On-farm participatory activities for soil fertility improvement and belowground biodiversity conservation- An ex-ante evaluation

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Ex-ante evaluation is a process that supports the preparation of proposal for new actions. Its purpose is to gather information and carry out analysis that helps to define objectives, to ensure that these objectives can be met, that the instruments used are cost-effective and that reliable later evaluation will be possible. This method of evaluation has been effectively used for developing several projects in different fields. Thus an attempt has been made on ex-ante evaluation to formulate proposals for on-farm participatory activities for soil fertility improvement and belowground biodiversity conservation in the Kerala part of Nilgiri Biosphere Reserve. Ex ante evaluation may be done as in-house work, by a team including members from the responsible operative unit(s), project implementers and representatives from the line departments. In the study area, the ex-ante evaluation process involved four meetings where the participating farmers, project team members and representatives the agriculture department participated. Each meeting was designed to collect adequate information on the points listed below:

a) Problem analysis and needs assessment

- What is the problem to be solved and what are the main factors and actors involved?

b) Objective setting

- Have the general, specific and operational objectives been defined in terms of expected results?
- What indicators are planned for measuring inputs, outputs, results and impacts?

c) Alternative delivery mechanisms and risk assessment

- What alternative instruments were considered and why was the proposed one chosen?
- What risks are involved in the implementation of the intervention and what countermeasures have been taken?

d) Added value of Community involvement

- Is the proposed intervention complementary to and coherent with other interventions?
- Does it produce synergies with them?

e) Lessons from the past

- What evaluation, audit or study results/experiences of similar actions are available?
- How can these be applied to improve the design of the programme?

f) Planning future monitoring and evaluation

- Are the proposed methods for collecting, storing and processing the follow-up data sound?
- Is the monitoring system fully operational already from the outset of the programme implementation?
- What types of evaluations are needed and when should they be carried out?

During each meeting following salient results of the first phase of the Project conducted in agricultural and agroforestry landuse systems in the Kerala part of Nilgiri Biosphere Reserve were explained.

1. In the cultivated lands indicated that organic carbon, exchangeable calcium, magnesium and potassium were considerably lesser than the level required for the optimum crop yield.
2. Application green leaf manure, farmyard manures, cultivation of cover crops are not adequate to sustain the crop yield and soil fertility.
3. Over-harvest of biomass without sufficient nutrient input is leading to the loss of nutrients from the crop lands.

4. Application at frequent interval of heavy dose of chemical pesticides into croplands can be attribute to the loss of below ground biodiversity.
5. Some of the faunal characteristics are either absent or sparsely represented in the of a given landuse systems.

The participants agreed the fact that continuous cultivation without external application of organic manures and without conserving the organic matters in the systems is identified as the reason for low productivity and soil organic matter depletion in different cropping systems. Farmers also identified that the competition between the weed community and crop community is another important cause for difficulty in maintaining the optimum crop yield. In the Landscape of Chaliyar River watershed, the study recorded a faster rate in landuse and land cover changes. The farming community also expressed the view that the conversion of one cropping system to another is more frequent resulting in the increased soil erosion and runoff rates. Further to this, the team has identified three activities for on-farm participatory experiments namely a) application of green leaf manure, b) application of plant growth promoting microorganisms and earthworm rich compost, and c) growing leguminous/biomass transfer species to reduce the weeds in the crop lands. The purpose of these on-farm experiments was to demonstrate the usefulness of these strategies and also disseminate information and technology to the wider user group. In order to assess the need and feasibility of each of the above mentioned on-farm experiments, ex-ante evaluation was conducted and the result of the evaluation is given below:

Activity1. Grow leguminous/biomass transfer species

Problem analysis and assessment	
1. What is the problem to be solved	Weeds in the croplands are leading to poor crop yield and crop cultivation un-economical.
2. What are the main factors involved?	• First phase of the study indicated that weed biomass in the crop lands ranged from 6,000 – 9,000 kg ha^{-1}. • Estimated cost for weeding is about Rs. 4,000/- ha^{-1} yr^{-1}. • Often harvested weed biomass cannot be incorporated directly as they re-sprout and spread and compete with the major crops fro water, nutrients and light. • Low under-storey coverage generally leads to poor biological activities, litter decomposition and nutrient cycling.
3. Who are the concrete target group?	• Homegardeners who are unable to manage weeds in their garden. • Coconut, arecanut, teak, cashew, and rubber growers
4. What are its needs/interests?	• Replace weeds with suitable leguminous/biomass transfer species which are economically beneficial to them and at the same time improve the soil fertility and crop yield
Objective setting	
1. General objective	✓ To replace weeds with suitable cover crops in different farming systems for improving soil productivity and crop yield
2. Specific objective	✓ To quantify the productivity of useful leguminous/biomass transfer species in the available land area by replacing weeds.
3. Operational objective	✓ To demonstrate the effects of replacement of weeds by leguminous/biomass transfer species in terms of changes in soil organic matter (SOM) content and diversity and population of earthworms, termites and micro flora.

