

Pilot Project on Commercialization of Small Holders' CA-based Planters in Bangladesh

Study on Policies and Roadblocks for Small Scale CA Farm Machinery Adoption

Focus Group Discussion and Survey Report

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Abbreviation

ACIAR	Australian Centre for International Agricultural Research
AD	Additional Director
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BDT	Bangladeshi Taka
BMDA	Barind Multipurpose Development Authority
BP	Bed Planting
BRRRI	Bangladesh Rice Research Institute
CA	Conservation Agriculture
CASI	Conservation Agriculture-based System Intensification
CASPA	Conservation Agriculture Service Providers Association
CEO	Chief Executive Officer
CIMMYT	International Maize and Wheat Improvement Centre
CHT	Chinese Hand Tractor
CP	Country Plough
CSISA-MI	Cereal Systems Initiative in South Asia- Mechanization and Irrigation (Project)
CSO	Chief Scientific Officer
CT	Conventional tillage
DAE	Department of Agriculture Extension
DD	Deputy Director
DSR	Direct Seeded Rice
EGP	Eastern Gangetic Plain
FGD	Focus Group Discussion
FMD	Farm Machinery Division
FMPHT	Farm Machinery and Post Harvest Technology
FMPE	Farm Machinery and Post harvest process Engineering
FYM	Farm Yard Manure
GoB	Government of Bangladesh
HC	Hoque Corporation
HP	Horse Power
ICM	Integrated Crop Management
iDE	International Development Enterprises
LSP	Local Service Providers

MoA	Ministry of Agriculture
MP	Murat of Potash
MU	Murdoch University
NAP	National Agricultural Policy
NGO	Non-Government Organization
OFRD	On-Farm Research Division
PTOS	Power Tiller Operated Seeder
RCT	Resource Conserving Technology
RDA	Rural Development Academy
RDRS	Rangpur Dinajpur Rural Services
RWRC	Regional Wheat Research Centre
SAAO	Sub-Assistant Agriculture Officer
SDG	Sustainable Development Goal
SPST	Single Pass Shallow Tillage
SRFSI	Sustainable Resilient Farming Systems Intensification (Project)
ST	Strip Tillage/Strip Planting
TAT	Turn Around Time
TMSS	Thengamara Mohila Sabuj Sangha
TSP	Triple Super Phosphate
USAID	United State Agency for International Development
VMP	Versatile Multi-crop Planter
ZT	Zero tillage
2WT	Two Wheel Tractor

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The Authors

Executive Summary

Introduction

1. Agricultural mechanization is a promising approach for Bangladeshi farmers to boost agricultural production by minimizing the emerging labour constraints. Research over the last decades in Bangladesh has also demonstrated that Conservation Agriculture (CA)-based production system, involving mechanized seeding of crops and non-puddled transplanting of rice could have a major role to reduce farm labour and production costs.

2. The concept of CA is fairly new in Bangladesh, and there is still limited practice on small farms especially in rice-based intensive crop rotations such in Bangladesh, while it has been practiced globally since 1960s. Since 2005, considerable research has been undertaken on developing CA for small farms in Bangladesh. Research over the last two decades has demonstrated that CA practices could have a major role in overcoming scarcity of farm labour and reducing costs of production and can boost crop production.

3. It is really encouraging that the planters made in Bangladesh (e.g., Versatile Multi-crop Planter, VMP and BARI models) are now being commercialized to allow owners of power tillers (2-wheel tractor, 2WT) to plant crops with minimum soil disturbance and crop stubble retention. From last few years, the ACIAR-funded CA Project led by Murdoch University, Australia in partnership with BARI, BIRRI, BARC, Hoque Corporation, DAE and BAU has been trying to disseminate CA based Versatile Multi-crop Planter (VMP) in North-west region of Bangladesh. Although the owners, operators, and users of VMP have positive opinion about the planter, the commercialization and adoption was not as fast as expected. With the funding support of ACIAR (LWR-2018-111) a study was undertaken to identify the barriers to rapid adoption and dissemination of CA practice and VMP in Bangladesh. The specific objective of this study was to identify gaps in policy, capacity, and roadblocks for the adoption of CA-based farm mechanization (especially VMP) on small farms.

