance the yield of vegetables like beans, cluster beans and tomatoes. It also helps in the control of leaf spot disease and in preventing bacterial and viral attacks.

Vemi-Wash :

Vermiwash is a liquid nutrient freshly extracted from the castings and sweat of earthworms. The vermiwash unit is set up using a barrel with an attached tap below. A 25-30cm layer of bricks or pebbles (2-4" in size) is placed in the barrel. The second layer is made up of 25-30cm of coarse sand. This sets up a basic filter unit. The third layer (30-45cm) consists of good loamy soil, which is kept moistened, and approximately 50 earthworms of epigaeic and aneceic varieties. Cow dung and hay are placed on the top layer of the soil. This is gently moistened every day, keeping the tap open for about 20-25 minutes.

After the unit is ready, water is sprinkled on it from a 5l vessel (plastic or mudpot) perforated at its base. This water slowly percolates through the compost, carrying with it the nutrients from freshly formed earthworm castings as well as washings from the drilospheres through the filter unit. The collected vermiwash is diluted with water in different strengths and sprayed on fruit plants and vegetable crops during the flowering and fruit yield stages.

Experimentation with vermiwash was conducted on different crops at the GREEN Foundation conservation centre.Forthe lemon crop,which had been producing minimal yield due to flower drop, vermiwash was sprayed in high concentrations with a dilution ratio of 3:1 every 15 days for two months. This was found to reduce the flower drop and increase productivity in lemon. Vermiwash was also applied on pomegranate plants which had yielded little for two years. When thisvermiwash spray with a 2:1 ratio was used once every 15 days over a two-month period, observation showed an increase in productivity of fruit from 2-3 to 24-25 per plant. Similar improvement was observed in pigeon pea.

Manure tea :

5kg each of the leaves of decomposable legume plants (cowpea, gliricidia, erythrina, pongamia) and compost are mixed with 200l of water. Here, leaves and other biomass, mud and cow dung are placed in layers and allowed to decompose for three months. To this, 200g of jiggery is added and then filtered. This filtrate is used as a foliar spray.When sprayed on growing plants, it increases plant vigour and fruit size in fruit- or vegetable-bearing plants.

Panchagavya :

This growth promoter is a combination of various ingredients, including five cow by-products: 5kg cow dung, 2l milk, 2l curd, 1l ghee, 3l cow's urine, 3l tender coconut, 3l sugarcane juice and 12 decomposed bananas (elakki bale).

The cow dung is mixed with water in a mud pot to make slurry, which is left undisturbed for 21 days. After this, the other materials above are addedand soaked for another five days. The panchagavya is then ready for application.

One litre of panchagavya is diluted with 100l of water and sprayed on crops like tomato, brinjal, chilli, lime, guava, sapota and mango at the flowering stage. It reduces flower drop and enhances yield and quality.

Amruta Sanjeevini :

This is a plant syrup preparedby mixing 10kg of cow dung, 1kg of pongamia/groundnut/neem cake, 2kg of jiggery and 100g of turmeric with 50l of water. After soaking for one week, the mixture can be used on a variety of crops such as plantation, fruit and vegetable crops to improve the quality of the produce.

Homemade Regulator :

This is a nitrogen supplement. The mixture is prepared with 5kg of cow dung and 5kg of leguminous plant leaves soaked in 200l of water. This mixture is kept for three weeks. After bubbles stop forming, it can be applied to the root zones of vegetable crops like tomato, brinjal, lady's finger and chilli.

Vertical Mulching Method :

Under this method, trenchesone foot deep and one foot wide are filled with biomass, cow dung slurry and soil. A distance of 1.5 feet is maintained between each trench across the water slope. These trenches are effective in preventing soil erosion, maintaining good soil moisture and soil structure and retaining nutrients in soil, leading to healthy growth of plants.

8 An Integrated Approach to Institutionalising PCI Initiatives

The importance of partnership between farmers and breeders/agencies/institutions has been increasingly recognised among all the concerned parties since the 1980s. Active collaboration and constant interaction between local people and outside facilitators have resulted in much more sustainable, eco-friendly and culturally acceptable farming systems. Institutionalising PCI initiatives can be undertaken through the following stepwise procedure.

Meeting of PCI Partners – The Beginning of The Process

The relationship between the farmers and other actors along with local networks has to be strengthened. The current situation facing farming systems should be analysed and understood. In addition, social values should also be given due consideration. This is expected to build a care network of breeders and farmers and also strengthen cultural values, which will in turn help in promoting PCI initiatives.

