

# Invest for 'Life in Soils'

10 ways to make 'Living Soils' possible



Revitalising Rainfed Agriculture Network

## Rainfed Soils are 'Thirsty and Hungry'...

**M**uch of life and livelihoods in rainfed areas depend on the quantum of rains that can be harvested and retained in the upper soil profile. Humus in soils holds water to an extent of 4 times to its weight. Sterile and biologically inactive soils cannot sustain life within or outside! Organic matter is essence of life in soils.

The hydrological function of organic matter in soils is important for rainfed agriculture in the context of climate variability and change. There is a secular decline in the use of organic matter, reaching very low levels of about 1.0 tons and 0.8 tons per ha, in case of small and large farmers respectively. The soil organic matter has declined from about 1.43 and 1.21 % in red and black soils in the 1950's to about 0.80 to 0.86 percent respectively at present. As a consequence, the overall response to fertilizers has also come down. In the 5th Five Year Plan, it was 15 kg per kg NPK, which came down to 6.5kg per kg NPK in the 10th Five year plan. In fact, in the case of irrigated cereal crops, it has come down from 13.4 kg in the seventies to 3.7 kg in 2008. A secular decline in the addition of organic matter to soils has led to

increased use of fertilizers, increasing the cost of production. Erosion of life in rainfed soils seriously threaten the long term production base of rainfed areas.



### Why this effort?

Revitalizing Rainfed Agriculture (RRA) Network has under taken field experimentation, documentation, analysis and synthesis of measures to improve soil fertility and organic matter with technical inputs from Central Research Institute for Dryland Agriculture and eminent soil scientists. It is pilot testing a comprehensive program on this issue in 9 sites across 5 states in the country.

This document synthesizes various experiences on ground into a package of 10 modules for action, amenable for government to invest.

The wide variety of options for enhancing soil fertility are elaborated in this document along with the basic issues confronting their adoption and policy measures.

## ..... And they need Investments

In India, about 64% of the fertilizer subsidy is consumed by the four major irrigated crops; paddy, wheat, sugarcane and cotton. The fertilizer subsidy per ha of gross cropped area in an irrigated state like Punjab (Rs.3924 per ha in 2007-08) is much higher than the rainfed state like Rajasthan (Rs.824/ ha) or Orissa. To be equitable, the rainfed areas need investments in organic matter than chemical fertilizers alone. Such investment is also important in the context of preparing rainfed agriculture to survive the vagaries of climate change.

### Specific Context of Rainfed Agriculture

Soil organic matter performs Hydrological, Biological and Nutrient related functions, which are both interrelated and distinct. The soil fertility discussions/ investments, including bio-fertilizers, so far, have been focused on the nutrient functions. Hydrological functions of soil organic matter have greater significance in rainfed agriculture as it is crucial for soil moisture retention to tide

over dry spells and for reducing runoff. Soil moisture and organic matter is essential even for improving the efficiency of biofertilisers and chemical nutrients. The returns on investments on soil and moisture conservation in watershed development will be substantially improved with complementary investments on soil organic matter as more moisture can be harvested and held in the soil profile for a longer time.

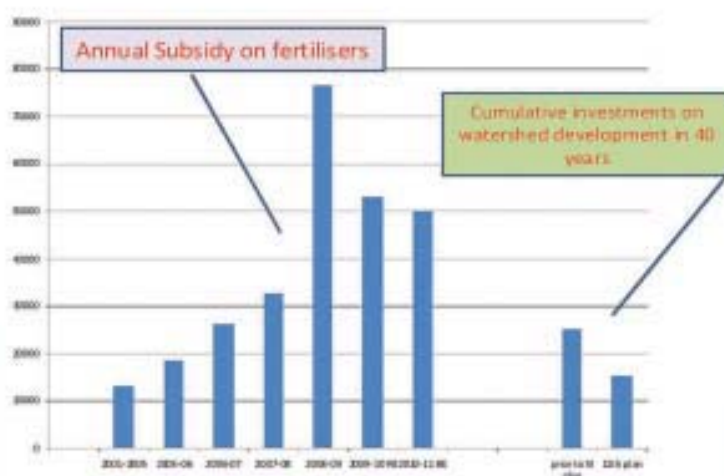
### Rationale for Investments

India today faces a food security crisis due to stagnation in our agriculture – both irrigated and rainfed. The poor health of the soils lies at the core of this stagnation – brought about by rampant overuse of fertilizers in irrigated India, and abysmally low investments in rainfed India.