Activity1. Grow leguminous/biomass transfer species (cont'd)

Alternative delivery mechanism and risk assessment		
	Alternative methods	Effects
1. What alternative instruments were considered?	Non-weeding	Leads to intensive competition with crops and reduce the crop yield and may also cause changing belowground biodiversity due to exotic weed dominance. Many useful species particularly when unmanaged may become alternative host for pests and disease causing organisms of major crops
	Weedicide application	Since the different landuse systems in Kerala are intermixed without differentiation between the residential area and cultivating area, weedicide application will have harmful effects not only on belowground flora and fauna but also on livestock and human beings.
	Physical weed removal	Expensive particularly due to poor/non availability of labourers.
	Growing additional/secondary crops	Farmers are not interested to cultivate additional or secondary crops due to lack of time and high cost of labour.
	Note: Considering all these drawbacks of the alternative methods of weed management, cultivation of leguminous/biomass transfer species is selected.	
2. What are the risks involved in implementation?	Risks	Counter measures
	1. Farmers' disinterest in participating to implement the activity.	Arrange formal and non-formal meetings to ensure farmers participation by clearing their doubts related to the activities.
	2. Non acceptance of species (leguminous/biomass transfer species) by the farmers	Conduct formal and informal meetings to provide information on growth pattern and usefulness of the species based on available data.
	3. Sustainability of cultivation of leguminous/biomass transfer species.	Select species which are known for their better growth, biomass production and nutrient release without adversely affecting main crops. Select species which are easily available and propagate with less expenditure.
	4. Competition of leguminous/biomass transfer species with major crops	Species known for their synergetic effects with major crops are selected. Ensure planting design which will reduce any kind of competition between leguminous/biomass transfer species and major crops.

Activity 1. Grow leguminous/biomass transfer species (cont'd)

Added value of community involvement	Traditionally, the farming community in Kerala aware the importance of ground cover enrichment in order to reduce the weed growth and also to improve the soil fertility. Thus, during the proposed intervention, one can expect more practical inputs and knowledge from the farming community for the successful implementation of the programme.	
Lessons from the past		
1. What evaluation/study results/ experiences of similar actions are available?	Farmers are successfully cultivating *Calapagonium mucunoides* in rubber plantations and *Sesbania aculeata* in paddy fields in order to control weeds and also improves the soil fertility	
2. How can these be applied to improve the design of the programme	In the Kerala, different cropping systems such as mixed species rich homegardens, single species rich homegardens, polyculture farmlands, monoculture plantations like coconut, arecanut, teak, rubber etc. are seen. However, cultivation of leguminous/biomass transfer species for weed control has not be attempted so far.	
Planning future monitoring and evaluation	A Table showing output results and impact indicators which will be useful for future monitoring and evaluation is given below	
Output indicators	**Result indicators**	**Outcome/impact indicators**
1. Participant farmers are selected	A list of participant farmers is available	Participants are involved in implementing the activity
2. Farms are selected for on-farm experiment	Area, cropping system/pattern, vegetation data are available	Activity are initiated in the field
3. Selection of leguminous/biomass transfer species	A list of species selected and approved by the farmers to cultivate is available	Species are planted
4. Monitoring of growth and yield of planted species	Data on growth, land coverage and biomass production of planted species are available	Farmers identified suitable species for different farming systems
5. Weed biomass indicators	Data on growth, land coverage and biomass production by the weed species area prior to experiment and after the experiment are available	Reduction in the area covered by weeds. Satisfaction expressed by the target group/s
6. Characterisation of farms for soil organic matter	Data on SOM in weedy area and area cultivated with leguminous/biomass transfer species are available	Soil organic matter contents in the experimental plots enhanced considerably
7. Study on soil flora and fauna	Quantitative information on diversity and abundance of selected soil flora and fauna are available	Change in composition and diversity in soil flora and fauna

