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# Promotion of Agricultural Technology Innovations for the Poor Smallholders in Marginal Rural Areas of Bangladesh: An Innovative Business Model Approach

**Ikhtiar Mohammad[*], Mohammad Abdul Malek[**]**

**Abstract** This article aims at demonstrating location specific approach for agricultural technology promotion and adoption in improving the livelihood of the small farmers in the haor basin and coastal belt of Bangladesh. Innovative technologies that have potentials are initially screened by ex-ante investigation and instrumented by the business model canvas, which is used as a bottom-up approach for sustainability of the adoption of proposed technology innovations. Village-level extension farmers, sub-district extension officers and farmers' cooperative are the unique and central features to the business models and forward linkages. Extension service, power tiller, low-lift pump, sunflower, shallow tube well, quality seed, forward linkage for farmed duck eggs, live ducks and open catch fish etc. are the suggested potential technology innovations for the small farmers. The technology adoption business model can be reinvented for different locations within or beyond the country considering the local agricultural problems and prospects for greater sustainability.

**Keywords** Agriculture technology innovations, business model, haor, coastal belt, Bangladesh

## I. Introduction

Around the globe, technology adoption in farming is considered one of the top ten engineering accomplishments in the 20th century in optimizing agricultural productivity thereby improving livelihoods. Despite the fact Bangladesh attained a phenomenal progress in fighting poverty and achieved better outcomes in socio-economic aspects in recent years, nearly one-third of

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the rural population is living below the upper poverty line, the majority of whom are primarily dependent on agriculture for livelihood. One of the key reasons for such dismal situation is the low agricultural productivity, which is the consequence of using sub-standard agricultural inputs and sub-optimal agricultural technologies by the peasants.

Based on the recent development of an interdisciplinary research framework on marginality (von Braun and Gatzweiler, 2014), we conducted an ex-ante investigation to identify technology innovations having potentials in the selected five marginal sub-districts of Bangladesh (Malek et al., 2013) and selected appropriate technology innovations for those locations (Malek, Haque and Moniruzzaman, 2015). Latter, we developed business plans for the adoption of most promising agricultural technology innovations in two selected marginal areas (one in the coastal belt and the other in the haor basin). Then, a business model is crafted on the requirements and prospective outcomes of adopting particular technology innovations by poor rural small farmers to increase their productivity and household income.

The business model canvas, which was invented by Osterwalder and Pigneur (2010), is modified to articulate the agricultural technology promotion business model for the two marginal sub-districts in Bangladesh. The intent of the business model is to facilitate the small farmers in the selected marginal areas. The model addresses the dire necessities of the farmers and proposed plausible solutions to their crucial needs to augment productivity and household income.

## II. Basic Elements of Business Model Canvas and Our Approach

The business model canvas describes how an organization creates, delivers, and captures value (Osterwalder and Pigneur, 2010). It has nine basic building blocks, which are customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure. This canvas allows to easily describe and modify business models to create new strategic alternatives for different types of organizations and start-ups in various sectors i.e. banking industry, fast moving consumer goods, information technology, pharmaceutical and so on so forth. The canvas can be printed out on a large surface so groups of people can jointly start sketching and discussing business model elements with ‘post-it note’ or board marker.

Though the ‘business model canvas’ is usually used for various other sectors, it is adapted in this paper for the promotion of agricultural technology innovations to facilitate customer segment hereby beneficiary segment (Table

2 and Table 3). A bundle of value propositions for the identified marginal areas are proposed to be implemented through customer relationships hereby beneficiary relationships and channels; based on key activities, resources and partnerships; resulting in benefits for the small farmers; outweighing cost of proposed offerings. The name of the building blocks of the business model canvas is slightly altered to tailor to the agricultural technology promotion. And it is worth mentioning that the idea of introducing the canvas is unique in the international development discipline.

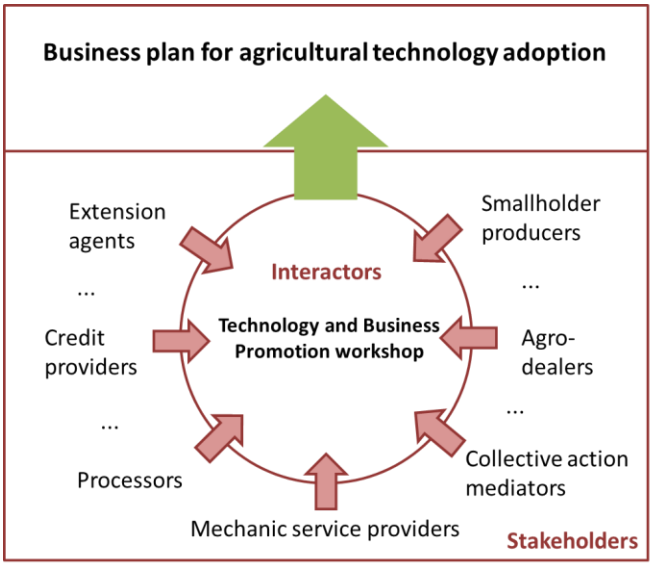
The marginal areas identified are usually bypassed by the policy makers due to generalized convention about the Agro-Ecological Zones (AEZs) as a whole and receive less attention (Malek et al., 2013). Therefore, marginal (or less-favored areas or laggard) regions, especially in poor developing countries and emerging economies in Sub-Saharan Africa and South Asia, are recently gaining much attention in the development literature (Conway, 1998; Fan and Hazell, 2000; Pinstrup-Anderson and Pandya-Lorch, 1994; Ruben, Pender and Kuyvenhoven, 2007; Pender, 2007; Reardon et al., 2014).

The first step towards designing systematic interventions is to identify underachieving rural areas where poverty is prevalent and other marginality aspects are high. Agricultural prospect is high in such areas due to high yield gaps, calculated as potential minus actual yields. Productivity gains for main staple crops are likely to be achieved in these areas. The identification has been done with high prevalence of societal and spatial marginality – based on proxies for marginality dimensions representing different spheres of life and an overlapping high (under-utilized) agricultural (cereal) potentials. The following five sub-districts have been selected as study sites for ex-ante assessment: Rajibpur (Kurigram), Dowarabazar (Sunamganj), Porsha (Naogaon), Damurhuda (Chuadanga) and Bhandaria (Pirojpur) (Malek et al., 2013).

In selecting technology, a bottom-up approach, aligning available technologies with the needs, aspirations and potentials of the poor small farmers, has been adopted. The list of technological innovations, that were selected in the earlier phase (Malek, Haque and Moniruzzaman, 2015) is reviewed for two marginal sub-districts following literature review, consultation with the government and non-government scientists, extension workers and officials at both national and local level (Table 1).

