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UNTAPPED POTENTIAL FOR AGRICULTURAL DEVELOPMENT: TECHNOLOGY INTERVENTIONS IN LESS FAVOURED AGRO-ECOLOGIES OF BANGLADESH

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ABSTRACT

Many projects relating to agricultural technology, food security and rural livelihoods have been implemented by government agencies with financial and technical support from development partners. In addition to achieving partly or fully the intended objectives of production enhancement or capacity building, the projects generate enormous experience about farmers' perspectives, opportunities and constraints, which could be used as potential knowledge for conceptualizing and designing of future projects. This paper attempts to reflect on experiences and lessons learned from four recently implemented FAO projects in less favoured agro-ecological regions of Bangladesh using a case study approach. The paper argues that during the implementation process of meeting project targets, important insights and wisdom of farmers/ beneficiaries may easily be missed, and that these have huge potential for use in future project design and implementation.

Key words: Agro-ecologies, project design, waterlogging, village based organization, rural livelihoods.

1. INTRODUCTION

Despite years of intensification and the emergence of commercial agriculture as a driving force in the rural economy, the untapped potential for agricultural development in rural Bangladesh remains considerable (World Bank, 2016). Cropping intensity ranges from 120% to >300%, with an average of around 190%. At the same time cropping systems have been demonstrated with as many as four crops per year, while land use patterns are evolving to include aquaculture, agro-forestry, orchard production and livestock, as farmers seek higher returns from diversified enterprises. Anecdotally, there is some evidence that land in some regions is kept fallow due to low profitability of rice farming (a combination of prevailing low rice prices and the high cost of labour). Improving economic returns to land, especially in

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less favoured agro-ecologies[3], will become a growing challenge as the country pursues its current path to sustainable development with particular attention to lagging regions (Planning Commission, 2015).

Implementation of food security and livelihood or technology improvement projects by government agencies – often in collaboration with development partners - have produced notable experiences, and some useful lessons to be learned. Commendable attempts have been made in the past to address rural livelihoods improvement through crop intensification with women empowerment being measured in terms of knowledge, organizational and institutional mainstreaming (Care- Bangladesh, 2005). Added interest comes where such interventions have been carried out in so-called lagging regions, with clientele less exposed to development support (FAO, 2015b; FAO, 2015c). A cornerstone of the government's 7th Five Year Plan is inclusive growth, in order to ensure that all enjoy the economic benefits. Addressing remaining pockets of food insecurity and rural poverty will be a policy imperative; one of the main means of achieving this will be through publicly-funded agricultural development programmes.

Agricultural development programmes in Bangladesh vary in nature and scale from project to project, but overall they can be characterized into a few main types – delivery of improved inputs; credit for crop and non-crop enterprises; organization of farmers for business development and strengthened market linkages; training and skill formation, through extension services; nutrition education and homestead production; women's entrepreneurship development, etc. While these have generally been reported to have made a positive impact on agricultural diversification, food security and rural livelihoods, the underlying lessons that these experiences have generated are largely underappreciated in development literature. There are also prominent differences in the ways development projects relating to rural change are conceptualized and the successes in technology diffusion are described, pointing out that natural resource management and rural development remains a problematic activity for the development personnel (Biggs, 1997). This may then mean that important insights about project design and implementation results are not incorporated into technology policy discussions and planning of future interventions.

The aim of this paper is to discuss some of the lessons learned from a number of specific project interventions supported by FAO Bangladesh over the recent years, in partnership with the government extension departments (Department of Agricultural Extension, Department of Fisheries, and Department of Livestock Services) and other stakeholders, and to reflect on key findings, their limitations and the possible policy implications.

II. APPROACH TO THE STUDY

For this paper, a case study approach is applied using project reports, consultations with beneficiaries, project personnel and selected field visits. The projects under study are selected from four agro-ecologically-defined regions generally characterized as less favourable, in terms of remoteness; soils, hydrology and topography; population and land availability, etc. The case studies in question include (i) livelihood interventions in water-logged areas in south west Bangladesh; (ii) integrating guided micro credit with improved crop and non-crop

[3] See sections 3.1 through 3.4.

production, and market linkages in northern Mymensingh areas; (iii) modernizing hill agriculture through improved cultivation practices and rain water harvesting in the Chittagong Hill Tracts; and (iv) promoting agricultural mechanization as an element of the broader rehabilitation programme in the *Sidr/Aila* affected districts of southern Bangladesh.