Understanding the Problems and Opportunities

The institutes/development agencies involved in PCI initiatives should identify the indigenous technical knowledge and also the relevant formal knowledge. Specific and pre-tested criteria should be used to screen and select the topics/approaches for further development so that the local resources are optimally used and sustainable systems of production are evolved.

The strongest driving force in any participatory programme is the farmers' own realisationthat the aim of the programme is to address their particular concerns. This will come about when a common understanding of the concerns is arrived at between the users (farmers) and the providers (facilitator agencies). The innovative ideas already existing with farmers need to be nurtured through institutional support to create better opportunities for PCI.

Looking for Alternatives and Approaches to Try/Implement

It is a well-known fact that research and extension agencies are not the sole source of innovation to solve the problems and realise the opportunities identified. It is known, though to a lesser extent, that the farmers and artisans in a community are capable of providing interesting ideas for action plans and follow-up. Depending on the practicability, feasibility and cost-effectiveness of the alternatives raised, the PCI facilitators should evolve a method of experimentation and improvement by systematic screening and constant monitoring. This would hasten progress in any participatory approach.

Experimentation and Implementation

Based on criteria spelled out by the farmers, which are assessed and understood through active association, the facilitating agencies must draw up clear-cut plans and designsfor experiments to be implemented. These should be frequently shared with outside scientists/breeders with a view to effectively improving the methodological procedures based upon proven scientific principles.

A special emphasis and a proper focus is a must to manage and evaluate the experiment at farmer level.The farmersmust be given adequate scope to use their own decision-making criteria by utilising their logic and experience. If the facilitator agencies have created an atmosphere for active involvement of the farmers in the PCI initiatives, it is only natural that the farmers' capacity to adopt

their practices and make continuous improvements will be very powerful. This can be better achieved through skill enhancement, group building, strengthening exchanges and supportive linkages with other useful organisations, training in the experimental techniques, and frequent evaluation of farmers' experiments by regular monitoring and review. These measures and strategies will make the farmers' experimentation more result-oriented.

Sharing the Results: Farmer-driven Extension

The results achieved by adopting the above-explained participatory methodology should be practically feasible and useful to the farming community. The next important responsibility of facilitators/development agencies is to communicate these findings, which have been evolved and developedby their farmer friends, to the local and scientific networks in order to enhance the process of scrutiny and interpretation. In the process, the facilitating organisations will also achieve one more objective, i.e., encouraging other farmers and scientists to adopt and test the results in similar/different circumstances to ascertain their validity.

Another important aspect to be borne in mind while popularising the results of farmer-driven experiments is the need to provide a platform for open discussion and continuous learning through analysis of these results. PCI initiatives also encourage the sharing of a wide range of issues with other farmers through the networks developed in the process, the dissemination of locally developed technologies in an effective manner, and the development of practically feasible methodologies of farmer learning and scientific experimentation. On the whole, these experiences and initiatives will result in better-quality needs-based research on the farmers'

fields and the output of these extension services will be better accepted by the farmers because these approaches have been evolved by farmer-breeders themselves.

Sustaining the Process of PCI

The facilitating agencies and development actors should also make special efforts to create a favourable and friendly atmosphere for farmers' organisations, local institutions and, more specifically, for the innovative inventors/farmer-breeders. This would help inmustering a better support mechanism in association with other partner agencies so that policy-level changes can be brought about. In the long run, this sustained effort can result in the establishment of physical infrastructure and educational enrichment through learning-by-doing facilities to support and strengthen the local experimental capacity in general and nurture the breeding spirit of the innovativefarmers in particular.

Whatever the method or process of the PCI initiative, the facilitator agency must ultimately aim for empowering the individual farmer-breeders and the participating communities with the capability to implement a "continuous and effective process of change". In other words, the PCI programmes must be developed in such a way that experimentation by the farmer-breeders will become a sustainable development mechanism in the local agro-ecological systems. In this whole process of PCI initiatives and empowerment of farmer-breeders, the role of outside facilitators will gradually change; they should then start shifting their attention and priority to other communities/areas/regions by meticulously planning withdrawal strategies. If the facilitator agency has done an effective job, the promoted PCI initiatives will continue to develop, evolve, improve and be sustainable even in the absence of facilitators – this should be the ultimate aim of each and every organisation working on participatory approaches.

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