How can research and development help upland farmers to improve their farming system? Experiences in Participatory Technology Development

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Abstract

The vast amount of marginal sloppy land available in Nepal is greatest challenge for research and development interventions. These areas are typically remote in access, marginal in agricultural production, lack cash generating opportunities. Soil erosion and land degradations have been a serious concern. In last few years, various technologies found to be effective in conserving soil and water, enhancing soil fertility and increasing crop production. However, inadequate consideration of farmers' local knowledge and resources, and poor participation of farmers in the research process resulted in low adoption of such technologies. As a result researchers are now given priorities to the farmers in the whole process of the technology generation.

This paper is based on the experiences of the research project aiming to identify integrated agricultural technological packages suitable for slopping land areas of Nepal. Participatory Technology Development (PTD) approach was used in the project to generate appropriate technological packages on soil and water management which will enhance food production and on-farm cash income. Paper examines the various agricultural technological packages identified, tested and adopted by research farmers. Participatory contour hedgerow, intercropping of legume with maize, mixed vegetable farming, strip cropping, forage and fodder production and other support mechanisms are some of the interventions. Various Participatory methods were used along with soil depth measurement and soil sample analysis. Farmers have tested these technologies and modified them according to their need and species adoptability. The initial results demonstrate the effectiveness of contour hedgerows in increasing the nitrogen content of soil, improving soil texture, soil deposition and maintaining the soil pH. It has been observed that the technology is promising in biomass production, promoting species diversities and providing economic benefit to farming households. Adoption and Adaptation of the technology is taking place gradually in the research and near by sites. Some of the government line agencies had already mainstreaming these technological interventions in their annual work plan. However, there is still a need of coordination and linkage among different stakeholders with possible mechanism for its wider scaling.

Key Words: Shifting cultivation, Participatory Technology Development, Participatory approaches, Contour hedgerows, Effectiveness of contour hedgerows, Adoption and Adaptation, Scaling.

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1. Introduction

The vast amount of marginal sloppy land available in Nepal is greatest challenge for research and development interventions. Marginal and sloppy lands have been over exploited and misused leading to increased poverty, soil degradation and loss of natural resources (Annual Report/NARC 2000).

Shifting cultivation, locally known as Khoria, is the predominant agricultural practices in many hill districts of Nepal. Regmi *et al.* (2003) shows that this practice is prevalent in 20 districts of Nepal and is typically remote in access, marginal in agricultural production, lack cash generating opportunities and are inhabited by very resource-poor farming communities mostly of indigenous ethnic origin. The study done by Sharma and Khatri (1995) pointed out that slash and burn reduces vegetative covers from the fields and increases rate of soil erosion.

Shifting cultivation is a traditional farming system practiced by Chepang ethnic groups of Nepal from the centuries. In traditional system, farmers used to cultivate 2-4 years until the land become infertile. As soon as the crop productivity decreases, farmers abandon the area and clear another patch of forest to grow their crops. The average fallow period between two subsequent slash and burn used to be a 10-15 years as against 1- 3 years at present. Increased population pressure combined with poor management of common lands and increased cropping intensity on land traditionally left fallow for winter grazing has put pressure on forest and grazing resources resulting in degradation (Carson 1992). Cropping on the hill slopes is not possible without livestock and forestry inputs. Livestock provide manure and draught power and forests supply fodder, fuel and timber which results in an integrated system of nutrient flows (Pokhrel 1997).

Chepang, are regarded as the most marginalised and resource poor ethnic group in Nepal. The study done by Balla *et al*. (2000) shows that about 47% of the total populations in the area are Chepang with only 3% of the farmers enjoying food surplus while more than 85% suffer from varying degrees of food deficiency). During the food scarcity period, those farmers depend largely on wild foods like Githa (*Dioscorea bulbifera*), Bhyakur (*D. daltoidea*), Chiuri (*Bassia bytiracea*), Ban tarul (Dioscorea spp), Neuro (Thelopteris spp) (Aryal 2004). In the other hand ownership of land is the big problem as they do not have land registration certificate.