4. Information for this study was collected by secondary and as well from primary sources using different data collection methodologies like literature review, key informant survey, and focus group discussions. From a literature review, the existing situation of agricultural mechanization (past and present), the existing policies on mechanization of Bangladesh agriculture were noted to identify the roadblocks/limitations of existing policies for adoption of

small-scale CA farm machineries like VMP. The actors involving in research and development of CA machineries are policy makers, researchers, manufacturers, national and international organizations, NGO workers and extension personnel. Information was collected from key informant persons in the respective organizations. Focused group discussions were carried out to capture the opinion of field level VMP adopter and users including machinery owners, Local Service providers (LSP) and final users (farmers). FGDs were conducted in four Upazilas under 4 districts where VMP machines are operating in farmers' fields.

Availability of CA Planters in Bangladesh

5. After the agricultural trade liberalization in 1988, the availability of irrigation engine and power tiller (2WT) at an affordable price was more available in Bangladesh. The use of 2WT for land preparation has increased rapidly in the country due to its versatile use, and lower cost for tillage. Since the mid-1990s, research and development work on CA-based resource conservation technologies (RCTs) started with locally developed small machinery, like minimum tillage or no tillage planters, crop production on permanent bed systems, and residue retention.

6. Initial research and development of planting implements/ seed drill/ seeders for 2WT in Bangladesh started in 1995 through the introduction of the Chinese-made 2BG-6A seed drills (which was named variously as the Chinese Hand Tractor [CHT] seeder; PTOS, etc.). Since then, several types of single-pass planters/seeders were tested or developed to establish crops in Bangladesh including PTOS, bed planter, strip planters, zero tillage planters. Three local manufacturers have been involved in producing PTOS; Mahbub Engineering Workshop (Jamalpur), Rahman Engineering (Kushtia), and Alim Industries (Dhaka). Both Rahman Engineering and Mahbub Engineering Workshops were involved with the early research and development and manufacturing process of PTOS seeder for several years with BARI and CIMMYT. All the locally made PTOS have been plagued by quality problems and therefore additional orders/sales have been slow to come, while the PTOS continued to spread mostly for tillage purposes to transplant onion seedlings.

7. After concluding that none of the planters imported or developed locally for 2WTs were capable of planting in all modes of tillage, a new planter was developed, under an ACIAR funded project commencing in 2006. This planter can be used for Single Pass Shallow full

Tillage (SPST, like PTOS), Strip Planting (SP), Zero Tillage (ZT), Bed Planting (BP), and for Conventional Tillage (CT) using full rotary tillage, when driven by 12-16 HP 2WTs. Incorporating features from a range of earlier planters for 2WTs, the **Versatile Multi-crop Planter (VMP)** was designed with capability for banding seed with fertilizer in up to four rows.

Promotion of the Agricultural Machineries in Bangladesh

8. The national research institutes, such as BIRRI and BARI have established linkages with a good number of manufacturers involved in fabrication and manufacturing of agricultural machineries. NGOs are also promoting machines by organizing landless farmers as a part of poverty reduction campaigns. CIMMYT also supports mechanization in terms of demonstration and training.

9. Ministry of Agriculture has been taken to popularize the machineries that have been tested in different locations of the country and found to be suitable. Some specialized projects funded by GOB and donor agencies have been designed to provide special efforts for wider extension, adaptation and utilization of some selected items of farm machinery. The major projects are: (a) Popularization of Agricultural Machinery (PAMP) Project, 2001-2006. Farm Machinery and Postharvest Technology Division (FMPHT) of BIRRI implemented this GOB funded project. (b) Agricultural Engineering Technology Extension Project, 2005-2011. DAE implemented this GOB funded project in 112 selected Upazila of 56 districts. The machineries that have been promoted are: Manual seeder, dry land weeder, rice-wheat reaper, open drum power thresher, rice-wheat thresher, manual and power maize sheller, and seed/fertilizer applicator. Under this project a few number of machineries were sold to farmers on 30% subsidized prices. (c) Farm Machinery Technology Development and Dissemination (FMTD) project, 2010-2015. BARI, BIRRI, and DAE implemented this project covering 48 Upazilas of 24 districts. (d) Enhancement of Crop Production through Farm Mechanization Project, 2010-2012. Despite the problems existing in agricultural field, DAE have taken this project for increasing crop productivity by solving the existing problems by mechanization. DAE implemented this GoB funded project mainly to sell agricultural machineries such as Power tiller (2-wheel), power thresher, maize sheller, tractor (4-wheel), combine harvester, sprayer and hand reaper to the farmers with 25% subsidized prices. The 2nd phase of this project was started from July 2013 by DAE and was continued up to June 2018, in 64 districts of Bangladesh. This project is mainly designed to sell agricultural machineries such as Reaper (rice, wheat), Power Thresher (rice,