III. CASE STUDIES

3.1: Agriculture and livelihood in waterlogged areas

Water logging has periodically affected areas of SW Bangladesh (Satkhira district and adjacent upazilas of Khulna and Jessore districts) over the past twenty years i.e. (notable water logging years were 2006, 2009, 2013, 2014, etc). The underlying cause is the failure of drainage of heavy monsoon rain, caused by sedimentation of the river system, illegal/unplanned or poorly executed construction, and the impact of polderisation and aquaculture on water flows. A programme of action research and technical assistance, funded by DFID, was implemented by FAO in association with World Food Programme, during the period 2014-2016.

FAO first undertook activities to map causes and examine social, economic and biophysical factors in water logging to make recommendations for both short term coping measures, and long term prevention of future water logging. These were validated in a series of consultative workshops at local and national level during 2015 and 2016. Two key findings of the study were as follows:

Firstly, loss of employment and livelihood options due to persistent water logging (and other adverse environmental impacts) is likely to force many ultra poor to live in poor conditions at remote polder sites or else migrate out to urban areas. Many of those who are marginal farmers today are likely to be alienated from their meager land resources (through leasing out or outright selling) and/or shift to non-farm activities i.e. rural trades, shop keeping, transport, wage labour, etc. One implication is that intended interventions must focus not only on rehabilitation or recovery of the poor but also address growth of overall local economy and of livelihoods options for the entire affected population.

Secondly, crop based agriculture is already changing fast in SW Bangladesh, witnessed by the growth of aquaculture (in Tala, Dumuria, Satkhira and elsewhere), horticulture (Satkhira and Keshabpur), home- based dairy and fodder cultivation (Tala)[4]. In these new sub-sectors of agriculture, emphasis on creating and sustaining market linkages will be the key, and there will be increasing demand for entrepreneurship and skilled human resources. Early recovery from water logging needs to be combined with potential investment opportunities for high value agricultural production, product marketing (and processing), input supplies, and local

[4] In a field visit by the first author to Jaila Ghoshpara in Tala, Satkhira it was evident that the small-scale dairy farmers rearing 5-10 cows took up commercial production of milk and to feed their animals with green grass they started growing fodder crops on the land previously used for paddy cultivation.

agribusiness services, all of which can engage otherwise bypassed households (landless, small and marginal farmers).

In addition to the study, practical technical assistance and inputs were provided by FAO with DAE to ultra-poor and marginal farmers – who tend to be the most vulnerable to shocks such as water logging - with training and provision of feasible technologies. The catalogue of options included technologies to cope in periods leading up to, during and after water logging episodes. Altogether around 3,000 farmers took part during 2015-2016.

Lessons learned:

1. Water-independent livelihoods are emerging – with water logging seen as also providing some economic opportunities. For example, combined rice- fish culture is becoming more common practice in many areas such as Tala and Keshabpur (Box 1).

Box 1: Crop to shrimp in water- logged land

In Satkhira waterlogged area, the changing land use pattern is *Boro* rice in the dry season and shrimp/prawn/white fish in the monsoon. Although rice is less profitable, it is grown in the interests of household food security.

The owners of lands (marginal, small, medium or large crop farmers) in water logged areas make contracts with the owners of *gher* (enclosed water bodies used for shrimp/fish farming) so that the latters drain out ponded water after fish production cycle is over in September- October so as to enable the farmers to prepare lands for *Boro* rice planting in December-January. The sludge deposits at the bottom of fish *ghers* add substantial fertility to the same land saving on fertilizer cost and giving significantly higher yields. Extent of *hari* (rental value) per unit of land for fish production varies with the variation of income from fish cultivation. The current lease value, locally called *hari* is reported to be Tk 30,000-Tk 45,000 (US$ 375-563) per acre per fish production cycle (US$1~TK 80). For modern variety *Boro* paddy benefit- cost ratio is 1.46; whereas for prawn –carp culture in *gher* it is 1.60; the same calculation for year round Bagda farming produces a return of 1.70; the highest average returns come from Golda (fresh water prawn) at 2.42 (FAO, 2015c).