With a view to have an understanding of the local settings, the researchers themselves visited two locations Bhandaria and Dowarabazar sub-districts out of five locations identified in previous phase. Abiding by the framework illustrated in Figure 1, the trips were intended specially to conduct two separate workshops involving agricultural stakeholders such as farmers, seed dealers, fertilizer and insecticide dealers, rice millers, government agricultural extension service officers, agriculture machineries sellers and technicians, etc.

The workshops were instrumented in soliciting information from the stakeholders pertaining to agricultural technology innovations, various agricultural constraints underlying farmers' poor livelihood in the respective areas, prospects to boost the efficiency and return for the smallholder farmers. Moreover, personal meetings with the different stakeholders in dispersed villages in the sub-districts helped to have a holistic view of the socio-economic picture of the two marginal sub-districts.




Source: Malek and Gatzweiler (2016)

**Figure 1 Stakeholders interact in a collective action process towards eliciting business opportunities and designing business plans**

Taking into consideration the field trips' insights and ideas, two full-fledged business models stated in Table 2 and Table 3 are developed to facilitate the smallholder farmers by adoption of agricultural technologies in the two sub-districts. Firstly, poor extension service, a very common phenomenon for agriculture in Bangladesh, needs to be addressed for both the sub-districts. Second, sunflower production seems to hold widespread opportunity in the coastal sub-district, Bhandaria, and structuring a good forward linkage for produced sunflower oil seed would open up livelihood opportunities for the local farmers. Furthermore, power tiller is unaffordable due to high price and

**Table 1 Suggested technology innovations**

| Theme | Dowarabazar | Bhandaria |
|---|---|---|
| Intensive crop system technologies | – | Group based fish + poultry + vegetable farming |
| Seed technology | Shallow tube well (STW), low-lift pump (LLP), rubber dam | Hybrid rice varieties, saline resistant rice varieties, sun flower, hybrid vegetable seeds |
| Technology related with water management and irrigation | Quality seed especially for flash flood tolerant rice varieties | |
| Mechanical innovations | Power tiller, thresher (both paddle and mechanical), rice miller | |
| Non-crop innovations (non-crop farming, non-farm enterprise/business, migration) | Extension service, seed distribution channel with awareness building, seasonal crop business (e.g. creating forward linkage for duck/fish/crops to sell surplus) | Extension service (to make people aware of agricultural potentials in the area), commercial enterprises for sunflower production with backward and forward linkages, business for seasonal vegetables, fishing + poultry, livestock + poultry, agro-machineries |

**Table 2 Integrated business model for Bhandaria, Pirojpur, Bangladesh**

<table>
<tr>
<td rowspan="2">Key Partners<br><br>- Project implementation team<br>- Local government department of agricultural extension<br><br>- Power tiller/low lift pump selling company<br>- Microfinance institution<br>- Mobile banking platform<br><br>- Seed company<br>- Sunflower oil seed processing company</td>
<td>Key Activities<br>- Recruiting and orienting sub-district extension officers<br>- Selecting and training extension farmers from each village<br>- Extension officers follow-up extension farmers<br>- Monthly meeting of extension farmers and officers<br>- Relaying popular/street theatre for awareness<br><br>- Forming farmers' cooperative<br>- Forming sub-team for power tiller/LLP maintenance<br>- Opening mobile/bank account<br>- Monthly cooperative farmers' meeting<br><br>- Training to cooperative farmers on sunflower cultivation<br>- Field day for demonstration</td>
<td rowspan="2">Value Propositions<br><br>- Extension service<br><br>- Power tiller<br><br>- Low-lift pump (LLP)<br><br>- Sunflower</td>
<td>Beneficiary Relationships<br><br>- Selected extension farmers from villages</td>
<td rowspan="2">Beneficiary Segment<br><br>- Small farmers</td>
</tr>
<tr>
<td>Key Resources<br>- Training personnel<br>- Training curriculum for extension farmers<br><br>- Power tiller/low lift pump on credit/monthly installment facility<br><br>- Quality sunflower seed, extension service</td>
<td>Channels<br>- Project extension officers at sub-district<br>- Partnering seed company authorized sub-district agricultural seed dealer</td>
</tr>
<tr>
<td colspan="3">Cost<br>- Monthly compensation to sub-district extension officers<br>- Monthly financial incentive for the extension farmers for the first year<br>- Cost of providing training to the extension farmers<br>- Pay for popular/street theatre<br><br>- Power tiller costs BDT 135,000[2]. Each of 25 cooperative farmers has to pay 12 monthly installment of BDT 450. Tilling cost will be paid by farmers and the money will be deposited to a common fund. Maintenance expenditure, pay to driver, fuel cost etc. will be met from the common fund.<br><br>- Low-lift pump costs BDT 35,000. Each of the 5 cooperative farmers has to pay installment of BDT 292 for12 months. Farmers will pay for the irrigation on hourly basis to a common fund. Installments, maintenance, fuel costs etc. will be incurred from the common fund.<br><br>- Estimated production cost for producing sunflower in one acre land is BDT 18,000 – 20,000.</td>
<td colspan="3">Benefit<br>- Extension service at the doorstep of farmers<br>- Sustainable extension service<br><br>- Availability of power tiller/LLP to the poor farmers at an affordable installment price on group basis. Low cost access to irrigation for smallholders using LLP. Surplus amount after meeting maintenance expenses of power tiller/LLP will be deposited to a mobile/bank account. Concerned microfinance institution may charge 13.5% flat or 27% declining interest for credit purchase.<br><br>- Estimated revenue from selling sunflower seeds of one acre land is BDT 42,000. Net profit per acre is BDT 22,000. Sunflower yield generally is 30 mound/1 acre land. Usually, 15 kg oil/1 mound oil seed is extracted. BDT 100/1 kg oil can be sold and earned.</td>
</tr>
</table>

Note: 1. 1.00 USD = 78.91 BDT as of 1 January 2017 (Retrieved from http://www.xe.com/currencyconverter/convert/?Amount=1&From=USD&To=BDT)