wheat), Combine Harvester (rice, wheat), Rice Transplanter, Seeder (PTOS) and Foot Pump to the farmers in subsidized prices. This project has also been designed to conduct farm level demonstration and training on agricultural machineries. Under this project, till June 2019, about 29,768 items of machinery were distributed under subsidy programme including 1,994 pieces of PTOS with power tiller.

In addition to that, 300 **"Custom hiring service centre"** for Ag machineries were created in 300 Upazilas (Anonymous, 2013). This Project was started in July 2016 and continued up to June 2019. DAE have been executing this project under MoA with GoB fund. This project was taken to provide custom hiring services of Ag machineries to farmers with minimum hiring charge. This project emphasized Transplanter, Reaper/ harvester, Thresher and Seeder. In total, 40,000 union councils were under this project having one service centre in each. A set of **one transplanter, one harvester and one thresher were given free** to each service centre with other additional alternate machineries like seeder (PT driven).

10. **VMP expansion:** Originally Murdoch University-Australia designed and developed the VMP, and tried to popularize VMP in some selected area of Bangladesh with the support of DAE and research organizations. Hoque Corporation has been manufacturing VMP from 13th version with the technical assistance by Murdoch University. HC is also working as a commercialization development partner of VMP in SRA-CA project collaboration with MU, BAU, CASPA & ACIAR since September'2015. They are also working on its demand creation, value chain, operator training & follow-up, after sales services and spares availability. Up to 2018, they have sold 205 units of VMP among farmers in north-west districts of Bangladesh and exported 40 units in 9 different countries.

Policy Issues on Agricultural Mechanization in Bangladesh

11. This report also highlighted the policy issues on Ag mechanization in Bangladesh. The then government of East Pakistan started to import Tractors, Power Pumps (DTWs and Low Lift Pump, LLP) with some limitations in late 1960s. In 1988, the Government of Bangladesh (GoB) reverse the import policy, started liberalizing markets, lowered the tariffs on machine imports. After the trade liberalization in 1988, cost of these machines especially power tillers and minor irrigation pumps fell by 50%, resulting in increases of 400% in sales of diesel engines and more than 1000% in power tillers compared to sales three years before the liberalization. Ministry of Agriculture (MoA) of Bangladesh prepared a comprehensive document on Ag policy in 1999

giving emphasis on self-sufficient in food through increasing production of all crops, including cereals, and ensure a dependable food security system for all". There were some conceptual ideas on Ag mechanization in this policy.

12. GoB has developed a **Road Map** policy for mechanization in the Agriculture sector to boost crop productivity by mitigating forthcoming challenges on the basis of SDGs of Bangladesh Vision 2021 and 2041. In the policy paper (which was approved in August 2016), emphasis was given to develop and improve new implements/ machineries and popularize & disseminate these to farmers to achieve sustainable Ag mechanization. **Conservation Agriculture (CA)** was referred to in the revised and updated Ag policy, and in the Road map policy on Ag mechanization. The targeted area coverage under CA will be 5% in 2021, 20% in 2031 and 40% in 2041. To achieve the targeted goal in the Road map, the incentive to farmers was 30 - 60% for Ag machinery purchase, but increased to 70 - 100% in risk-prone and backward areas. MoA has formed a specialized committee to write a policy paper on Ag mechanization and the committee working on that has already submitted it to the Ministry of Agriculture for further action and approval. Finally, MoA has published a policy paper 'National Ag mechanization policy 2020' in January 2020. There is a *section on Conservation agriculture* where highlighted the importance and necessities of CA to compensate the existing problems and protect the natural resources.