Source*: FAO (2015): Mapping Exercise on Water Logging in South West of Bangladesh.*

2. This emerging pattern of rice-fish culture creates potential scopes for more productive use of available land and water.[5] This rice- fish combination in alternate fashion also helps resolve conflicting interests of small landowners and organized shrimp/ fish farmers. This also implies need for improved knowledge, training, quality inputs supply and market linkages for small –scale productions. Scopes for new crops in low land agriculture remain to be tapped.[6]

[5] Higher profitability of rice-fish culture compared to only *Boro* paddy production is also reported in the empirical study by Dey, et al., 2012.

[6] For example, Bangladesh Agricultural Research Institute (BARI) regional station at Benarpota, Satkhira is working on new varieties and agronomic practices e.g. sojorn, pyramid and floating methods of fruit and vegetable cultivation.

3. Duration of water logging (and the level of water salinity) varies from location to location, meaning that local experience and technology support influence choice of aquaculture design and adaptation to local soils, topography and choice of cropping patterns.

4. As fish farming is more profitable and techniques become more available, small farmers are increasingly shifting to rice-fish culture (concurrently or sequentially) using local capital, owned/leased land and local social network. This is in sharp contrast to situations in early years of shrimp *ghers* in 80s and 90s that it was prompted by investment from outside the locality.

5. To support this new trend of internalizing water logging through profitable localized investments in evolving new agriculture, capacities of local agricultural extension (DAE), livestock (DLS) and fisheries (DoF) need to be upscaled through training and dissemination platforms in which room for NGO participation and private sector investment in agribusiness development is widened.

Follow up lessons:

1. The important lessons learned through the exploratory study led to the implementation of a preliminary cash for work programme in this water logging project area by World Food Programme (WFP). One notable finding was that beneficiaries used their earnings to invest in productive assets, despite being functionally landless. These included quality seeds, plant saplings, production tools, chickens and small livestock-all for homestead production, where homesteads were founded on the embankments. The cash-for-work project beneficiaries were expected to buy food produced mostly locally with the income, with expected gains to market traders and the local food economy. Anecdotally this effect seems to have been quite limited.

2. In another FAO project in the same area targeting improved nutrition through poultry production, farmers boosted egg production significantly, but rather than consuming the eggs as was expected from the project, they sold around 72% eggs produced. The money earned was re-invested, or spent for education of their children and medical treatments. In both cases, a better understanding is needed of the motivation of the target beneficiaries.

3. As regards governance and ownership of assets, some derelict canals were excavated by 'cash for work' schemes. However, in some cases improved canals were commandeered by local influential persons for their personal interests i.e. aquaculture.

3.2 Guided micro credit through VBOs

FAO implemented a micro credit project with the support of the Italian Cooperation organization- to support village based organizations (VBOs) between 2012-2016 in remote northern most areas of Mymensingh and Sherpur districts, commonly known for lack of institutions and infrastructure. It combined small scale finance with technical training and support to improve the chances of success where investments were made in productive assets by rural borrowers. Altogether, 48 VBOs were involved, with a total of around 10,000 beneficiaries in the project.

Composition of 48 VBOs by household type with average loan transacted by variety of income generating activities (IGAs) was studied. An analysis of micro credit matching with amount, purpose, borrower's professional background and training received is produced in Table 1. Demand for livestock loan (i.e. cow rearing, beef fattening and poultry rearing) was high, indicating larger participation of female entrepreneurs; next was off-farm activities mainly done by women, investment in small business also showed growing demand (Table 2). Demand for credit to purchase farm equipment could not be met by small amount received as micro credit. Machinery training was also too inadequate to enthuse a new entrepreneur.

A number of lessons emerge from the analysis:

Firstly, let us take the point of borrower's choice in credit transaction. How much choice does a typical borrower have about the amount of credit, use of credit or the timing of credit delivery (and payback terms) commensurate with enterprise cycle or linking individual purposes with group liability requirements? Loans taken for beef fattening, aquaculture, or orchard development- all require initial investment before generating a return in the medium term (e.g. orchard may be 2 or 3 years). As a result these investors are usually the wealthier members of the community.