**Table 3 Integrated business model for Dowarabazar, Sunamganj, Bangladesh**

<table>
<tr>
<td rowspan="2">Key Partners<br><br>- Project implementation team<br>- Sub-district Government Agriculture Office<br><br>- Power tiller/shallow tube well selling company<br>- Microfinance institution<br>- Mobile banking platform<br><br>- Seed company</td>
<td>Key Activities<br>- Recruiting and orienting sub-district extension officers<br>- Selecting and training extension farmers from each village<br>- Extension officers follow-up extension farmers<br>- Monthly meeting of extension farmers and officers<br><br>- Relaying popular/street theatre for awareness<br><br>- Forming farmers' cooperative<br>- Forming sub-team for power tiller/STW maintenance<br>- Opening mobile/bank account<br>- Monthly cooperative farmers' meeting<br><br>- Extension farmers may sale quality vegetable seed in mini packet of BDT 10-20 at the local village market</td>
<td rowspan="2">Value Propositions<br><br>- Extension service<br><br>- Power tiller<br><br>- Shallow tube well (STW)<br><br>- Quality seed</td>
<td>Beneficiary Relationships<br><br>- Selected extension farmers from villages</td>
<td rowspan="2">Beneficiary Segment<br><br>- Small farmers</td>
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<tr>
<td>Key Resources<br>- Training personnel<br>- Training curriculum for extension farmers<br><br>- Power tiller/STW on credit/monthly installment facility</td>
<td>Channels<br>- Project extension officers at sub-district<br>- Partnering seed company authorized sub-district agricultural seed dealer</td>
</tr>
<tr>
<td colspan="3">Cost<br>- Monthly compensation to sub-district extension officers<br>- Monthly financial incentive for the extension farmers for the first year<br>- Cost of providing training to the extension farmers<br>- Pay for popular/street theatre artists<br><br>- Power tiller costs BDT 135,000. Each of 25 cooperative farmers has to pay 12 monthly installment of BDT 450. Tilling cost will be paid by farmers to a common fund. Maintenance expenditure, pay to driver, fuel cost etc. will be met from the common fund.<br><br>- Shallow tube well costs BDT 20,000 (Engine+ Pump+ Boring). Each of the five cooperative farmers has to pay installments of BDT 334 for12 months. Farmers will pay for the irrigation on hourly basis and will be deposited to a common fund. Installments, maintenance, fuel costs etc. will be incurred from the common fund.<br><br>- Vegetable seed per packet costs BDT 10-20<br>- 1 kilogram foundation seed costs BDT 42 (around 10 decimal can be planted with 1 Kg seed)</td>
<td colspan="3">Benefit<br>- Extension service at the doorstep of farmers<br>- Sustainable extension service<br><br>- Availability of power tiller/STW to the poor farmers at an affordable installment price on group basis. Low cost access to irrigation for smallholders using STW. Surplus amount after meeting maintenance expenses of power tiller/STW will be deposited to a mobile/bank account. Concerned microfinance institution may charge 13.5% flat or 27% declining interest for credit purchase.<br><br>- Villagers could give requisition for quality seed in advance to the village extension farmers.<br>- Village extension farmers may enjoy commission on seed sales.</td>
</tr>
</table>

not available when needed by the farmers in both areas. In addition, as a plausible solution to the irrigation problem during dry season, low lift pump is proposed in the coastal area and shallow tube well is proposed in the haor basin. Moreover, lack of quality seeds for different crops reported as a problem by the local farmers in the haor basin and requires a solution. Finally, structuring a good forward linkage for fish and farmed duck eggs can ensure promising income prospects for the farmers in Dowarabazar haor basin.

## III. Integrated Business Model

## 1. Technology Innovations Dynamics: Geographical Information

Bhandaria sub-district is located in the Pirojpur district, which is close to the Bay of Bengal in the southern part of Bangladesh. The area of the sub-district is 163.56 square km. Bhandaria is endowed with a natural ecosystem consisting of rivers, canals, forests and other natural resources. In the sub-district, 49.2% of the population lives on agriculture with a concentration of 34.58% on cropping, livestock, forestry, fishery and 15.24% as agriculture labor. Just over 70% (70.05%) of the local people own agricultural land and 29.95% are landless. Four cropping patterns observed in Bhandaria are given in the following Table 4.

**Table 4 Cropping pattern at Bhandaria**

| Serial No. | Rabi[1] (October-March) | Kharif-1[2] (March-July) | Kharif-2[3] (July-October) |
|---|---|---|---|
| 1 | Rabi crops | Transplanted Aus[4] (LIV[5]) | Transplanted Aman[6] (HYV/LIV) |
| 2 | Fallow | Transplanted Aus (LIV) | Transplanted Aman (HYV/LIV) |
| 3 | Rabi crops | Fallow | Transplanted Aman (HYV/LIV) |
| 4 | Boro[7] (HYV[8]) | T. Aus (LIV) | Transplanted Aman (HYV/LIV) |

Note: 1. Winter cropping season
2. Early monsoon cropping season
3. Monsoon cropping season
4. Rain fed lowland rice
5. Locally improved variety
6. Rain fed monsoon rice
7. Irrigated winter rice
8. Irrigated winter rice

Source: Department of Agricultural Extension, Bhandaria, Pirojpur, Bangladesh

Agriculture accounts for 49.82% of the main sources of income for the local people. Approximately 26,000 peasant households live in the coastal sub-district of Bhandaria. Total number of farmers can be further fragmented in the following Table 5.

**Table 5 Number of farmers in Bhandaria**

| Category by Farm Size (Acre) | Number of farmers |
|---|---|
| Large scale farmers (7.5 and above) | 708 |
| Medium scale farmers (2.5 to 7.49) | 3,332 |
| Small scale farmers (1.5 to 2.49) | 5,328 |
| Marginal farmers (0.5 to 1.49) | 11,926 |
| Functionally Landless farmers (0.05 to .49) | 4,418 |
| Total | 25,712 |

Source: Department of Agricultural Extension, Bhandaria, Pirojpur, Bangladesh (2009-10)

Dowarabazar is a sub-district of Sunamganj District in Sylhet Division of Bangladesh. It has an area of 263.35 square km bounded by Meghalaya state of India on the north. Agriculture accounts for 71.14% of the main sources of income for the local people. Among them 54.72% people own agricultural land where as landless people accounts for 45.28%. A cropping pattern matrix is given in Table 6 that is observed in Dowarabazar.

**Table 6 Cropping pattern at Dowarabazar**

| Serial No. | Rabi (October-March) | Kharif-1(March-July) | Kharif-2 (July-October) |
|---|---|---|---|
| 1 | Boro | Fallow | Aman |
| 2 | Boro | Fallow | Fallow |
| 3 | Fallow | Aus | Aman |
| 4 | Vegetable | Aus | Fallow |
| 5 | Vegetable | Vegetable | Aman |
| 6 | Fallow | Fallow | Aman |

Source: Department of Agricultural Extension, Dowarabazar, Sunamganj, Bangladesh

Approximately 2,900 peasant households live in the haor basin of Dowarabazar sub-district. Total number of farmers can be further fragmented in Table 7.

**Table 7 Number of farmers in Dowarabazar**

| Category by Farm Size (Acre) | Number of farmers |
|---|---|
| Large scale farmers (7.5 and above) | 780 |
| Medium scale farmers (2.5 to 7.49) | 5,335 |
| Small scale farmers (1.5 to 2.49) | 10,270 |
| Marginal farmers (0.5 to 1.49) | 9,415 |
| Functionally Landless farmers (0.05 to .49) | 3,000 |
| Total | 28,800 |

Source: Department of Agricultural Extension, Dowarabazar, Sunamganj, Bangladesh (2012-13)

## 2. Extension Service

Local farmers in the two marginal sub-districts of Bhandaria, Pirojpur and Dowarabazar, Sunamganj reported that they are not getting the timely and available extension service. According to the government-employed agricultural extension officers, it is not possible to reach all the farmers in all the villages in a given season with the existing fewer human resources. As a result, farmers often face financial losses due to improper utilization of their land, pest attack, improper selection of planting seed, inappropriate cropping pattern etc.