Opinion about VMP

13. We gathered the learning and opinion of stakeholders (researchers, manufacturers, marketing companies, machinery owners, LSP, and farmers) and identified the bottlenecks and barriers to adoption of small scale machinery like VMP at field level. All the stakeholders opined some positive ideas and as well give some specific suggestions for further improvement of CA machineries like VMP for accelerating the adoption of CA machineries. They mentioned that Conservation Agriculture is a win-win approach that reduces operational costs, including machinery, labour, and fuel, while increasing yields and better utilizing natural resources. Conservation Agriculture helps farmers to reduce production costs while maintaining or increasing crop yields, and improving soil health, crop diversity and timeliness of cultivation. In total, VMP helps to achieve present GoB goal like increasing crop yield by keeping environment well (keeping soil health, saving water), saving cost, saving labour etc. So, increase adoption of VMP is essential to save environment, save cost of cultivation and increase yield and profit. But

there are many factors which limit its adoption. From formal and informal discussions with key informant groups, factors affecting the adoption and dissemination of VMP were identified, and a brief summary of them is given below.

Factors Limiting Dissemination/Adoption of VMP

14. Lack of awareness about CA benefits among major stakeholders (e.g. Farmers, Extension specialist, development workers, etc.) due to limited promotional activity and awareness build-up of CA technology by public and private sectors. In general, farmers (beyond project area) are not familiar VMP/ST practice as an alternative to ploughing for crop cultivation. Therefore, demonstration plots on farmer's fields are the opportunity for them to gain experience with CA and show farmers how the system works. So more demonstration, field day/ farmers rally (during planting and before maturity stage) will be helpful for motivating farmers. Sufficient fund allocation for extension activities is essential to build up awareness among stakeholders.

15. Proper weed management and crop establishment requires new skills in CA based practices which farmers need to learn to adopt CA practice. For weed control, farmers need to use herbicide in pre and post seeding, but most farmers have shallow knowledge on the safe and effective use of herbicides. Farmers, LSPs and field level workers knowledge on proper weed management needs to increase/ update by giving training/ orientations.

16. **Limited utilization of VMP:** It is very difficult to make the VMP machine business profitable if use of machine is restricted to 1-2 months for Rabi season crops (Daily low coverage, seasonal business, limited opportunity for multipurpose use). So limited use of machine hampers out scaling of CA and as well VMP. VMP is now working in the Rabi season for non-rice crops, covering only 1.5 to 2 months. If it can be used for DSR (direct seeding rice) then work for 7-8 months is possible. Soil puddling is the common field preparation practice for rice seedling transplanting but it is time consuming, capital intensive, and degrades the soil physical condition. Direct seeding rice will solve all the problems as well increase working scope of VMP round the year. More research and development work on it will help with scaling out of the VMP use.

17. **Un-skilled machine operator:** Sometimes poor germination occurred due to unskilled machine operators which de-motivates farmers to continue hiring the VMP machine. Skilled machine operator and optimum soil moisture content are both important for good germination. The LSP should have knowledge on suitable moisture content of the soil, not too dry or too moist, to ensure high seed germination. Practically-oriented training for LSP and operators covering technical knowhow about soil and crop management will help to solve these problems.

18. **Shallow technical knowledge of LSP:** The LSPs are not familiar with fertilizer recommendations, so they commonly follow the farmer's recommendation for using basal fertilizer dose (especially TSP, MP). If yield is not good due to low TSP and MP, farmers may blame the VMP. So it is very essential to update LSP's knowledge by giving them crop wise fertilizer management training in addition to technical training. Supply of leaflet covering crop wise fertilizer dose can also help them.

19. **Unavailability of functional markets:** Currently there is limited availability of spare parts, and mechanics for repairs due to unavailability of functional market and weak dealership network of manufacturers for CA machineries. There are little promotional and marketing activities for VMP services in the market. It was felt by LSP and users interviewed that the lack of promotional activities presents a major issue in creating demand for VMP services at the field level. Spare parts, mechanics and maintenance services are not instantly available in all respective feasible area. Hence it takes 3-4 days to repair the VMP in case of breakdowns.

20. The private companies especially ACI Motors, Metal Engineering etc. are working on marketing and adoptions of several agro based machineries and have nationwide sales and service centres. They can use their setup for demand creation, adoption and marketing of VMP also if they got the responsibility (in addition to Hoque Corporation) from the authority like MU and government. For that need to seat all the stakeholders together and make a roadmap of work plan and match up together with 'decided concrete message' for farmers.