There are various technological options, commonly known as Sloping Agriculture Land Technology (SALT), have been researched internationally and proposed for such areas. In Nepal, ICIMOD and NARC have been instrumental and active for testing various SALT options for last few years and have found that these technologies are effective in conserving soil and water, enhancing soil fertility and increasing crop production. However, adoptions of such SALTs by hill farmers have been very poor and limited, and not quiet appealing to the farmers (Pratap and Watson 1994; Tang Ya 1999). The identified technologies are found less attractive to the farmers since whole research process was managed and controlled by researchers (Maskey 2001). In the other hand, inadequate consideration of farmers' local knowledge and resources, and poor participation of farmers in the research process are regarded to be the main reasons for the poor adoption rate of these technologies in the farmer's field (Carson 1992). This scenario put more emphasis in identifying technological packages that are capable to reduce soil erosion and increase soil fertility thus increase in production to improve the livelihoods of marginal farmers.

There has been some realization in reviewing the past initiatives and developing new methodology and approaches to deal with the aforementioned issue. Based on the experiences, participatory technology development approach look very promising and significant to address the adoption and adaptation challenges faced in past initiatives. It was also realized that the increasing problem of soil fertility loss and soil erosion in sloping and shifting land areas need to be addressed quickly and the potential option could be explored jointly with farmers. Considering this field realities, LI-BIRD in financial support from Hill Agriculture Research Project (HARP/ DFID) has implemented three years pilot project in two mid hill districts Gorkha and Tanahun of Nepal. The main purpose of the project was to increase the sustainability of agricultural production by promoting integrated technological packages for enhanced food production and on-farm cash income. Participatory contour hedgerow with a wide range of hedgerow and fruit species, intercropping of legume with maize, mixed vegetable farming, strip cropping, forage and fodder integration with livestock are the interventions promoted in the area. The project was developed in assumptions that if farmers are involved in technology development process, it will have the greater chance of adoption and diffusion. So the project adopts practical process (PTD) where farmers, as "insiders", bring their knowledge and practical abilities to test technologies, and interact with researchers and extension workers—the "outsiders". In this way, farmers and the outside facilitators are able to identify, develop, test and apply new technologies and practices.

2. Methods

2.1 Site Description

The study site is located in two mid-hills districts Gorkha and Tanahun of Nepal (Fig: 1). The study is mainly focused on the Chepang communities and confined to only Chimkeswori and Bhumlingchowk VDC of Tanahun and Gorkha districts respectively. Agriculture is the

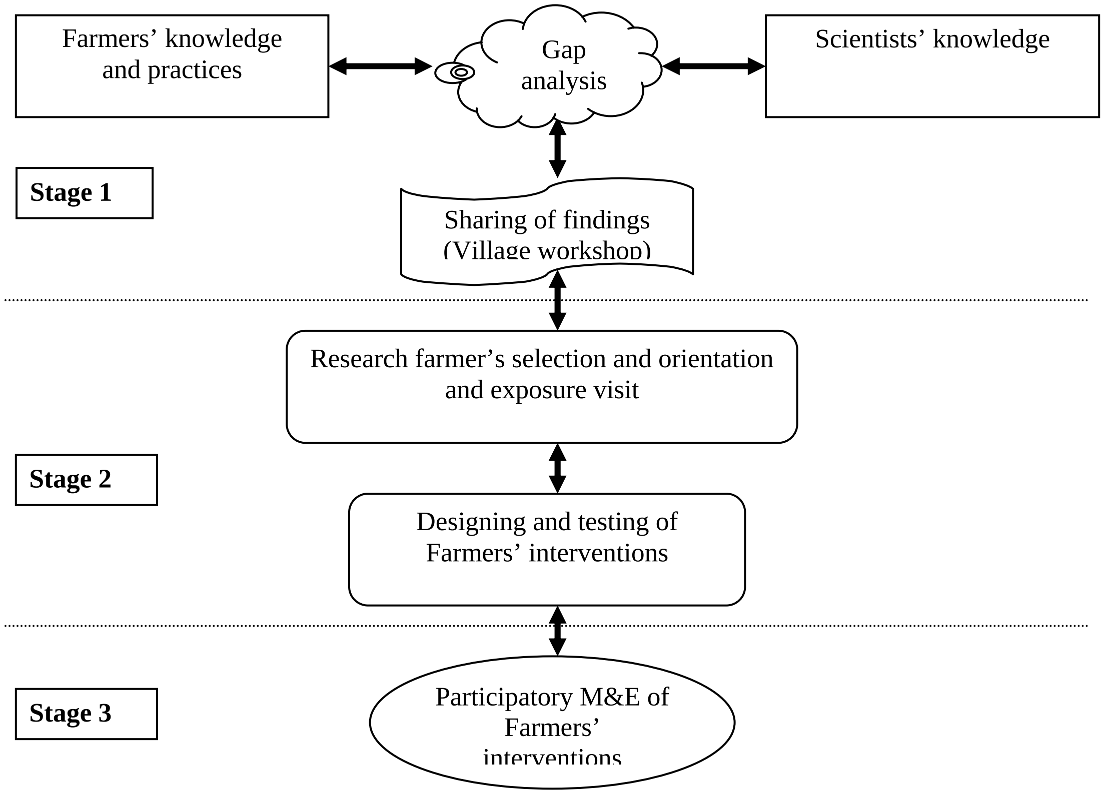
principle occupation and shifting cultivation is the predominant farming practices practiced by this group.