Watershed development over the past three decades has partially helped stem the loss of soils in rainfed areas, but the absence of humus is still a constraint in increasing the productivity. The

cumulative investments on watershed development over the last thirty years is less than half of the annual fertilizer subsidy (see figure 1).

Even the watershed development programs have not invested on soils beyond its conservation! The 12th Five Year Plan therefore, needs to create a separate dispensation specifically aimed at enhancing organic content in soils.



## 1

## Improving Quantity and Quality of FYM/Compost at Homesteads

**F**arm Yard Manure (FYM), compost and vermi compost are under this genre. The value of compost is not in its major nutrients but in its role in stimulating microbial activity in the soils and in improving soil properties. Vermi composting though widely promoted, needs relatively greater care, moisture and labor. It can be promoted for value added crops. But it is important to promote bulky organic manures that can be prepared nearer to the rainfed lands, with little moisture and labor. Improvement in methods of field application of manures can further improve yields with limited quantities.



Dung from livestock is commonly heaped nearer to the homesteads or cattle sheds along with household waste, bedding material in the sheds and littered fodder. The poor quality manure heaps contain low levels of N (0.5 to 1.0%), P (0.2 to 0.3%) and K (0.5 to 1.0%). Proper composting can potentially increase the quality of manure and its nutrients. With proper methods of composting, for each household having two animals, the total manure production can be increased from 4 to 5 tons (an increase by 25%).

### Issues in Composting/ FYM

- ❖ Normally dung to biomass ratio is high (*as most of the material is dung*)
- ❖ When C:N ratio is high, decomposition is low
- ❖ Low moisture levels, resulting in poor decomposition
- ❖ Lack of space and shade
- ❖ Heaping is mostly in low lying areas without proper drainage
- ❖ Enriching quality of manure

### Areas for Action and Public Investment

- ❖ Add more biomass directly, or as bedding material
- ❖ Maintain C:N ratio in the range of 30-40:1
- ❖ Support large scale knowledge transfer
- ❖ Application of water regularly to maintain around 60% moisture
- ❖ Support for watering and overturning of material with centralized operational mechanisms
- ❖ Provide land for compost pits (*individually or collectively*), with proper shade, drainage, and watering facilities
- ❖ Systematize compost making in every Gram Panchayat by allocating land for composting
- ❖ Ensure hygiene and proper decomposition with proper drainage
- ❖ Establish urine collection facilities in the sheds; Support for infrastructure for collection of urine in cattle sheds.
- ❖ Inoculation with PSB; provide PSB at subsidized rates
- ❖ Quicken the decomposition and enrich the nutrient value by addition of powdered mussoorie rock phosphate.

*Promote bulky organic manures.. with little effort and few incentives!*

## 2

## Biomass based Manure Generation

**G**reen leaf and crop residues are in this category. Earlier green leaf was generated from forests and common lands. As these areas are shrinking, biomass production for soils need to be integrated into the farm lands (on field bunds, boundary rows etc). Intensifying biomass production in various types of common lands and degraded forests can further enhance its availability. Producing compostable biomass *in situ* reduces the cost of transport. Experience has shown that with centralized watering services, each acre of farm land can potentially produce two tons of manure annually. It only requires regular support/ provision of 15 labor days per acre. This support will go a long way in building up a healthy 'living soils' base for vibrant production systems in rainfed areas.



The green biomass from Gliricidia plants (about 1500 plants on bunds at a spacing of 0.5 m) will provide about 25-30 kg N per ha, and also improves physical properties of soil over a period of time.

### Issues

- ❖ Lack of sources of biomass, the biggest constraint
- ❖ Managing biomass and crop residues
- ❖ Lack of compost facilities in farm lands
- ❖ Lack of watering facilities
- ❖ Higher transport costs of carrying biomass

### Areas for Action and Public Investment

- ❖ Biomass plantation in the common lands, on the field bunds and around the compost pits.
- ❖ Green manure crops such as sunhemp and Daincha on the field bunds and in boundary rows.
- ❖ Green manure crops with a crop holiday in rainfed lands.
  - ❖ Supply of seeds of green manure crops before monsoons
  - ❖ Weeds (before seeding) and crop residues to be composted instead of burning or throwing out.
- ❖ Establish at least one compost pit per acre with a volume of 12 cum with shade.
- ❖ Support for digging compost pits and biomass plantation and enriching compost
- ❖ Support watering, as a common service where farmers do not have *in situ* access to water.
- ❖ Support local transportation of biomass to composting facilities



Adequate biomass for soils can be generated easily, provided we invest on it!