In response to the aforementioned situation, sustainable extension service is inevitable for the farmers. A possible solution to the problem is to appoint one or two agricultural extension officers centrally in the sub-districts, who in turn will corroborate with locally selected two smallholder (SH) extension farmers from each village and provide them special training on extension service. These village extension farmers will act as the agent of sustainable agricultural extension in the villages if at some point of time the appointed agricultural extension officers are removed. Furthermore, these trained extension farmers will be linked with all local agricultural stakeholders including government extension service officials.

Hiring sub-district agricultural extension officers to give backup to the village extension farmers is the first task in this regard. Deciding the number of extension farmers to be recruited to serve a considerable number of smallholders in the area is critical. After recruitment, the extension service officers will be given orientation. Agricultural extension officers will select two or more number of extension farmers from each village and the selected farmers would be small farmers, who can identify the problems and what is necessary for their activities. These extension farmers will be given training for helping their own community. Project implementation team appointed sub-district based agricultural extension officers will have to closely tie up

with the village level extension farmers. Moreover, they have to sit in meetings with the extension farmers at least once a month. Besides, follow-up over cell phone should be regular. Furthermore, extension farmers will contact the extension officers as and when they feel the need to consult.

Target group of beneficiaries for the extension service ought to be small farmers. According to local farmers, comparatively large-scale farmers or farmers who are relatively wealthy have better communication with the government agricultural extension officers. Small farmers are more vulnerable in accessing extension service.

So, to help them, appointed extension service officers will have to play a crucial role not only in training and supervising the village level extension service farmers, but also in managing the backward value chain solving some other input requirements for the small farmers. Extension officers will also have to work toward accumulating and selling farmers' sunflower oil seed produces demonstrated in Table 2.

Selected agricultural extension farmers from each village will be held responsible for conducting the necessary consultation within their community. These agricultural extension farmers will also be the touch points of ordering the necessary input requirements for small farmers. Extension farmers in turn will contact the appointed sub-district based agriculture extension officers and other stakeholders to put forward their input requirement.

As extension service is the key product to deliver, so as to ensure sound service to the beneficiary groups, training personnel are the key resources for developing proposed village-level agricultural extension farmers. A detailed agricultural extension service-training manual will be distributed to train the village-level extension service farmers.

Expenditure for extension of the service model includes, but is not limited to, the following: monthly compensation for extension officers, financial incentive (may be in the form of sales commission of production inputs) for extension farmers, cost of providing orientation and training to the extension officers and extension farmers, recruitment and selection of extension officers and extension farmers, monthly meeting arrangement with extension farmers, etc.

The attempt to promote agricultural extension service in the selected marginal areas is directed at sustainable agricultural development. The idea of developing extension service farmers from within the community will help to achieve the purpose. By the same token, disadvantaged small farmers will have access to extension service within their reach. Eventually, small farmers will be able to protect themselves from tentative productivity or financial losses due to lack of access to information.

The entire plan will have to be implemented under close supervision of the project implementation team in strategic partnership with the Department of Agricultural Extension at the sub-district level.

## 3. Power Tiller

Small farmers of Bhandaria and Dowarabazar sub-districts are so poor that it is quite expensive for them to afford power tillers. Furthermore, the cost of tilling is so high that some of the smallholder tenant farmers leave half of their land uncultivated because they cannot afford to pay for tilling. In both sub-districts, there are some power tillers in different locations and those are purchased and rented by some comparatively wealthy persons, who are not actually farmers, but are renting the machines to make money. Addressing the demand, a group-based credit purchase facility is devised to make power tiller available to farmers.

Smallholder farmers who cannot afford to purchase their own power tiller are the target beneficiary group. Trained extension farmers in each village will help in forming farmers' co-operative or village organization of, say, 25 persons. The extension farmers will help in the purchase of power tiller for the farmers' village organization through appointed sub-district agricultural extension officers.

Project appointed sub-district agricultural extension officers would take requisition from the deployed village extension farmers for purchasing power tiller. If the extension officers become convinced by the formation of the co-operative and farmers' real need, then s/he will oversee the final purchase and hand over the power tiller to the farmers' co-operative.

It is not possible for the smallholder farmers to pay for the power tiller upfront, even though in a group, they do not afford to give the chunk of money at once. So, the smallholders will be given the opportunity of paying in installments through credit purchase. Consequently, it would be easier for the farmers to repay the money, say, in twelve monthly installments.

Formation of farmers' village organization or co-operative is central to this model of power tiller. A sub-group or maintenance team of three farmers from the co-operative will be formed to look after the maintenance, transactions, installment payments, etc. A mobile bank account or traditional bank account will be opened in the name of the co-operative and any surplus amount, after meeting all costs, will be deposited to the bank account for future contingency. Co-operative members have to sit for monthly meetings to discuss maintenance and financial transaction issues related to the power tiller.

A power tiller usually costs BDT 135,000. If, for example, 25 farmers have to pay for the credit purchase spanning 12 equal monthly installments then

each of the farmers will have to pay BDT 450 monthly. Farmers will continue to pay for the tilling of their land proportionate to their own land amount. However, they will pay at a lower rate than the one practiced in the locality. For instance, if BDT 2,000 is the local rate for tilling fifty decimal of land, then farmers will actually pay for BDT 1,700.

All maintenance cost including pay to drivers, repairing cost, fuel cost and monthly installments for credit purchase of the power tiller will be paid from the cumulative fund actually paid by the smallholders as tilling cost. Surplus amount will be deposited to a mobile bank account or bank account opened after the co-operative or village organization. It is possible that the monthly installments for the credit purchase of power tiller will be directly paid from the mobile bank account to the power tiller selling company.

Overall, through their effort, farmers will afford to access the utility of power tiller. Moreover, the tiny amount of monthly installments payable for the credit purchase will not be a problem for them. And, it is already told earlier that after meeting all expenses the surplus amount will be deposited to a bank account or mobile bank account, which will act as a contingency fund. Interest may be charged at 13.5% flat or 27% declining rate by the loan extending organization as an earning option, if equal monthly installment (EMI) facility is not provided to the farmers' cooperative.

Finally, in managing the implementation plan, sub-district based extension officers and the village level extension farmers have to play a vital role as they will act as the facilitator in forming co-operative and purchasing the power tiller for the smallholders.