The sites have sub-tropical type of climate with altitude ranging from 500 m to 1700m asl. The topography of the site largely determines the technologies for their agriculture which is based primarily in the production of their stable crops (Maize, Black gram, Soybean, Bean etc.). The traditional farming system and cultivation on steep slopes have accelerated the rate of erosion and degradation. LI-BIRD (2002) baseline survey shows that the literacy rate and income status of households is very low. Most of the people are poor and have food deficit for about 6 months. The area is difficult to access, marginal in agricultural production, lack cash generating opportunities. People depend upon wild foods for their survival. It was also observed that the nutritional status of family members is worst and most of the children are suffering from malnutrition.

2.2 Participatory Technology Development

The participatory Technology Development (PTD) process was adopted in the project. This approach involves farmers right from the beginning, when they are asked to identify their problems. It is a process led approach which encourages active involvement of community people at all stages of technology development. The project worked towards developing a process and methodology by which technology options addressing a common constraint across a range of livelihood and biophysical circumstances could be identified and evaluated. The process includes four stages: problem identification; knowledge analysis and sharing; farmers' experimentation; and participatory monitoring and evaluation. Focus Group Discussion, Interviews, Observations, review of process documentation was used to gather information. Soil sample analysis, soil deposition measurements were also done to calculate changes over the time period. c.

Fig 1. Participatory Technology Development Process



3. Results and discussion

3.1 PTD is found as a process led approach

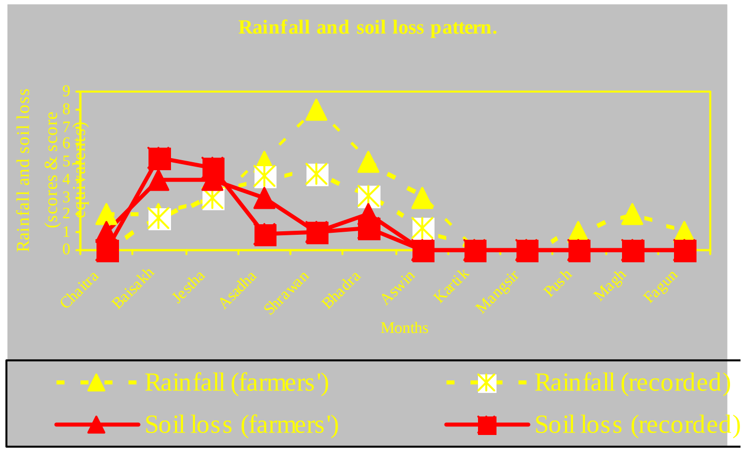
The PTD process adopted in the study has provided important and useful learning to the researcher's, scientists, farmers and other concerned stakeholders. The experiences suggest that application of the Knowledge Based System approach not only ensures incorporation of farmers' knowledge and perspectives in the technology development process but also improves farmers' empowerment and participation in the technology development process. The initial result also showed that participatory technology development process involving farmer experimentation was more effective than conventional on-farm research in dissemination of new information and technologies to other farmers in the community

> *One of the important lessons learned in PTD process is Planning and working with farmers needs to happen rapidly and with commitment. Farmers must not feel that a program is all talk and no action.*

3.2 Knowledge analysis

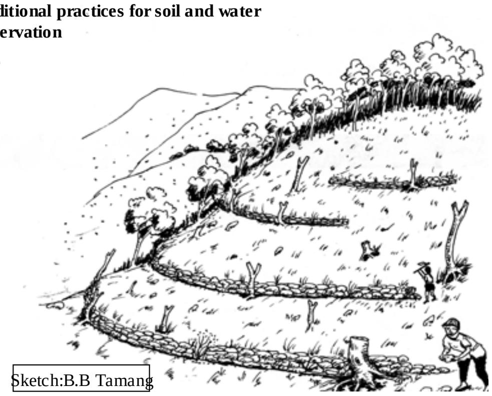
3.2.1 Local Knowledge Vs Scientific Knowledge

Sharing of farmers' and scientists' knowledge with the farming community and exposing research farmers to research and demonstration sites helps farmers to visualize the positive and negative aspects of their practices, to conceptualise the new interventions, and to motivate them to undertake their own research. Acknowledgement of the farmer's knowledge comparing with the researchers help to encourage them to involved in the programme effectively. And involving the farming community in various stage of project process ensured continued support in the smooth running of the research activities.