# 3

## Green Manures and Cropping Systems

**R**ainfed crops have few options of growing green manure crop, as main crops are sown with first rains. Promotion of a grain crop holiday in rainfed lands for raising green manure crops in the monsoons and their incorporation into the soils is the need of the hour. Green manure (legumes) crops when integrated as intercrops, would add about 1.5 to 3 tons/ ha of fresh biomass *in situ*. Studies have shown that legume intercrops can add 0.30 to 2.4 tons of leaf litter per ha even in a drought year; with 4.1 to 35.6 kg N per ha.

### Issues

- ❖ Non availability of specific lead time for green manure crops, as rainfed crops need to be sown with rains
- ❖ Non-availability and high cost of quality green manure seeds
- ❖ Incorporation of green manures
- ❖ Legume intercrops, a traditional practice in the rainfed areas across the country, is being fast replaced by mono-cropping.
- ❖ Non-availability (time, quality and high cost) of seeds of intercrops
- ❖ Higher costs of (manual) weeding in inter crops

### Areas for Action and Public Investment

- ❖ Promotion of Green Manures as intercrops
- ❖ Suitably including a pulse crop rotation within or across year depending on the moisture regimes
- ❖ Establish green manure seed production and supply systems, for timely supply of quality seeds at affordable cost
  - ❖ Incentivize farmers taking up green manure crops
  - ❖ Develop appropriate implements / machines.
  - ❖ Incentivize legume inter crops rather than subsidizing chemical fertilizers
  - ❖ Establish local intercrop seed supply systems for timely supply of quality seeds at affordable costs
  - ❖ Provide incentives to labor to offset higher weeding costs



*Incentivise farmer to build life in soils instead of making them sterile*

## 4

## Concentrated Manures

**C**oncentrated manures are less bulky but with high nutrient content. Unlike bulky manures, decomposition and release of nutrients in concentrated manures is faster. Commonly used concentrated manures are oil cakes (Neem, Pongamia, Castor, Groundnut etc), meal group manures (Blood, horn and fish meals), poultry and small ruminants manure.

Oil cakes, the residues after extraction of oil from seeds, are quick acting water insoluble, concentrated organic manures with N ranging from 2.5 to 7.9%, P from 0.8 to 2.9% and K 1.2 to 2.2%. Nutrients from the oilcakes are made available through decomposition by micro organisms. The edible and non-edible oil cakes, though costly, provide a good source of nutrients and also improve soil properties.



### Issues

- ❖ High cost and non-availability in sufficient quantities in time
- ❖ Competitive use for oil cakes as animal feed

### Areas for Action and Public Investment

- ❖ Establishment of suitable supply systems to make quality manures available in time at reasonable prices
- ❖ Establishment of decentralized oil-expellers increases local availability of oil cakes
- ❖ Tie ups with oil milling industries (both local and industry units) to meet the need of oil cakes
- ❖ Linkages with slaughter houses



*Establish systems to enable nutrient flows between agriculture/ industry/ cities*

## 5

## Soil Amendments

**S**oil amendments improve the physical and chemical condition of the soil. They influence plant growth favorably by increasing nutrient availability either by altering soil reaction or by changing nutrients from non-available to available form. Silt from water bodies like tanks is a precious amendment for marginal soils. Application of at least 10 tonnes of tank silt per acre once in 3 years increases soil productivity considerably. Press mud, a by-product of sugar industry, is another option. Lime in acidic soils and Gypsum in alkaline soils are the common amendments. But, application of these is generally constrained by local availability.