Another example might be an individual borrower wanting to buy a farm machine for custom hire service i.e. power tiller or a grain thresher, or to invest in a shop. Under the project, VBO loan amounts were not sufficient for such items as illustrated in Table 1. However, there was some evidence that extended family members could pool credit, with as many as five loans to make the required investment. Although this shows a variant of joint liability loan, sharing of responsibilities with respect to operation and repairing of machines, procuring diesel fuel, spare parts and timely repayment of loan installments appeared as problems.

Table 1. Micro-credit matching factors under FSMSP

Purpose	Matching with credit amount (received/ person) %	Matching with seasonality %	Matching with profession %	Matching with training received %	Remarks
1,350 VBO members cultivated field crops , vegetables, spices and horticultural crops using CRF	100	90	95	90	
3,277 VBO members took up livestock using CRF	90	90	95	90	
482 VBO members took up fish culture using CRF	95	90	95	90	
482 VBO members	90	90	30	70	

took up off-farm using CRF					
3,470 VBO members took up small business using CRF	95	90	90	70	
193 VBO members bought agricultural equipment using CRF	25	80	90	50	Established power tiller hiring services
386 VBO members took up other activities (auto rickshaw, van, CNG, etc.) using CRF	90	80	90	90	

Note: FSMSP: Food Security Mymensingh-Sherpur Project; VBO: Village Based Organization; CRF: Community Revolving Fund

Source: CCULB (Cooperative Credit Union League of Bangladesh). 2016. Micro-credit report, FAO, Bangladesh, MIS.

It was reported that a bought piece of equipment was used more and maintained better by the owner, compared to the ones which were donated by project (such as the cyclone rehabilitation project in the south Bangladesh). Equally, small scale poultry sheds were also one of the investments made under the project.[7] Smallholder borrowers were very conscious of the costs of investments, and it would appear that on a like-for-like comparison, costs of sheds were considerably lower than those built to be donated in the southern districts.

Secondly, one challenge for micro credit operation is how to guide the borrower to make good (economically viable) decisions. Under the project, agricultural extension department and others were involved in facilitating the process and providing technically-sound guidance. At the same time it was important for the borrowers to "own" the decision (Box2). How do you do that? Well, advocacy, production and business training, upscaling of credit limit, farmer's field visits, market information about new technology, and demonstration of innovative practices are some of the possible approaches.

[7]Of course, the advice of a local entrepreneur about scientific construction of poultry shed together with an assured supply of quality day old chicks, including linking the small poultry farmers with local traders for feeds and marketing of live birds, proved to be a very innovative venture.

Box 2: Upscaling duck farm with VBO credit

Abul Hashem, a 52 year old farmer cum farm labourer from Dhubaura Mymensingh has been rearing ducks for ten years with capital borrowed from village money lenders. He collects ducklings from Sylhet and rears them 5-6 months in nearby open water bodies. He usually makes a good profit but he has to give away around 50% of his profit as interest to money lending. As a member of Debal VBO in Dhobaura upazila Hashem borrowed TK 25,000 and got duck rearing training, guidance, market linkage information and related support linked with the Community Revolving Fund (CRF) credit. The VBO credit did not require any collateral, but the amount was not sufficient to expand his duck farming as he wanted. He mobilized additional TK 75,000 with high interest from non-institutional sources. The entire capital was spent for purchasing 1,000 day-old chicks, making and netting a duck shed, buying feed and medicine and paying labour cost.

DLS officials conducted the duck farming training and provided reliable vaccines and care through farmer-facilitators linked with DLS. Market linkage workshops attended by local traders, input dealers, producers and buyers proved a very effective forum for establishing a product marketing network. Hashem sold ducks to *bepari* and other traders coming from Sylhet, Dhaka and other districts. His net income from duck farming had gone up to TK 12,000 per month in addition to crop farming.

Thirdly, the main lessons learned from community revolving fund (CRF) credit are that micro credit, when guided by appropriate training, supervision and marketing support, becomes more productive and repayment rate becomes high (Table 2). CRF credit ceiling is not enough for big enterprise.

Besides, power tillers and LLPs, 644 power thresher, 961 Knapsack sprayers, 2,227 Foot pumps, 52 Batch dryers and 1,269 USG applicators were provided to the beneficiaries by the project. The project also constructed 346 small scale irrigation structures in the project area. Prior to the project, they used small scale irrigation for *Boro* paddy production through LLPs, which remain mostly underutilized due to shortage of water in the canals.