Source: Acharya 2004

Traditional practices for soil and water conservation



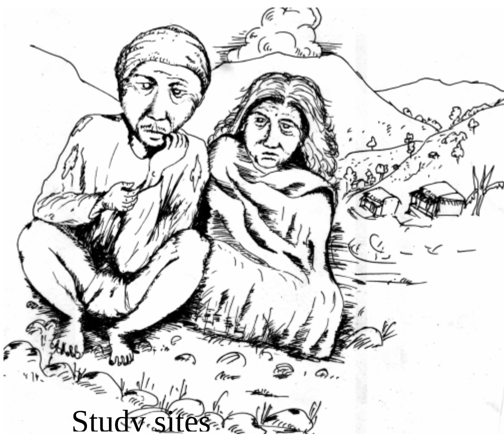
The knowledge elicitation strategy and the knowledge analysis process ensure as systematic acquisition of farmers' knowledge, explore causal links between knowledge and practice, explain the rationale of current farming practices, and identify gaps in knowledge and articulation among farmers as well as scientists

3.3 Effectiveness of contour hedgerow technology

The results demonstrate the effectiveness of contour hedgerows in increasing the nitrogen content of soil, improving soil texture, and increase in soil deposition. The technology is promising in biomass production, reduces soil erosions, increase production and species diversities and provides income to the farmers.

Farmer's perception about the technology

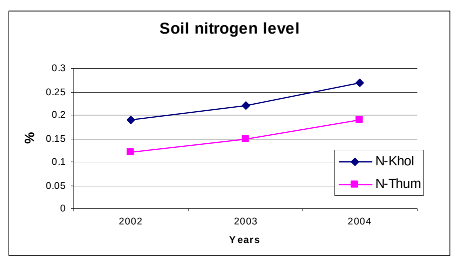
Farmer's who have shown their interest towards the intervention say that the technology is promising for them since it provides heavy biomass for their livestock, reduces soil erosion, restore soil fertility, diversify and increase production. They view this technology as advantageous since it had provided multiple benefits to them. Farmers in the same villages and near by areas have already started to expand the technology in their farm. However, farmers had always worried about their land as they do not have land registration certificate.



Study sites

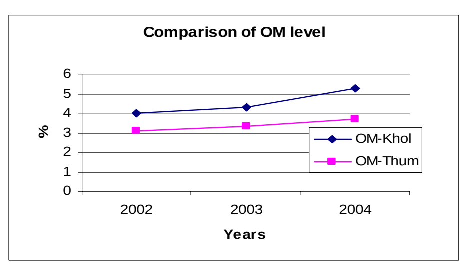
3.3.1 Increased nitrogen content in the soil

It was observed that the total N in contour hedgerow plots has increased. The data shows (chart 1) that nitrogen content in soil is higher in case of Kholagaun area (0.24, 0.22, 0.27) than Gorkha research site (0.16, 0.15, 0.19). Slash and burn system is practiced with rotation fallow system in Tanahun site whereas, almost permanent cultivation is done in Gorkha. The fallow period left in Gorkha site may be the reason in creating difference in the nitrogen content.



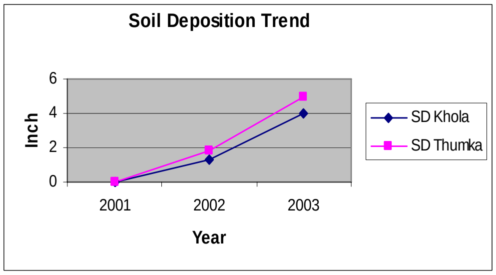
3.3.2 Increase in organic matter (OM)

As shown in chart, the organic matter (OM) content in soil has increased substantially every year. The trend shows that OM content is higher every year. The organic matter content is higher in case of Tanahun than Gorkha.



3.3.3. Soil deposition

The chart below shows that there has been positive impact of hedgerow technology in minimizing soil loss. The soil deposition trend is really encouraging. In both of the site, the soil deposition has increased gradually. During the first year the deposition is minimum whereas, it has increased more in the second year. During first year the species were just planted and at survival stage so investment is less comparing to the data of 2003.