## 4. Low-lift Pump

Smallholder farmers, who are struggling to irrigate during the winter season due to a lack of proper water management and affordability, are the target beneficiaries for this model. Peasants at Bhandaria sub-district are dependent on the nature for irrigation. During dry or winter season, which spans from October to March, farmers face difficulty in cultivating 'Boro' rice because of scarcity of irrigation water. As a result, hectares of land remain fallow during the dry season. However, other winter crops, requiring lesser amount of irrigation, have significant prospects.

Visiting villages in the locality and discussing with the farmers and government agricultural extension officers, revealed that during the dry season water logged in the closed water bodies around the cultivable lands. The problem is to transfer the logged water from that nearby water bodies into the field. To address this problem, low-lift pump is a way out for water management and irrigation.

To address the problem, village level agricultural extension farmers will act as community facilitators. Selected extension farmers in the villages would help smallholders to form co-operative, assist them in credit purchase of low-lift pump and most importantly, provide timely information on relevant issues.

As in the power tiller model, the sub-district based project deployed agriculture extension officers will keep connection with the village level extension farmers and guide them, follow them as and when necessary. Sub-district extension officers will verify the farmers' co-operatives and then facilitate the credit purchase of low-lift pump.

Credit purchase facility for the smallholders is a key solution in this model. Payments over 12 monthly installments will enable the destitute farmers to afford the low-lift pump. A low-lift pump requires an investment of around BDT 35,000, which can be allocated separately for engine, pump, pipe, filter, etc. The purchasing cost can be allocated as follows.

- Engine BDT 20,000+Pump BDT 6,000+Pipe BDT 7,500+Filter BDT 1,000+Transport BDT 500 = Total BDT 35,000

Besides, there are some other operating expenses to run the low-lift pump and these costs may vary from year to year. Such operating expenses include for instance,

- Diesel: For the 'Rabi' or dry season, diesel or fuel costs around BDT 9,000.
- Spare parts: During every 'Rabi' season around BDT 2,000 may require for spare parts.
- Mechanic: Cost of repairing may be around BDT 1,000 over a year.
- Drainage: For distributing water to different plots, drainage may cost around BDT 3,000.
- Shed: Building a hut for the pump will cost around BDT 3,000.

In brief, forming 10 member farmers' village organization is crucial. Recruited village extension farmers will assist and supervise the formation of the village organization. These village extension farmers will communicate with the sub-district based extension officer and place requisition for the credit purchase of low-lift pump. Then, the extension officer will facilitate the machine purchase. A 3-member subcommittee will be formed to look after the maintenance and transaction related issues. A bank account will be maintained after the village organization. This bank account may be a traditional or mobile bank account. Co-operative farmers will have to pay for irrigation

using low-lift pump, but at a lower price than the usual rate in the locality. After meeting all the maintenance costs, e.g. fuel cost and repairing cost, the surplus amount will be deposited to the mobile/bank account. The monthly installments for credit purchase can be easily transferred to the sellers' account from the village organization's mobile bank account. Village organization or co-operative farmers will have to sit together for meeting once in every month to discuss financial transaction related issues and to ensure accountability of the three-member sub-committee.

Eventually, low-cost access to irrigation using low-lift pump through co-operative effort will enable farmers, especially smallholders, to grow crops in the fallow lands. Farmers may otherwise not be able to afford the costly irrigation. A margin of 27% declining interest rate or 13.5% flat rate can be charged for the credit purchase by the machine selling company or the loan providing financial institution.

## 5. Sunflower

Sunflower cultivation seems promising in Bhandaria, Pirojpur. If farmers can be induced to cultivate sunflower just after harvesting the 'Aman' paddy, it will take little irrigation for the sunflower due to prolonged rain till the end of October. It must be mentioned that sunflower needs only two spells of irrigation whereas 'Boro' paddy requires 25 spells of irrigation. Say, for example, if the sunflower is sowed in mid-November, it will take 120-130 days to harvest the oil seed. Hybrid variety requires seven more days. And, in March the farmers may sow the late 'Boro', which will in turn partially subsidized by the rainstorm that usually starts in mid-April in Bangladesh.

Local farmers are enthusiastic in producing sunflower provided buy-back guarantee of their produces exists. Popularizing sunflower cultivation and setting an effective value chain could improve the livelihood of the marginal poor farmers in the area. Some of the farmers who attended the workshop said that they could not initiate cultivation last year due to unavailability of information, i.e., where to collect the seeds. The majority of farmers do not know how sunflower should be cultivated and how profitable this vegetable oil seed is.

Two sunflower varieties can be cultivated in the area, BARI Sunflower-2 and hybrid Hysun-33. Both of the varieties already showed good yield in the greater Barisal region. Usually, two days-sundry seeds of BARI Sunflower-2 yield about 11 mounds/bigha (33 decimals). And, Hysun-33 variety's yield is much more than BARI sunflower-2. Hysun-33 is uniform in height and in flower size. Unfilled seeds are comparatively less. So, yield is relatively higher.

There is a huge cost difference between the BARI Sunflower-2 and Hysun-33 seeds. Hysun-33 is about BDT 1,400 per kilogram, whereas BARI seeds are only BDT 60 per kilogram. But farmers require only 1 kilo of seed for 1 acre of land and with the same fertilization and irrigation cost, hybrid Hysun-33 seed's yield is higher compared to other varieties. Cultivating sunflower on one acre of land will cost BDT 18,000 - 20,000 approximately, which includes all production inputs such as seed, fertilizer, tillage, irrigation, weeding, labor, harvesting, etc.

Some problems during cultivation may pose risks and costs for the farmers. For instance, just after sowing seeds, some of the seeds may be eaten by ants. Furthermore, during the flowering period, passersby may steal some flowers. Moreover, in case of pest infestation both BARI Sunflower-2 and Hysun-33 varieties face difficulties. At the last stage, caterpillar infestation is severe. Finally, farmers may need to take protection by spreading nets over the plants to prevent birds from eating up the matured seeds.

Basically, small holder farmers are the target beneficiaries for this proposed model. Farmers in the selected areas usually left their land uncultivated during 'Boro' or dry season mainly because irrigation in the dry season is costlier for them to afford. Few farmers in Bhandaria, Pirojpur do lentil cultivation during dry season. So, producing and selling sunflower oil seed will utilize the fallow lands thereby increasing their income by 2 to 2.5 times. In addition, farmers could sell their produced oil seed in the open market to the local oil millers or other local traders at the spot market price. But in this case, how much return they could earn is not certain.

A mechanism of buy-back guarantee for the farmers could be developed. If sales of the produced sunflower seeds can be insured in advance of production upon agreement with any sunflower oil seed processor, then the farmers will become more enthusiastic concentrating in sunflower production. Moreover, other farmers in the area will become interested to produce sunflower due to the buy-back guarantee.