Fourthly, ensuring quality governance of village based organizations (VBOs) is an issue of concern. The VBOs are formed following the conventional 'cooperative' approach, which formally requires payment of membership fees, attending weekly or fortnightly group meetings, maintaining a number of record books (*Khata*), participating in training, regular payment of loan installments, etc.

Table 2. Sector wise CRF disbursement status

Sector	No. of borrowers	Sector wise borrower (%)	No. of female borrowers	Female borrowers (% of sector wise borrower)	Average amount borrowed/ borrower (TK)	Sector wise % of total credit advanced	% CRF recovery rate
Crop							
Field Crops	578	6	266	46	18000	7	90
Vegetable, spices and hort. crops	772	8	386	50	15500	6	92
Sub total	**1350**	**14**	**652**	**48**	**16570**	**13**	**91**
Livestock							
Cow rearing	1542	16	848	55%	22000	15	95
Beef fattening	964	10	492	51%	21000	13	95
Poultry/ goat/buffalo etc.[8]	771	8	432	58	15000	7	95
Sub total	**3277**	**34**	**1772**	**54**	**20765**	**35**	**94**
Fisheries							
Pond fish, fingerling etc.	482	5	217	45	16000	5	90
Off-farm activities[9]	482	5	289	60	15000	4	92
Small Business[10]	3470	36	1388	40	20500	35	94
Agricultural equipment[11]	193	3	58	30	25000	3	94
Others[12]	**386**	**4**	**77**	**20**	**25000**	**5**	**95**
Total	**9640**	**100**	**4453**	**46**		**100**	**93**

Source: BAUEC (Bangladesh Agricultural University Extension Centre). 2015. Monitoring Report, based on CCULB report, and VBO record keeping.

[8]Local hen/ sheep/pig/pigeon/rabbit /duck rearing, buck hatching, etc.

[9]Bamboo made product, *chumkirkaz, karcupi, nakshikantha, mura* making, carpenter, onion cake, tailoring, mattress production, cycle mechanics, apiculture, card making, fried rice, rice husking, etc.

[10] Vegetable seller, seed seller, cloth selling, furniture business, trunk business, mini garments, rice business, egg business, dry fish seller, fertilizer business, pharmacy business, grocery shop, toy business, fruit business, tea stall, bakery, wood business, fruit business, hotel business, irrigation business, vangari business, household utensils, sanitary business, flexi load, mobile servicing, computer servicing, etc.

[11] Power tiller, shallow tube well, thresher machine, rice husking, etc.

[12] Rickshaw, auto rickshaw, van, CNG, etc.

What is conspicuously missing in VBO management is the realization that there is a cost of cooperation in terms of opportunity cost of time, especially for the poorer borrowers and that there is hardly any incentive structure for those who voluntarily give time and labour for record keeping. In many associations, there are banking days or repayment days for which some members are engaged in dealing with accounts, but an absence of cash or kind provisions creates disincentives for this extra work. However, providing cash incentives may create more problems than it can solve because it would entice other members to queue for the same task. How to arrange compensation for extra time and effort by the selected few in the one hand and not jeopardize VBO activities by way of accommodating demands from contending members on the other is a formidable challenge.

Another governance issue involves size of the VBO. Some have begun to allow members from neighboring villages. This is likely to create problems as community bonds – and peer pressure to repay loans – are weakened.

One may also wonder what makes a good VBO good. Generally, the management committee that did play proactive roles in credit decisions and showed transparency and integrity in credit transactions proved highly successful. Weak capacity of the management committee and 'political interference' was cited as factors where success had been more limited. There was no strong correlation between the proportion of male to female participants and relative success of the VBO. However, women VBO members reported increased income, and increased access to family income and assets, as a result of the project.