### Issues

- ❖ Silt application is expensive which involves removing silt, transportation and application
- ❖ Soil amendments such as Gypsum are expensive and are not easily available
- ❖ Support available is ad hoc and irregular

### Areas for Action and Public Investment

- ❖ Support silt removal from water bodies (for digging and loading / transport) and its application, wherever appropriate.
- ❖ Priority must be given to poor and marginal rainfed lands.
- ❖ Identification of areas clearly where such amendments are required
- ❖ Establishment of suitable supply systems and sharing of costs
- ❖ Cost sharing in the reclamation of problem soils

## Livestock Penning

**P**enning of sheep and cattle is a traditional practice that is founded on a historical relation between pastoralists and farmers. It is more common along the long grazing routes of the pastoralists. The addition of organic matter depends on the number and duration of stay.

Promoting livestock population integrated into the agriculture system contributes to healthy soils. Investment on livestock needs to be a part of an overall program of soil revival.

## 6



### Areas for Action and Public Investment

- ❖ Recognize the role of pastoral systems in maintaining soil productivity in rainfed areas and institute supportive policies for strengthening such systems

### Issues

- ❖ Many hindrances to pastoral systems

*Livestock is the lifeline of agriculture that converts biomass into soil nutrients*

## Supplemental Measures

The following measures generally supplement application of bulky organic manures to the soil by improving the microbial activity in the soils and stimulating plant growth. These however, can never substitute for addition of soil organic matter, which must remain the principle focus in soil regeneration efforts.



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### Bio Fertilizers

'Bio fertilizers' are substances with living microorganisms that are applied to seed, plant surface, or soil. Bio fertilizers add nutrients through the natural processes of nitrogen fixation, solubilising phosphorous and stimulating plant growth through the synthesis of growth promoting substances.



8

### Liquid Manures

Prepared out of local material and with simple knowledge, liquid manures have immense potential in improving crop nutrition. Formulations such as Panchagavya, Jeevamrutam are gaining scientific acceptance and popularity. These formulations have multiple contributions in terms of increasing the microbial activity in the soils, stimulating plant growth and nutrient supplementation.

## Issues

- ❖ Availability of quality bio fertilizers and liquid manures and their higher costs

## Areas for Action and Public Investment

- Promoting decentralized production of biofertilisers with quality assurance/ control systems
- Establishing quality parameters, process standardization, large scale knowledge transfer, promotion and development of local enterprises



9

### Mulching and Reduction in the intensity of tillage

Mulching protects the soil from evaporation of surface moisture, preserve and add to organic matter in soils in addition to improving soil properties. Less intensive tillage protects organic matter in the soil by preventing exposure to heat and consequent disintegration.



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### Soil and Moisture Conservation

Soil and moisture conservation is the backbone for improving soils and must precede any efforts on improving soil quality or productivity. The watershed development and employment generation programs are investing on these.

## 'Organic Matter is Possible'

A summary of the potential for biomass production from various options in rainfed areas demolishes the myth that 'organic matter is impossible'. The data below, taken from several field experiences, proves that generation of 'organic matter is possible'.

Potential quantity of manure that could be generated on and off the farm (kgs/ acre)

S.No	Biomass source	Biomass produced per year	Remarks
1	Composting at homesteads (Kgs / household)	4000 to 5000	• Households with minimum of 2 cattle with higher biomass to dung ratio
2	Biomass based manure at farm level (Kgs/ acre)		
a	Glyricidia / Cassia siamea (200 per acre) planted on bunds and around compost pits	3000 to 4000	• 30 Kgs / plant /year-From 5th year after planting (2 to 3 loppings) • Plantation at a spacing of 0.5 m.
b	Sunhemp sown on bunds/ borders	350	• @ 1.3 Kgs/ sqm. 50% cover across the bunds of about 280 m length.
c	Biomass yielding trees per acre, either in the farm lands or in common lands or private fallows	450	• 2 loppings of pongamia/ neem/ or other plants • @ 150 kg per tree/ year
d	Weeds	200 to 300	• Collection of weeds
e	Crop residues	500 to 1000	
f	Legume inter-crop	500	
	<i>Total farm based fresh biomass</i>	<i>4000 to 5000</i>	<i>• A moderate figure</i>

The ground experiences synthesized into this hand-out by the RRA network indicates the potential. Many of them are indigenous practices. Stagnant and low farm incomes, higher cost of labor has moved farmers away from such practices. Comprehensive, adequate and flexible public investments with appropriate incentive and facilitation structures can make these practices viable and affordable over a wide range of rainfed landscapes in the country.