Sunflower seed unavailability during seed sowing season and forward linkage during harvesting season are the two major obstacles in the locality. Development of a proper marketing channel is crucial for the scalability of sunflower production. Local farmers have some queries regarding sunflower cultivation i.e. from where to procure quality seed, method of cultivation, who will buy the produces, will the selling price payoff the production cost etc.

Farmers need to be linked with the input suppliers and that can be termed as backward integration. Farmers will collect all sorts of production inputs including quality sunflower seeds from the trained extension farmers or from the project authorized dealers in their respective villages.

After harvesting, the seeds of sunflower need to be further processed for edible oil. Here comes the necessity of forward integration, how the farmers

will sell their produces. The project implementation team will make arrangements for buying and selling between farmers and oil seed processors. The project authorized sub-district extension officers and village level extension farmers will have to play a key role in this arrangement.

The extension farmers will assist the formation of farmers' co-operative for sunflower cultivation. The role of extension service is undeniable to make the farmers aware about sourcing production input, production method and selling produces. Project appointed sub-district based extension officers will facilitate the process of connecting farmers' co-operative with the prospective buyers or processors of sunflower oil seeds.

Production inputs required for sunflower cultivation are seed, fertilizer, insecticide, irrigation pump, power tiller, etc. Moreover, the group approach or block approach (farming in a wide area of land) to cultivate sunflower through farmers' co-operative will be a strength of unity for the farmers. Consequently, system loss, i.e. stealing flowers, ransacking plants by livestock, etc. can be minimized. The need of group based farming is also significant for the scalability of the sunflower cultivation in the region. Watching a group of farmers cultivating on a wider scale and making handsome profit, other farmers in the region will also become enthusiastic in sunflower cultivation.

The project implementation team will make alliance upfront with sunflower seed processors. Furthermore, the supply of quality sunflower seeds and other production inputs through the deployed extension farmers will be ensured. Moreover, microcredit loan provision will be extended to the farmers for sunflower cultivation in collaboration with microfinance institutions.

Providing training to farmers at different level of cultivation is another key activity. As a new crop to the majority of the farmers, training will be given on seeding, irrigation, fertilization, weed management and harvesting of sunflower. These farming trainings should be arranged in the vicinity. Arranging the training sessions in the local setting will help in the diffusion of the sunflower cultivation idea among others. Trainings will be conducted by the project appointed extension officers and farmers in collaboration with the department of agricultural extension office in the sub-district.

Arranging 'Field Day' on the day of harvesting would be an effective way to attract other farmers in the area. On a 'Field Day' farmers in the locality along with their wives will be invited to participate in the harvesting event. 'Popular Theatre' or 'Street Theatre,' another useful way of creating awareness among rural people, will be played across the sub-district to popularize sunflower cultivation.

To further demonstrate the benefit of sunflower cultivation, according to Department of Agricultural Extension, approximately 33 mounds seed can be harvested from one acre of land at a market price of about BDT 52,800 (BDT 40/kg). In case of hybridseed, about 40 mounds seeds can be harvested at a

market price of BDT 64,000 (BDT 40/kg). In addition, dried stem of the plant is months-long good fuel for cooking thereby saving daily fuel costs for the farmers. Generally, farmers can sell their produced seeds at a price ranging from BDT 1,300 and BDT 1,600 per mound. So, a farmer producing sunflower in one acre of land and selling seeds can earn as follows:

- Cost of production for one acre: BDT 20,000
- Yield in one acre: 30 Maund (Least)
- Selling price: BDT 1,400 per Maund
- Revenue: BDT 1,400 * 30 Maund = BDT 42,000
- Net profit: BDT 22,000

Farmers may wish to crash the seeds themselves using traditional mustard crashing machine. A land area of 16.5 decimal is enough for a medium size family to consume own produced oil round the year. Roughly, 5 maund seeds can be expected from 16.5 decimal of land. In turn, 75 kilogram oil can be extracted from 5 maund seeds at a rate of 15 kilogram oil per maund of seeds. It is mentionable, locally produced sunflower oil is selling in the south bengal region at BDT 100 per kilogram. Where as the market price of bottled sunflower oil is about BDT 220-320 /kilogram.

## 6. Quality Seed

Smallholder farmers are the target group of beneficiaries for this business model as they are the worst sufferers due to lack of quality seeds. Farmers in the haor basin of Dowrabazar sub-district are not getting quality seeds due to weak distribution channels and high cost. According to the Bangladesh Ministry of Agriculture, the public and private sector seed providers in Bangladesh supplied only 18% of the total requirement for seed in 2008-9. The remaining 82% are low-quality seeds retained by farmers. The same is applicable to this sub-district. Local farmers reported that the unavailability of quality seed during different planting season is a severe problem. Due to lack of quality seed, farmers' cropping yield is not up to the mark thereafter resulting in lower profit margin or even loss. So, to increase smallholder farmers' productivity, superior quality seed at a reasonable price is inevitable.

Farmers and agricultural extension officers reported that due to unavailable good quality seeds for cereals and crops in the area, the productivity of summer vegetables, winter vegetables and cereals is low. Furthermore, the number of government appointed extension farmers are very limited from whom the farmers could get some instructions about quality seeds. A strong

foothold of quality seeds' distribution at the farmers' door step could be a way out to solve the problem. With a view to extend the reach of quality seed, the village level proposed extension farmers will be the touch points or customer points for collecting quality seeds for the local farmers.

In Bangladesh, the distribution of seeds takes place through retail outlets that receive seeds from the producing companies through intermediate distributors, or through wholly integrated companies. Bangladesh Agricultural Development Corporation (BADC), which is a government-owned self-regulated organization, has a seed sales center in the Sunamganj district. The organization has a registered sub-dealer in Dowarabazar sub-district. However, government supply objectives frequently do not meet and seed stocks remain unsold because the public sector usually operates on 'passive distribution systems,' simply stocking with agro-dealers where a farmer can collect seed but often leave many outlets un-stocked or with the wrong varieties. Such systems are not responsive to the needs of the farmers (ICARDA, 2003). Thus, the private sector has scope to work for the improvement of seed value chain.

The seed market competition often lures seed sellers to sell those companies' seed that generate a greater commission. These customer touch points often mislead the farmers, derived by their own interest in higher profit margin. In this case, the seed sellers often overlook quality. The situation of Dowarabazar is not an exception in this regard. Partnering with a seed company and enlisting a local seed dealer in Dowarabazar and subsequently spreading a strong foothold deploying village level extension farmers throughout the sub-district to tap the seed market of 28,800 farmers will be beneficial to the seed sellers as well as to the small and marginal farmers in the area.

Given the circumstance, proposed village level extension farmers will sell seeds to the farmers in the villages. Extension farmers and extension officers will conduct yard meetings to make local farmers aware about the significance of using quality seed along with the information, 'from where to collect the quality seed.'