Overall, micro finance operations have generally focused on small loans to support small home based enterprises i.e. poultry rearing, cattle raising, pond fishing, plant nursery, handicrafts, shop keeping etc. This is fine as long as household income improves and loan installments are paid regularly. However, this is not truly market-oriented development as it still retains a 'productionist' focus with some elements of commercialization to keep pace with rural transformation processes. It would be recommended to look beyond micro credit, and articulate programme designs to encourage a focus on increasing the bargaining strength of small borrowers, networking them with input- output traders, adopting scale- appropriate technology, creating synergy with farmers organization i.e. farmers field schools and wherever needed increasing credit limit to allow larger investment. Upgrading training modules from centrally-driven extension advice to a more responsive marketing- focused effort is a prime need. In any case, much of the typical extension materials and information is already provided by the private sector (through input dealers).

Finally, we put emphasis on redefining sustainability of livelihoods of the poor. The driving force should be a shift from continuation of same portfolio loans to wealth creation as pillar of livelihood diversification and reinvestment in human capital, especially education, health,

nutrition and information. Innovations in financing mechanisms to support the beneficiary farmers with varying objectives seem important.[13]

3.3 Enhancing production through improved cropping practices and rain water harvesting in Chittagong Hill Tracts (CHT)

The CHT are the most disadvantaged geographical region of the country, which can be characterized by poor accessibility, uneven topography and lack of irrigation facilities, all of which limit modernization of agriculture. Following pest attacks and flash floods during the period 2010-12, remote rural communities in CHT struggled to restore their agricultural production systems. Cash grants were provided by WFP. These were followed by a series of technical interventions providing training and improved inputs - supported by ECHO –for around 6,000 beneficiaries at two locations in Rangamati (Sajek) and Bandarban (Thanchi) over the period 2013-2016.

Severe shortage of water in dry season and also inadequate draft power limit crop intensification, especially improvement of rice, vegetables and fruits; *Jhum* cultivation is still the main practice of hill farmers who are constrained by water, quality seeds, pest and rodent threat (Uddin, et al., 2014). Project constructed a number of mini dams on creeks passing through the hills. Initial results of piped water system up the hill are encouraging as reliable source of domestic water supply and irrigation to *Jhum* land and orchard (FAO-Bangladesh, 2015a; Box 3).This also reduced women's arduous job of collecting water from distant locations.

Box 3: A mango orchard

Babu Marma owns a five- acre orchard in Gograchari in the sadar union. The ten-year old garden has 350 mango (amropali) and 99 litchi (muzaffar, China1,3 and Dinajpur varieties) plants which have been managed successfully and profitably. In 2014, 17 tons of mango and good harvest of litchi brought about a gross sale of TK 600,000 (from mango) and TK 150,000 (from Litchi). The products are sold from Marma's 13/14 show rooms at Khagrachari. In the hill tracts, there is an increasing trend of establishing orchard on lands which were previously used to be put under banana, papya, turmeric, etc. These crops do not grow well these days due to fall in rainfall, which however favour growing of mango and other fruits. According to local agricultural scientists, annual rainfall dropped from around 3000 mm to 1500-1800 mm in recent years, which favour cultivation of mango and due to dryness in this region mango is harvested at least a month earlier than in other regions of the country. Irrigation at extreme dry months will no doubt increase mango yields.

One important lesson learned is that providing farm equipment such as power tillers to hill farmers is indeed an important step but full potential of such investment requires additional support i.e. credit and machine repair and maintenance service, improved road infrastructure,

[13]Our experience with accelerated cucumber production and marketing in a dispersed southern region in Bhola shows that progression from NGO micro credit to commercial financing by a leasing company increased group bonding, farmers' bargaining power as well as sustainability of business.

transport services, electricity and market development.[14] In particular, provisions for quality seeds for *Jhum* crops, vegetables, fruits, agronomy and horticultural training, post- harvest handling of perishable products are needed in the hill.

It is also important to recognize that the provision of mechanized cultivation practices i.e irrigation, tillers do also open up linkages for expansion of rural non-farm activities. The major crops grown in the area include rain fed *Aman* rice, *Boro* rice (where irrigation is available), water melon, *Aus/Jhum*, fruits and vegetables, and all these products are marketed through the Taindong market. This bazar in Matiranga Upazila has been growing rapidly from few temporary shops a few years ago to currently a rice husking mill, saw mill, furniture shops, groceries, medicine stores, hair cut shops, shoe shops and a recently established residential hotel. Once again, it reinforces the argument that any project for supply of inputs and technology packages has to be combined with market linkage and community participation, especially if it is for remote and less favourable ecologies.