3.3.4. Biomass production

The forage biomass production is visible in the area. Research farmers have extracted forage and kept record of the biomass. The chart below shows that biomass production is very encouraging in the area. Most of the interviewed farmers have expressed their satisfaction over the amount of forage they have collected. Biomass production is varied depending upon farmers.

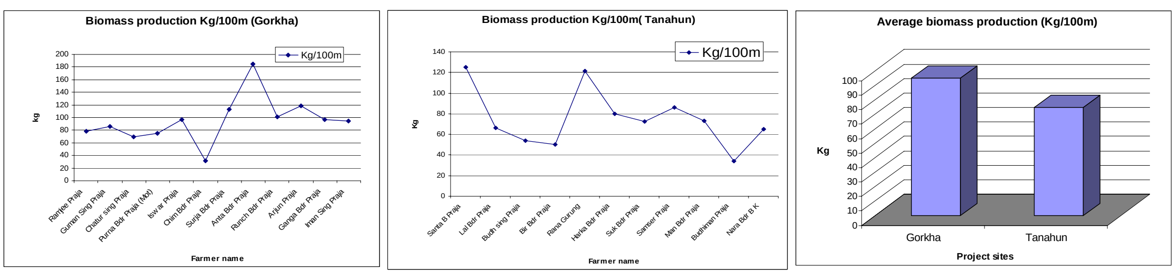
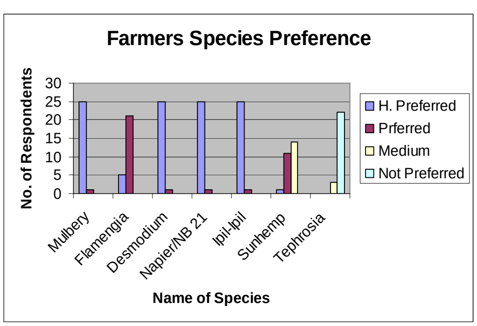


Chart: Biomass Production trend (a. Gorkha, b. Tanahun, c. comparison)

3.3.5. Other visible Impacts

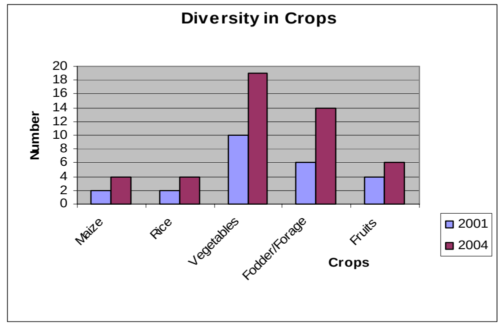
Farmer's hedgerow species preferences

It was found that hedgerow species that are liked by livestock, that can survive well and fast and easy to germinate are preferred by farmers. Based on the chart shown, majority of farmers highly preferred mulberry, desmodium, Napier, NB 21 and ipil- ipil. Tephrosia and sun hemp is less



likely preferred by farmers. The basic reason was that tephhorisa and sun hemp are less preferred by livestock and their germination and growth rate is quiet lower.

Diversity in crops



The baseline report indicates that farmers did not have so much of diversity in crops and the choice is also limited. Only maize based production system and associated local varieties were found in the area. After the intervention, there has been increase in crop choices like many new and locally adopted and preferred varieties were introduced in the area. Chart above clearly shows the diversity in vegetables and fodder and forage species comparatively than other crop varieties or species.

Changes in Land use Pattern

It was observed that there have been some changes in land use pattern in both of the research sites. Slash and burn system was the major land use system in the areas with maize-fallow (2-3 years)- maize and black gram-fallow- maize system in case of Tanahun and Maize+Cowpea- Fallow- Maize+Cowpea in case of Gorkha. Due to intervention, new cropping pattern and species have emerged. Slash and burn system is completely stopped due to technological options. Intercropping of vegetables with maize is being popular in Gorkha research site.

Improvements in income status and livelihoods

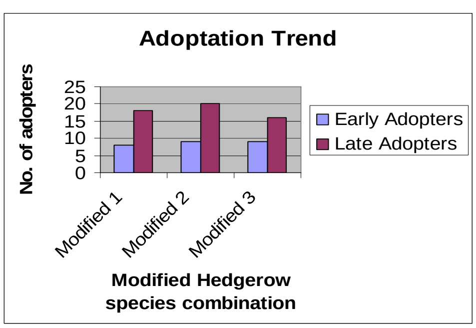
Although there is no concrete data to support that income status and livelihoods of Chepang has increased due to intervention. There are a lot of evidences to indicate the initial impact of the technology. Due to introduction of diversified cash crops and legumes farmers have expressed that their income has increased. The choice of crop has increased thus making them busier in farm works and often selling some of the products to nearby market. The vegetable and mushroom production not only increases their income it also increase the dietary diversity which indirectly improve their health status.