Activity 2. Application of microbial and earthworm rich compost

Problem analysis and assessment		
1. Problem to be solved	Crop productivity is declining	
2. What are the main factors involved?	• Changing pattern of cropping systems leading to soil erosion, nutrient run-off and loss of soil organic matter • Soil organic matter content in the soil is reasonably poor to sustain crop yield	
3. Who are the concrete target group?	• Homegardeners, coconut, arecanut, teak, cashew, and rubber growers who are facing the problem of poor yield due to poor soil quality	
4. What are its needs/interests?	• Improve the soil fertility and belowground biodiversity with an aim to optimal crop yield.	
Objective setting		
1. General objective	✓ Sustain the soil fertility for obtaining sustainable yield	
2. Specific objective	✓ Explore the possibility of utilizing microbes and earthworm rich compost to improve the soil fertility	
3. Operational objective	✓ To demonstrate the preparation of nutrient rich compost using microbes and earthworms ✓ To demonstrate the benefits of microbes and earthworm rich compost in building up soil organic matter (SOM) content.	
Alternative delivery mechanism and risk assessment		
	Alternative methods	**Effects**
1. What alternative instruments were considered?	Vermi-composting	It is comparatively a slow process
	Application of cow dung and other organic wastes.	Non-availability of materials Direct application of dung and organic waste may enhance weeds, pests and diseases.
	Direct application of green leaves and other materials	Scanty availability d materials are scanty. Most available materials are slow decomposing and nutrient release is slow. Besides, complete decomposition in field condition is difficult.
	Note: Considering the drawbacks of the alternative methods, it was decided to inoculate microbes to bio-waste and after partial decomposition, to inoculate earthworms to obtain nutrient rich compost materials.	

Activity 2. Application of microbial and earthworm rich compost (cont'd)

2. What are the risks involved in implementation?	**Risks**	**Counter measures**
	1. Farmers' disinterest in participating to implement the activity.	Arranged formal and non-formal meetings to ensure farmers participation by clearing their doubts.
	2. Non acceptance of the method	Conducting formal and informal meeting to provide information on the usefulness of the combined effects of microbes and earthworm in producing nutrient rich compost.
	3. Ease and fastness of the method	Selected microbial species are known for their better multiplication and tide over extreme conditions. Earthworm selected are common species are well accepted for their good fecundity rate, fast composition and high nutrient content
	4. Mechanical or physical damage to the organisms used for composting.	Worm pits are made in safe places and appropriate measures are taken against the attack of predators
Added value of community involvement	Farming community in Kerala knows the beneficial effects of composting waste materials and applying it in the field to improve soil fertility and also optimal use of their land. Thus, the proposed intervention, which will be an improved version of the general practice of composting, is expected to get ideas and knowledge for its successful completion.	
Lessons from the past		
1. What evaluation/study results/experiences of similar actions are available?	Farmers are successfully composting organic/kitchen waste for their local use. Many firms are supplying vermi-compost commercially.	
2. How can these be applied to improve the design of the programme	In the Kerala, different cropping systems such as mixed species rich homegardens, single species rich homegardens, polyculture farmlands, monoculture plantations like coconut, arecanut, teak, rubber etc. are seen, and may farmers locally making compost in their home for their local needs. However, microbial and earthworm rich composting technique has not be attempted so far.	

Activity 2. Application of microbial and earthworm rich compost (cont'd)

Planning future monitoring and evaluation	A Table showing output results and impact indicators which will be useful for future monitoring and evaluation are given below:	
Field of intervention: microbial and earthworm rich compost		
Output indicators	Result indicators	Outcome/impact indicators
1. Participant farmers are selected	A list of participant farmers are available	Participants are involved in the implementing activity
2. Different farms are selected	Area, cropping system/pattern, vegetation data are available	Activity are initiated in the field
3. Selection of microbes and earthworms	A list of species selected and approved by the farmers to cultivate is available	Species are ready for use
4. Monitoring the rate of decomposition by microbes	Data on duration for partial decomposing rate are available	First part of decomposition is completed
5. Monitoring the rate of decomposition after inoculating earthworms	Data on duration for complete decomposing rate are available	Nutrient content, time for decomposition etc. are available.
6. Nutrient status of the compost	Quantitative data on pH, N, P, K and organic carbon are available	Improvement in the nutrient status of the compost when compared to that of the conventional compost
6. Characterisation for soil organic matter in farms for which the compost is incorporated	Data on SOM in control (compost not incorporated) plots and in plots where the compost is incorporated are available	Soil organic matter contents enhanced considerably in the experimental plots
7. Study on soil flora and fauna	Quantitative information on diversity and abundance of selected soil flora and fauna are available	Change in composition and diversity in soil flora and fauna

Activity 3. Green leaf manure application

Problem analysis and assessment	
1. Problem to be solved	Crop productivity is declining
1. What are the main factors involved?	• In the Study area, about 30% of the farmers apply about 1,000 - 6,250 kg ha^{-1} yr^{-1} of green leaf manure as a method of nutrient input to their crop lands. However, due lack of information on the quality, nutrient status, decomposition rate and nutrient release pattern, farmers are not sure that whether they are using as mulch a right combination leaves of different species, mulching is done during right cropping period and there is synchrony between nutrient release from mulch and nutrient absorption by crop plants.
3. Who are the concrete target group?	• Homegardeners, coconut, arecanut, teak, cashew, and rubber growers who are facing poor crop productivity due to poor soil quality
4. What are its needs/interests?	• Improve the soil fertility, crop yield by using the right combination green leaf manure
Objective setting	
1. General objective	✓ Sustain the soil fertility for obtaining sustainable yield
2. Specific objective	✓ To demonstrate improved soil conditions by the application of locally available green manure species. ✓ To understand the rate of decomposition of green leaf manure species supplied at different combinations, release pattern of different nutrients from the green leaf manure and measure the soil fertility by estimating the particulate organic matter (POM) content at regular interval after the green leaf manure application.
3. Operational objective	✓ To demonstrate the effectiveness of green manure species in increasing soil organic matter and soil micro-flora and fauna.