3.4 Early recovery from disaster through new agricultural technology package

Parts of southern Bangladesh are exposed to frequent natural disasters as well as suffer from problems of salinity and water logging. Following two major cyclones in 2007 and 2009 (Aila and Sidr), a recovery and rehabilitation packages was developed with the main extension departments, delivered jointly with FAO, and financial support from the World Bank. The Emergency Cyclone Rehabilitation and Recovery Programme (ECRRP) targeted over 150,000 beneficiaries from 13 upazilas of 6 districts of southern Bangladesh, with inputs, farm equipments and training on crops, livestock, aquaculture and fisheries.

Under the project, supply of 1364 power tillers and 801 low- lift pumps proved useful intervention, which contributed to increasing yield, acreage, new crops, production and profits (Table 3).

Besides, power tillers and LLPs, 644 power thresher, 961 Knapsack sprayers, 2,227 Foot pumps, 52 Batch dryers and 1,269 USG applicators were provided to the beneficiaries by the project. The project also constructed 346 small scale irrigation structures in the project area. Prior to the project, they used small scale irrigation for *Boro* paddy production through LLPs, which remain mostly underutilized due to shortage of water in the canals.

Table 3. Impacts of power tiller and LLP provided by the ECRRP

Impact	Power tiller	LLP
No. delivered (No.)	1364	801
No. of beneficiary households	17050	-
Increased area coverage/machine (%) for rice)	148% (103 acre to 152 acre)	99
Increased coverage area (%) for oil and pulses	149% (51 acre to 76 acre)	92

[14]Overall policy support and local provisions for machine repair and maintenance service is of strategic importance to promote mechanization of farm operations (for illustration see Mandal, et al.(ed.), 2017.

Impact	Power tiller	LLP
Increased coverage area (%) for horticulture crops	200% (0 acre to 2 acre)	100
Increased coverage area (%) for other crops- maize, wheat etc.	149% (15 acre to 24 acre)	92
Increase in yield with intervention of power tiller (rice)	112%	-
New crops introduced	Sun flower, maize, water melon, mustard, groundnut, potato, BINAdhan-8	-
Net profits earned[15]	TK 50,053/season	TK 10,587/season

Source: Calculated from ECRRP- Emergency 2007 Cyclone Recovery and Restoration Project data.

Farm equipment were delivered as donations to farmers clubs e.g. IPM club, or Farmers Field Schools, which reinforced grass roots institutions. Since it relies on collective ownership farmers have very little incentives to maintain and operate the machines to their optimum capacity (Box 4).

Box 4. Power tillers (PT) for livelihood improvement

A total of 1364 power tillers were gifted to cyclone affected farmers by the Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP-040) in Barisal and Patuakhali districts. These were delivered to IPM clubs or Farmers Field Schools through an agreement for group ownership and management of equipment. A club member worked as operator and was paid TK 400-500/ day for tilling land. Power tillers were used generally for preparing land for transplanted *Aman* rice, winter vegetables and *Boro* rice. The hire rental charges for three ploughings varied from TK 1500-1800 per acre for club members and from TK 1800-2700 for non-members. This differential charging of fees was mainly to show benefits of joining farmers clubs. A quick round of interviews with representatives of 15 clubs revealed that the PTs increased productivity through quick land preparation and reduced turn around time between crops. It also earned a net profit of TK 16000-20000 per PT with an average pay back period of four years. This income however dropped gradually as the number of PTs increased and also PT performance decreased owing to increasing breakdowns. About a half of the 15 PTs interviewed were actually reported functioning after five years or so, while the other half were left unused requiring repair.

Important lessons learned:

1. Sustainability of power tillers given as gifts remains an open question; distribution of the equipment to group management does not provide sense of ownership to individual farmers, which results in poor maintenance and management of equipment; cost- free equipment turns out to be ‘every body’s business is no body’s business’.

[15]Net profit was calculated as: gross income of a power tiller TK. 275/hour – cost of operation Tk 138/ hour (i.e. fuel Tk 78 and wage Tk 50)= Tk 137/hour. At this net profit, average pay back period for a PT would be 2 years and that of an LLP 3 years, which might be even faster when the same engines are used for other purposes as well.