To inform farmers about the 'quality seed' initiative, relaying popular theatre in villages will be instrumental as a promotional method. Popular or street theatre is a sort of awareness creating drama at the same time recreational drama addressing social issues. The theatre artists (usually 10-15 members group) will have to be paid for each show.

Considering affordability of the farmers, BDT 10-20 packet of quality seed for vegetables could be convenient. For all type of crops' and cereals' seeds, a partner seed producing company will be held responsible for the production, transportation and distribution of seeds to the dealers. Proposed extension farmers will procure and sell seeds to the village farmers. Consequently,

smallholder farmers can access an ease source of superior quality seed within their reach. And the partnering company can exploit an untapped market.

Finally, consistent supply of quality seed at the dealers' end is a key success factor for implementing the business model. Hence, project appointed sub-district based extension officers will have to keep in touch with the appointed seed dealer to ensure the quality of shelved seeds and to make sure the replenishment of stock for availability of high quality seeds.

## 7. Shallow Tube Well

Due to a lack of proper irrigation, smallholder farmers in the Dowarabazar haor basin cannot cultivate their land during the dry or 'Rabi' season. As a result, hundreds of hectares of land remain fallow during the dry season. Even if farmers can manage to irrigate their land using shallow tube well, the cost is very high. Many of the smallholders left their land uncultivated because of unavailable and costly irrigation system.

For facilitating the smallholders in the area, shallow tube well is considered to be the best alternative considering the establishment cost and environmental aspect of some other form of irrigation systems i.e. floating irrigation system, rubber dam, and deep tube well. Smallholder farmers who cannot afford to bear the cost of irrigation are the target beneficiary segment for this model.

This model of shallow tube well is similar to previously described power tiller model. Proposed agricultural extension farmers will assist the formation of farmers' cooperative and act as intermediary between farmers' co-operative and proposed sub-district extension officers. As in the power tiller and low-lift pump model, the proposed extension officers will facilitate the machine purchase after getting requisition from the village level extension farmers.

Farmers will get the opportunity to buy shallow tube well on credit. They do not have to pay for the whole chunk of payment upfront. Instead, they can avail themselves to the option of installment payments, for example 12 equal monthly installments.

A 2,600 horsepower shallow tube well usually costs BDT 16,300 - 18,300 and including the boring cost around BDT 20,000. Boring cost includes the labor cost as well. So, a co-operative of five farmers will have to pay no more than BDT 334 in equal monthly installment (EMI) over 12 months. Adding a 13.5% flat interest or 27% declining interest will raise the monthly installment amount to BDT 379 only. In Dowarabazar sub-district, farmers usually pay for irrigation on hourly basis and the rate is BDT 120 per hour. So, cooperative farmers will continue to pay for the irrigation, but at a lower rate, e.g. BDT 50 per hour. And, this irrigation fee will be used to form a common fund from which all the maintenance costs will be borne.

Affordable and sustainable irrigation is the purpose of this model. Farmers will benefit from paying less for the irrigation and at the same time meeting maintenance cost and pay for the credit purchase of the shallow tube well from a common fund. The surplus amount after covering all costs will be deposited to the co-operative's bank account for future contingency.

The activities that need to be performed for this model are similar to those of power tiller or low-lift pump model. The basic difference here is that the co-operative will consist of five members. The village-level extension farmers will act as the facilitator and intermediary between the extension officers and the farmers' co-operatives. Two/three members' sub-committee from each cooperative will look after the maintenance and other stuffs such as handling bank account, payment of installments etc. A bank account in the name of the co-operative should be opened and it could be a mobile banking account by which monthly installments and other transactions can be conducted.

A strategic partner to sell the shallow tube well on credit purchase on monthly installments will be contracted or a microfinance institution will be partnered to extend loan to the co-operatives for purchasing shallow tube well in return for monthly installments.

## IV. Forward Linkage Model

### 1. Farmed Duck Eggs and Live Ducks

In Dowarabazar haor basin, a dozen of duck eggs are being selling at BDT 60 or USD 0.77 only. Whereas in the capital city Dhaka and in other urban areas of the country a dozen duck eggs cost BDT 135 or USD 1.73. Almost a 100% price difference per dozen is quite significant in terms of purchasing power of mass people.

In parallel, the price of chicken eggs also plunged in Dowarabazar as chicken eggs are substitute of duck eggs. Consequently, both duck and poultry farmers do not get the justified price for their farmed eggs. If the surplus quantity can be pushed out of the locality by forward integration to the urban areas, the commercial farm owners as well as the individual duck owners are expected to make higher return.

With a view to curb the excess supply of duck eggs to help the duck farmers and the urban or local consumers, a new form of value chain needs to be in place. The existing value chain consists of the following actors, depicted in Figure 2.

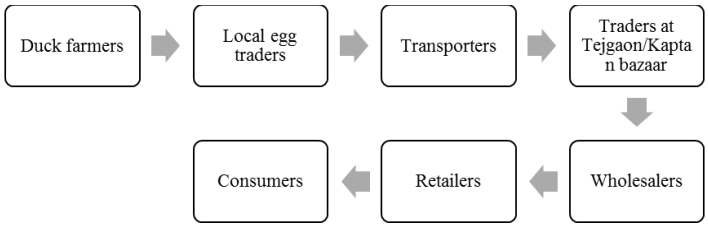


**Figure 2 Existing forward linkage for duck eggs**

The major problem residing with the existing forward linkage is that there are influential individuals who buy eggs at a lower price from local households and commercial farmers, and in turn these influential persons meet the capital requirements of the commercial farmers. Thus, the influential traders squeeze out profit of the duck farmers. Moreover, other actors within the value chain also held responsible for an increased price at consumers' end and a lower profit at farmers' end.

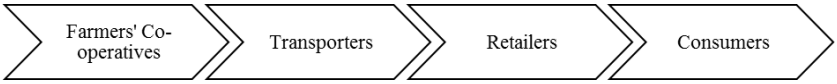


**Figure 3 Slashed forward linkage for duck eggs**

Eventually, to increase the bargaining power of the duck egg commercial and backyard farmers, forming farmers' co-operatives could be an ideal solution. These farmers' co-operatives (for example, each consisting of 20 farmers) will have to be linked with the urban retail super shops as shown in Figure 2. Either the farmers' cooperatives or the retail super shops will arrange the transportation of egg supplies to the doorstep of the retail outlet.

By the same token, live ducks for meat may also be sold following the same forward integration. Initially, the proposed village level extension farmers will have to facilitate formation of cooperatives and proposed extension officers will conduct the introductory formalities between the cooperatives and retail super shops.