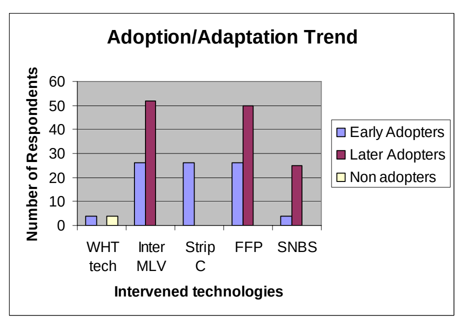
3.4 Policy Initiatives

Any policies related to shifting cultivation and land management in shifting cultivation will affect the livelihoods of shifting cultivators. One of the major problems in our case is that the shifting cultivation is not under land categorization and the government person doesn't want to hear the practice is prevalent in the country. However, this project raised the issues of land tenures and rights of the shifting cultivators to the wider audiences so the awareness on shifting cultivation issues has increased among the stakeholders. ICIMOD with support from IFAD has already initiated work to establish a plate farm for exchange of ideas, and to develop detailed policy recommendations to support the work of governments.

3.5 Adoption and Adaptation Trend

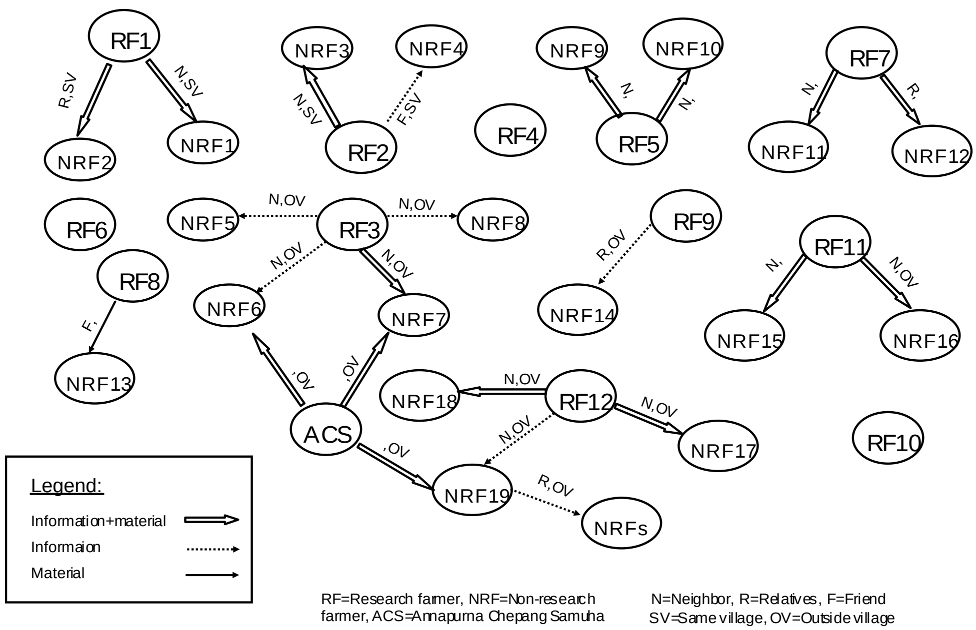
Based on the findings, it was revealed that economic benefit, technology generation process, visibility of farmers' experiments, village resources, flexibility for farmers, involvement of different stakeholders and land tenure security plays an important role in facilitation the adoption and adaptation of technologies in sloping and shifting land areas. Analysis shows that farmers are more interested towards species that have multiple benefits and provide direct impact on both short and long run. Eight farmers have been able to establish new hedgerow lines in their slopping land and 14 farmers have extended the length of hedgerow. All farmers have decided to add few more hedgerows in this coming season. 18 farmers have asked about the technology and source of the planting materials from the neighboring farmers as well as relatives from other village. Generally, farmers asked about the information and benefits of the technology and the source of materials with their counterparts.





The flow of information is more prominent than the flow of materials. It was observed that very minimum material is flowed from research farmer to non research farmer. However, material flow is more between and among research farmers. Figure below shows the flow of information and material among and between research and non research farmers.