Activity 3. Green leaf manure application (cont'd)

Alternative delivery mechanism and risk assessment		
	Alternative methods	**Effects**
1. What are alternative instruments were considered?	Enhance the quantity of green leaf manure to be used for mulching	Desired results may not be obtained if the quantity of mulch is increased without considering the right combination of leaves of green leaf manure species.
	Use coconut husk/cow-dung etc.	Imbalance in the status of different nutrients the soil could be possible
	Use chemical fertilizers	Imbalance in the status of different nutrients the soil could be possible. Economically loss due to use of external nutrient input instead of using nutrient sources available within the system.
	Note: Considering the drawbacks of the alternative methods, it was proposed to identify the right quantity and combination of leaves of a set of green leaf manure species the right combination of locally available green manure species	
2. What are the risks involved in implementation?	**Risks**	**Counter measures**
	1. Farmers disinterest in participating to implement the activity.	Arrange formal and non-formal meetings to ensure farmers participation by clearing their doubts
	2. Non availability of leaves of a set of green leaf manure species	Ensured to select green leaf manure species whose leaves are available easily and locally
	3. Improper selection of species	A list of potential green leaf manure species will be prepared. Available information, including traditional knowledge about the quality of the leaves of these species in terms of nutrient status and decay pattern will be collected. A set of species will be chosen in discussion with the participant farmers

Activity 3. Green leaf manure application (cont'd)

Added value of community involvement	Farming community in Kerala has the tradition of using green leaf as mulch in different farming systems with aims to increase the crop yield and sustain the soil fertility their crops and also sustain the soil fertility. Since the present on-farm activity is aimed to give scientific input into the traditional practice, community involvement will be beneficial both to the successful implementation of the programme and demonstrate the results of the experiment to a wider farming community.
Lessons from the past	
1. What evaluation/study results/experiences of similar actions are available?	Farmers are successfully using green leaf manure species like *Eupatorium odoratum*, *Artocarpus heterophyllus*, *Calicopteris floribunda*, *Gliricidia sepium*, *Macaranga peltata*, *Mangifiera indica* and *Terminalia paniculata* for enriching the soil nutrient.
2. How can these be applied to improve the design of the programme	In the Kerala, different cropping systems such as mixed species rich homegardens, single species rich homegardens, polyculture farmlands, monoculture plantations like coconut, arecanut, teak, rubber etc. are seen, and these green manure species are commonly growing in these farms may farmers locally making compost in their home for their local needs. However, application of different combination of green manure species has not attempted so far.
Planning future monitoring and evaluation	A Table showing output results and impact indicators which will be useful for future monitoring and evaluation are given below:

Field of intervention: Green leaf manure application		
Output indicators	Result indicators	Outcome/impact indicators
1. Participant farmers are selected	A list of participant farmers are available	Participants are involved in the implementing activity
2. Different farms are selected	Area, cropping system/pattern, vegetation data are available	Activity are initiated in the field
3. Selection of green manure species	A list of species selected and approved by the farmers to cultivate is available	Species ready for use

Activity 3. Green leaf manure application (cont'd)

4. Monitoring the rate of decomposition of green manure leaves	The rates of decomposition and nutrient releases both for individual and a combination of green leaf manure species are available	A set of species which have the ability to release nutrient synchronizing with the crop yield are identified.
5. Nutrient status of the compost	Quantitative data on pH, N, P, K and organic carbon are available	Improvement in the nutrient status of the compost when compared to that of the conventional compost
6. Characterisation for soil organic matter in farms for which the green leaf manure is incorporated	Data on SOM in control (green leaf manure not incorporated) plots and in plots where the green leaf manure is incorporated are available	Soil organic matter contents enhanced considerably in the experimental plots
7. Study on soil flora and fauna	Quantitative information on diversity and abundance of selected soil flora and fauna are available	Change in composition and diversity in soil flora and fauna

Conclusion

The ex-ante evaluation has been performed by adopting a participatory approach aiming at the pro-active involvement of different actors, and a dialogue-oriented relationship among the evaluator and the various stakeholders. The evaluation process is successful as it has ensured a close co-operation and an effective dialogue with the stakeholders for implementing different on-farm experiments to demonstrate the effectiveness of different soil fertility improvement methods both for sustainable yield and conservation and management of belowground biodiversity.