2. Group approach is not necessarily suitable for operating and managing equipment in a multi user situation; this rather act as source of internal feuds with no effective means of resolving conflicting interests; and this becomes more complicated when clubs or groups lacks legal entity or registration, rendering poor repair and maintenance of machines. In this respect, VBOs in Mymensingh case have distinct advantage as these are registered as Cooperatives.

3. In some cases, de-facto individual control over the gifted machines is established. Where this is not the case the equipment are poorly maintained or left damaged because nobody is particularly responsible to fix it.

4. Mere distribution of guidelines by the project for use of machines without any incentives at individual level is not effective. Some machines, especially those delivered in later years of the project were said to be of lower quality, while the power threshers were bigger than appropriate size. In some cases, commonly owned machines did in fact threaten hire rental business by individually-owned machines. Nevertheless, how these machines delivered by the project have helped the structure and conduct of farm mechanization market and repair services provision through the local service providers remains to be seen.

IV. CONCLUSIONS AND POLICY RECOMMENDATIONS

Against the backdrop of many agricultural technology innovations and rural livelihood projects being implemented by the government in collaboration with development partners there is a felt need of gaining better understanding of project experience and results, especially with respect to production enhancement, livelihood diversification and farmers' income. While most assessments make generalized comments on findings and impacts, projects operated in less favoured locations generate useful practical lessons which need special focus and intervention strategies.

This paper discussed four FAO implemented projects. These included water logged areas in south west Bangladesh, guided micro credit advancement through registered village based organization in remote Mymensingh- Sherpur regions, technology support including rain water harvest structures in Chittagong hill tracts, and provision of agricultural inputs and machinery delivery through farmers' organization in *aila/sidr* affected areas of southern districts.

While the projects under review generally produced positive results with respect to improvement of understanding of complex sociopolitical conditions (e.g. waterlogged environment), some experience of 'elite capture' of project inputs and machineries or concentration of livelihood support to tiny segment of extreme poor in disadvantaged locations was not uncommon. Others such as guided micro credit project and rainwater harvest project had made more inclusive impacts on beneficiaries' ability to invest in

productive assets and income streams such as mango orchard in hills or profitable cropping patterns in Mymensingh region.[16]

It is observed that after withdrawal of project interventions, the internal qualities and functions of the farmer's organization have deteriorated in the project areas. It is the responsibility of the government agencies to overcome these difficulties and help activate farmer's organization with whom they are mandated to work for technology dissemination. Record keeping and financial documents were not updated in most clubs. There were also reports of delivering inappropriately-sized machinery (e.g. power thresher) that were not fit for threshing paddy or being moved from place to place. Repair of broken machines requiring cash involvement remained a problem.

Distribution of machinery free of cost through group approach, as was the case in the ECRRP project can fail to create a sense of ownership on the part of group members, nor does it ensure sharing of responsibility in repair and maintenance of machines, especially when this involves cash expenses. One feasible alternative may be to link delivery of machines with a provision of some partial payment by the beneficiary farmers groups; the funds mobilized this way can then be used for meeting regular repair and maintenance costs, providing training on machine operation and also for replacement of spare parts. This is also likely to ensure better participation of group members and thus help improve utilization and management of equipment. The other step would be to gather opinions of the beneficiary farmers, before designing the project interventions, about what type of machines they would prefer to suit their requirement, rather than imposing prescribed standardized set of equipment, as project "packages".

One major conclusion drawn from interventions in waterlogged areas is that a unique conventional engineering structural solutions i.e. poldering or river dredging can be undermined because of the lack of coordination between agencies and human interventions (canal blockade or public cut) limit the results of interventions. Our main lesson is that people trapped in waterlogged conditions adopt myriads of coping mechanisms and some of them are more rewarding financially than the conventional practices. For this to sustain and also to act on preventive measures, wider negotiations amongst multi stakeholders (government, NGO, local bodies, private sector, communities) needs to be taken into account in design and implementation of projects.

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[16]In projects with provision of farm machines delivery, farmers can harvest *Boro* rice crop in 20-30 days earlier in comparison with pre- intervention period due to timely tilling of land, and also they do not have to wait for labour for implementing other farm activities timely. Some new/additional crops such as wheat, maize, sunflower, mustard, mung bean, etc are now cultivated in the locality.

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