Fig Information/materials flow, Gorkha



3.6 Scaling Up modality

There are certain conditions under which any technologies are acceptable by farmers. According to the discussions and findings, direct and visible benefit, rapid return of investment and labor, available resources, continued technical and monitoring support, low cost and input requirement, integration of various components with cash generating options, awareness raising through strengthening and mobilizing farmers and farmers group, government initiation to incorporate some of the activities to provide some level support to the community and training to farmers regarding the technology are some of the fundamentals for creating favorable environment for farmers to adopt the technology

3.6.1 Modalities and Pathways for Scaling-up Project outputs

To facilitate scaling up of new intervention from project sites to wider farming communities, the extension and development workers of District line agencies particularly working on soil and water conservation in the region were involved in every stage of project implementation. The project made use of well presented extension materials for the dissemination of the research outputs to the target beneficiaries. The outputs were disseminated through leaflets, posters and other materials. These materials were designed through consultation with farmers and involved stakeholders so that it was understandable and applicable. The extension materials were distributed all the concerned stakeholders. Rural radio programme was used as means of disseminating the good practices of the project.

Key actors

- *Research farmers*
- *Local community members*
- *Research and academic institutions*
- *Community Based Organisations*
- *Government line agencies*
- *Non-Governmental Organisations*
- *Private enterprises*

A one day workshop was organized where participating farmers, concerned research organizations and experts, government line agencies (DADO, DSCO, DLSO, DFO, and DDC.) and other NGOs and INGOs were invited. The project outputs and relevant achievements were presented along with mechanism for scaling up and dissemination will be discussed, identified with clear roles and responsibility of the key partners. The following scaling modality was agreed among stakeholders.

MODALITY 1: Mainstreaming: *Scaling-up through the Local Development Planning Process.*

MODALITY 2: Integration: *Scaling-up through "integration" within the conventional extension programmes of local government line agencies*.

MODALITY 3: Contextualization: *Scaling-up through networking and collaboration with existing special projects implemented by both public and private sectors* (*for district, regional to national levels).*

4. Lessons learned

1. PTD builds trust among stakeholders. It helps to build the farmers' confidence, tapping their potential for innovation and initiative
2. Planning and working with farmers needs to happen rapidly and with commitment.
3. Exposure visits encourage farmers to design trials (Seeing is believing)
4. Farmers are reluctant to adopt the practice since they have a fear that their land could be claimed by government as they do not have land registration certificate.

5. Recommendations

At local level

1. Participatory Technology Development (PTD) should be the focus of intervention as it builds trust among the farmers.
2. Good practices or technologies identified in the projects have potential to be scaled up in the villages and near by sites.
3. Some of the leader farmers could be identified as potential local researchers and they should take a lead role in technology dissemination.
4. Community nursery should be strengthen

At National Level

1. Participatory Technology Development (PTD) should be the focus of intervention in the future.
2. Government should be responsible for the institutionalizing of the technology developed and mainstreaming this with their concerned line agencies
3. Strong network and linkages among different stakeholders is necessary to share experiences, information and promote collaborative learning and actions
4. Documentation and sharing of technologies will offer more options for marginalized communities as well as it will be the basis for influencing policy makers.
5. Increase security of land tenure for shifting cultivators is needed and the knowledge and skills of these people should be acknowledged.

International Level

1. Good practices or technologies identified in the projects have potential to be scaled up
2. Lessons learned from the project will provide forward thinking for the researchers and other concerned stakeholders while implementing the activities.
3. Encourage coordination and networking between and among organizations/institutions working in the similar field

6. Conclusion

The Participatory Technology Development approach adopted by the project has proved to be very effective and significant to address the ecological and socio-economic problem of Chepang households in the research sites. During the entire process, farmers' involvement is ensured. Farmers are directly involved in testing and developing different SALT and other technological options suitable for the area.

A couple of technological intervention was initiated in the area. Contour hedgerow technology is promoted where farmers have themselves selected best species suitable for their hedges. Other technological options like intercropping of maize with legume crops and vegetables, kitchen gardening, livestock production system, fodder and forage improvement, integrated IGA interventions and Water harvesting techniques are some of the technology promoted in the area. Farmers have tested these technologies and modified according to their need and species adoptability.

The results demonstrate the effectiveness of contour hedgerows in increasing the nitrogen content of soil, improving soil condition through adding organic matter, increasing phosphorus and potash, increasing the soil depth and deposition and maintaining the soil pH. It was also observed that the technology is perceived to be promising in biomass production, options for species diversities and provide direct benefit to farming households. Farmer's who have shown their interest towards the intervention say that the technology is promising for them since it reduces erosion, restore soil fertility, increase production as well as diversify production. They view this technology as advantageous since it had provided multiple benefits to them.

