TECHNICAL BULLETIN

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Improvement of Agroforestry in Char Areas of the Tista River Basin

The Nilphamari and Rangpur districts of northern Bangladesh have vast *char* (Fig. 1) areas formed by the River Tista. During the pre and post-monsoon seasons, scarcity of water becomes a big problem and restricts livelihood options available to the *char* inhabitants. Soil erosion and desertification, low soil fertility and productivity, low humidity and high air temperature are the major ecological problems in *char* areas. *Char* dwellers are very poor, yet they have to negotiate extreme events such as, floods, droughts, storms, hail storms, char erosion, erratic rainfall, cold waves and climate variability off and on. Agriculture remains the only option for them to survive and sustain livelihood. Agroforestry may address the ecological problems in *chars* and improve livelihood of the inhabitants. This KGF sponsored project attempted to introduce improved agroforestry production systems in farmlands and homesteads of the *char* areas of the Nilphamari and Rangpur districts in the Tista River Basin of Bangladesh with a view to ensuring sustainable, environment friendly and climate resilient land use in the *char* areas.

Fig. 1. A typical *char* formed in the downstream area of a major river of Bangladesh (source: Google)

Methodology

Selected *char* lands were surveyed in terms of demography, farmers' knowledge of agroforestry and communication status, plant diversity, etc. Baseline information was collected from 200 farmer households in the *char* areas. Nine farmers were selected for field experiments. Each farmer's land was divided into three experimental blocks: one dedicated to sole tree planting, another for sole crop cultivation, and the remaining block for experimenting with tree-crop intercropping as an agroforestry system. Nine different timber and fruit tree species were planted. Eight winter vegetable/crop species and five summer vegetable/crop species were intercropped with the trees to evaluate diverse combinations as agroforestry landscaping. The agro-forestry based experiments were conducted in Dimla upazila, Nilphamari and Gangachara upazila, Rangpur where the following systems were tested: i)

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malta + chili, ii) *moringa* + maize, iii) *gamar* (tree) + sweet gourd, and iv) mango + potato (Fig. 2). During the winter season, chili, potato, garlic, onion, red amaranth, maize, brinjal and sweet gourd were grown in an agroforestry-crop system. To assess the efficiency of intercropping, the Land Equivalent Ratio (LER) was calculated for each combination. Economic and ecological benefits of the timber-based agroforestry practices were evaluated. Soil physical, chemical, and biological characteristics were determined once before the experiments and again after the experiments.

Fig. 2. Mango based agroforestry on a *char* land in the Tista Basin area

Results and Outputs

The *char* dwellers were found to be relatively young, poor people having limited education agriculture being the main livelihood. Plant biodiversity in *char* land is still low. Abundance of the eucalyptus tree is extreme. Leafy and creepy vegetables are common in the *char* lands, while marketable vegetables like tomato, brinjal, carrot, cauliflower, and cabbage are less prevalent. Introduction of fruit trees in the agroforestry system changed the char landscape (Fig. 3). Planting fruit trees slightly decreased yields of winter and summer vegetables (ranging from 4.35% to 12.50%), but taro was an exception. The partial shade-loving nature of taro actually increased its yield by 8.02% to 20.69% under the agroforestry system.

The economic analysis of the agroforestry systems was promising. Although the initial Benefit Cost Ratio (BCR) and Income Equivalent Ratio (IER) were low, they steadily improved over time. Some systems achieved BCR exceeding 3.0 and IER exceeding 2.0, indicating profitability. The land equivalent ratios (LER) also consistently increased, often reaching around 2.0. The selected fruit trees demonstrated remarkable resilience to flooding, a common natural hazard in char lands.

Fig. 3. Transformation of the *char* landscape: left to right, barren land, mono-cropping and agroforestry with intercropping

In assessing the the economic impact of newly established agroforestry systems on selected farmers' lands (, income was analyzed separately for Kharif-1, Kharif-2, and Rabi cropping seasons. A significant increase in overall economic returns for farmers who adopted agroforestry practices was observed over previous sole cropping practices on the same piece of land. On an average, farmers experienced a 126% increase in income, which highly satisfied the farmers.

In view of the agronomic performances of and economic returns from the tested agroforestry systems, several options were found to be highly promising. Six improved agroforestry models

were developed: (1) mango-potato/cauliflower/sweet gourd (winter)-*gimakalmi/taro* (summer)-tomato (next winter), (2) guava- potato/garlic/cauliflower (winter)- *gimakalmi*/taro (summer)- tomato (next winter), (3) *lombu* tree (upper layer)-lemon (middle layer)-red amaranth/cauliflower (winter)-*gimakalmi*/okra (summer)-tomato (next winter), (4) *malta*-chili/cauliflower (winter)- *gimakalmi*/taro (summer)-onion (next winter), (5) litchi-sweet gourd/cauliflower (winter)- gimakalmi/taro (summer)-tomato (next winter) (Fig. 4), (6) mahogany tree-brinjal/cauliflower (winter)-*gimakalmi*/okra /taro (summer)-onion (next winter)

Expected Impact

Fruit tree based agroforestry has been found to be a highly promising cropping system for the char areas. Some marketable vegetables like brinjal, cauliflower, okra can be successfully cultivated at the floor of the young malta, mango, litchi, guava, *gamari* and mahogany tree orchards/woodlots. Six improved agroforestry models have been developed which have the potential to transform the marginal char lands into agro-economically productive ecosystems. The new agroforestry systems may also help mitigate problems of soil erosion and desertification, low soil fertility, low humidity and high air temperature, the major ecological problems in the *char* areas of the Rangpur and Nilphamari districts of Bangladesh.

Fig. 4. An agroforestry model for char lands: litchi-sweet gourd/cauliflower-gimakalmi/taro-tomato

Recommendations

To optimize land use and resilience in *char* areas of the Tista River Basin, monocropping should be transformed into multifunctional agroforestry systems integrating high-value fruit trees (*malta*, guava, litchi, lemon, jujube, mango) or forest trees (mahogany, *lombu, gamari*). Capacity building is needed to enhance knowledge of agroforestry practices among agricultural extension workers, and knowledge sharing of knowledge in agroforestry among farmers, extension workers, government agencies, NGO workers and researchers. BARC and NARS institutions need to facilitate and strengthen *char* land agroforestry research.

This Technical Bulletin has been prepared on the basis of technical information available from a completed BKGET-KGF Funded CGP Project, the details of which are given below:

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