## 2. Open Catch Fish

The majority of the land areas in Dowarabazar, Sunamganj went underwater throughout almost for seven months. This period ranges from mid-May to mid-November called the 'open catch' period. During this time, as most of the land area flooded, individual fishermen can have access to fishing in their surrounding water bodies. During the remaining period of the year, from mid-November to mid-May, water subsides to the specific areas of haor and river

basins. This period of time is called 'organized catch' season. Relatively big fishes are caught in this season and accounts for two third of the total fishes caught around the year.

However, there are complications regarding the ownership of different wetlands in the haor areas. Influential leaders lease the demarcated wetlands and haors and in turn sub-lease them to local influential individuals. These local individuals rent out specific area of water bodies to individual fisherman or fishermen groups for fishing. This rent-out may take place in exchange of cash rent or on the basis of shares of caught fishes. Some local influential persons also deploy fishermen to catch fish for them.

The organized catch season is considered the peak season for fishing and the related stakeholders are more active during this season. Local influential persons are relatively less stringent in regulating fishing during open catch season. As a result, poor individuals or fishermen, who are not exclusively living of this trade but carry out livelihood temporarily, try out fishing in the submerged wetlands during the open catch season.

However, fishes caught by these individual fishermen are not significant. It is possible to form farmers' co-operatives and link them with the retail supermarkets in the capital city Dhaka or in nearby Sylhet city. For instance, there are around 10 retail supermarkets with hundreds of branches in Dhaka and these retail supermarkets need on an average two tons of different species of fishes every alternative day. So, continuous supply of fishes needs to be ensured at the suppliers' end. Existing fish forward linkage contains many intermediaries which create obstacles and unnecessarily increases the price of fish to the end customers as illustrated in Figure 4.

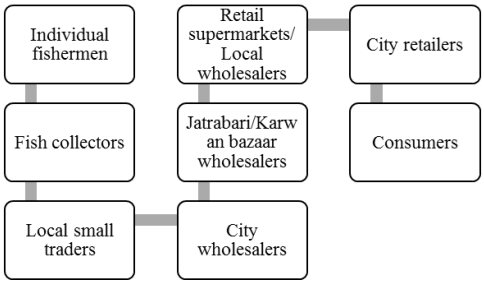


**Figure 4 Existing forward linkage of fish**

Due to the many intermediaries involved in the existing forward linkage, the price of fish at the consumers' end increased by a significant amount. The irony is that even though the fishermen create the major value, they enjoy the smallest share of the final retail price paid by the consumers. Removing intermediaries and put in place a new value chain would be a

difficult, but possible solution to assure better selling price for the fishermen as shown in Figure 5.


**Figure 5 Curbed forward linkage for open catch fish**

For the curbed value chain, farmers need to be congregated to have a greater amount of caught fishes and to ensure continuous source of supply for the retail supermarkets. Proposed extension farmers and extension officers will have to assist the discrete small fishermen to form co-operatives and thereby linking the co-operatives with the retail supermarkets.

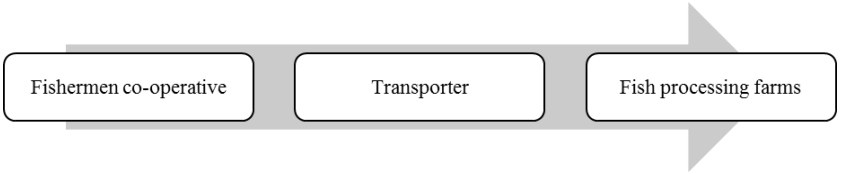


**Figure 6 Alternative forward linkage for open catch fish**

An alternative idea as depicted in Figure 6 is linking the fishermen co-operatives with the nearer fish processing farms. According to the local fish processing companies, their capacities go underutilized in the open catch season. So, it would be mutually beneficial for the fishermen and the fish processing plants to have cooperation with each other.

## V. Discussion and Conclusion

We apply the business model canvas developed by Osterwalder & Pigneur (2010) in promoting agricultural technology for the first time. Proposed village extension farmers, sub-district extension officers and farmers' co-operative are cross-linked and central to the integrated business models and forward linkages. The term, 'integrated business model,' underscores the same key partners, activities, resources, beneficiary relations and channels for the selected technologies or value propositions. Moreover, grooming extension farmers from within the community is integral for the sustainability of the benefits to be recouped.

Instead of the traditional top-down 'pipeline' approach, the TIGA ex-ante assessment takes a bottom-up approach by matching available agricultural technologies with the circumstances in which the poor live and the lives they

want to live (Malek and Gatzweilier, 206; Malek, Gatzweilier and von Braun, 2015). Scaling up the agricultural technology innovations blueprint in other locations within or beyond the country should be subject to customization contextual to the local agricultural problems and prospects.

As formulated by Malek and Gatzweilier (2016), the starting point of identifying potential productivity enhancing innovation packages should be with current farming or management practices and technologies, or newly-introduced goods and services, or machineries and equipment required. Furthermore, those innovation packages should be for the majority of the poor smallholders and to be readily available in the locality. For instance, despite having exploitable potentials, farmers in some areas are adopting technology innovations while others are not. In a similar context, few smallholders are getting very good returns close to exploitable potential yields from those innovations awhile others are getting considerably less. Technology innovations could also include institutions or policies and can take many forms such as new products, production processes, cheaper inputs, improved distribution and marketing and even improved ways of innovating.

For identifying potential technologies, relevant stakeholders which have an interest in promoting smallholders' productivity (typically those within the value chain, but not yet linked) might be brought together in Technology and Business Promotion (TBP) workshops. Alternatively, a business consultant may interview the relevant actors, agree on a set of technologies they would focus on and make informed estimates about the number of farmers reached, the outcomes and the output of the technologies to be applied. Stakeholders or actors are e.g. farmers, technology providers and producers, credit providers, knowledge providers, input providers (agro-dealers), collective action facilitators (mediators), processors and wholesalers etc.

The aim of each actor should be an increase in the productivity of the smallholdings, which apply the technology and an improvement in the outreach (e.g. number of farmers receiving seeds, or training). Productivity growth can be achieved by, e.g. fetching a higher price on the market, reducing farm input or labor costs and increasing yields per area etc.

The bottom line is that technological innovations can fail to be adopted and scaled up because of the following general reasons. Firstly, if the innovation calculus becomes uneconomic at the smallholder level, i.e. the smallholder finds it too costly to adopt an innovation for productivity growth. Secondly, the absence of institutions and property rights may lead to a sub-optimized cost or benefit allocation or may inhibit the generation of sufficient benefits for the smallholder. Finally, uneconomic innovation calculus at mass scale. Some smallholders may decide to adopt the innovation while most are not in a position to do so (Malek and Gatzweilier, 2016).

In the end, to implement the business model in an agrarian context, collaboration amongst different stakeholders is critical. Moreover, it is found that relevant stakeholders have strong incentives to collaborate, but lack a common platform or coordinating body, are hindered by insufficient capacity and funding, which are expected to be toppled by the stated agricultural technology innovations business model.

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