It was observed that there are many research farmers who have initiated in scaling the technology within their own farm. Some of the non-research farmers have also adopted the technology and many are interested to adopt in future. However, many farmers demand the seedling material. The level of awareness on the issue of land tenure has increased and the government official has realized the issue is directly linked with the livelihoods of the local people. All the facts and figures described in the result and discussion section demonstrates that the modified contour hedgerow technology and other integrated agricultural technological options have great potential for replication as well as significant for conserving soil and water on sloping and shifting land areas. However there is strong need, support and commitment from the government institutions and concerned stakeholders for technology dissemination.

References

Acharya, G. P. and McDonald, M.A. 2003. Strip cropping minimizes soil and nutrient losses during rainy season in maize based system in sloping bari lands. Paper Presented in Dissemination workshop on Integreated Agricultural Technological Packages, Pokhara. Organized by LI-BIRD and HARP.

Aryal, K.P., Regmi B.R, Tamang B.B and Subedi A. (2002) Synthesis of farmers' knowledge; A case study of kholagaun and thumka of Tanahun and Gorkha districts of Nepal. LI-BIRD, Pokhara, Nepal

Balla, M.K., Awasthi, K.D., Shrestha, P.K., Sherchan, D.P. and Poudel, D. (2002). Degraded Lands in Mid-hills of Central Nepal: A GIS appraisal in quantifying and planning for sustainable rehabilitation. LI-BIRD, Pokhara, Nepal.

Bandy, D.E., Garrity, D.P. and Sanchez, P.A. (1993). The worldwide problem of slash-and-burn agriculture. Agroforestry Today, July-September 1993, pp. 2-6.

Carson B., 1992 *The land, the farmer and the future: a soil fertility management strategy for Nepal.* ICIMOD Occasional paper no. 21. ICIMOD, Kathmandu, Nepal.

Pokhrel T.**,** 1997 Cropping Patterns and Farming Systems in Rainfed Agriculture in Nepal in Rainfed Agriculture in Asia, Report of an APO Study Meeting 23-30 July 1996, Kathmandu, Nepal, Asian Productivity Organisation. *http://www.panasia.org.sg.nepalnet/agriculture/CROP1.html*, 12.4.99

Cooper PJM and Dennish GL ed. 1999. Scaling Up the Impact of Agroforestry Research. Report of the Agroforestry Dissemination Workshop. 14-15 September 1999, Nairobi, Kenya.

Maskey, R. B. 2001. Options for Sustainable Land Management in the Mid-hills of Nepal: Experiences of Testing and Demonstration of Contour Hedgerow Intercropping Technology. . Proceedings of an International Symposium Held May 21 to 24, 2001 in Kathmandu, Nepal.

NARC. 2000. Annual Report (FY 2056/2057;1999/2000).

Regmi, B. R, A. Subedi and K. P. Aryal. 2003. Dynamics of Shifting Cultivation Systems and Practices in Nepal. Technical Paper. Unpublished.

Regmi, B. R, K. Aryal, A. Subedi, P.K. Shrestha and B. B. Tamang 2004. Factors Responsible for Acceptance or Rejection of SALTs and Other Technological Options Suitable for Shifting and Sloping Land Cultivation Areas. Technical Paper submitted to HARP.

Sharma, C & Kharti, J. 1995. Slash and Burn Agriculture in Makalu and Yaphu VDCs of Makalu Barun National Park Conservation Area Project MBCPA, DNPWC -report 27.

Shrestha, P. K. 2003. Incorporating Local Knowledge in Participatory Development of Soil and Water Management Interventions In The Middle Hills of Nepal. PhD Thesis submitted to School of Agriculture and Forest Sciences, University of Wales, Bangor.

Tang ya. 1999. Factors Influencing Farmers' Adoption of Soil Conservation Programmes in the Hindu Kush Himalayan Region. Paper presented in workshop on Issues and Options In the Design of Soil and Water Conservation Projects held in Llandudno, Conway, UK, 1-3 February, 1999.

Tang Ya. 2001. Why Don't Farmers Adopt Recommended Technologies? The Example of Contour Hedgerow Intercropping Technology. Mountain Agriculture in the Hindu Kush-Himalayan Region. Proceedings of an International Symposium Held May 21 to 24, 2001 in Kathmandu, Nepal.