Limitation on Policy Issues

21. GoB has no CA based specific technology dissemination programme but some national research organization (like BARI, BIRRI, etc.), international organization (CIMMYT, MU, Australia) and NGO (like HC etc.) pursue aspects of CA. DAE had executed some mega projects

on Ag machineries dissemination, but have not included CA based machine like ST, ZT, VMP etc. (Note PTOS is included but it is not a CA machine) even through there is a project plan to disseminate CA based machineries. So, CA machineries need to be added with the dissemination programme in any future project/ activities under DAE.

22. In Bangladesh, government subsidies are available for a range of machinery but limited support is available for CA planting machineries. Carefully targeted and weighted price support can act as an incentive for LSP and farmers to take up mechanized CA planting, but care needs to be exercised in avoiding price distortions in the market.

23. Government ongoing subsidy programme on machine purchase discourages farmers to purchase VMP which doesn't attract a subsidy (Government of Bangladesh gives 50% subsidy on 5 categories of Ag machineries like PTOS+PT, Reaper, Power Thresher, Combine harvester, Rice Transplanter, and Foot Pump through DAE project on "Increasing crop yield through farm mechanization"). Inclusion of the VMP under GoB subsidy programme on agricultural mechanization should be pursued. And the present planting 'incentive' programme by the VMP project (given by MU, Australia) should be continued.

24. Bank loan facilities for purchasing Power Tiller (PT) and VMP need to continue. (Presently the farmers availing 80% bank loan facilities for purchasing VMP and PT, Hoque Corporation and Liaison Office of Murdoch University make arrangement with National Bank Limited, Rajshahi branch for advancing loan to farmers).

Limitation of VMP Machine

25. The VMP field capacity/efficiency and daily coverage is less than the PTOS. The operating speed of VMP is slower since it runs in first gear and the seeding coverage per time is 4 lines. Driver should have to walk behind machine when seeding. So further modification/improvement of VMP by increasing width up to 6 lines (if possible), will help to increase its capacity/ working efficiency, helps to increase LSP's profit.

26. VMP has more weight and tedious to drive. Need to reduce weight, which will help driver to drive the machine smoothly. And imbalance weight of the machine is also creating problems in planting time. Back side has more weight than front side. Drivers are using extra load in front

of the machine for smoothly driving. In addition to these, VMP have some shortcoming, which need to improve for better service and adoption. The additional shortcomings are;

- The fertilizer box is made of metallic sheet, which become rusted after 2-3 years use.
- The furrow openers are not heavy/strong, become bending after 2-3 years use (comments for earlier models).
- No seed device is available for ground nut and for small seeded crops like chili.

27. Weight of the machine could be reduced by changing metallic fertilizer box by plastic box, reducing weight of roller, etc. Working efficiency of the VMP can be increase by solving the above-mentioned limitations, research and development is needed to further refine CA packages and adapt them to different regions.

Policy Intervention Needed

28. To address these key blocks and catalyze scale out, a new mega project is essential to support innovative approaches and new partners, including govt. (DAE, Research), private sector manufacturers and NGO workers & organizations to help with awareness building, increase business skills, and other key areas. Other efforts to accelerate scale out include strengthening links between farmers and service providers and intensifying leveraging of public sector programs, like the govt. agriculture mechanization programme under DAE. Coordination among machine manufacture, research, and extension personnel in the field level will enhance out scaling and enrich the LSP's performance.

29. The VMP machine is still having scope to improve for speed up adoption. Further improvement of the VMP covering limitations and increasing its width size will helps to increase LSP profits which enhance more adoption of this machine.

30. Inclusion of VMP in government subsidy programme will help support more dissemination/ adoption. For that a campaign to brief the government policy makers and administrators under the Ministry of Agriculture needs to be pursued.

31. Capacity building is a key component in the complex process of achieving development outcomes of the project. Strategic partners need to enhance their capacities to accelerate awareness rising on CA, improve proper application and to enable sustainable and responsible scaling of CA innovations.

32. For improving in depth knowledge on CA, need to include special subject on CA in under graduate and post-graduate courses of public and private agricultural universities.

33. Commercialization of the technology for adoption of CA is needed to spread the benefits to small farmers. The private sector is a key partner by supplying planters through dealer networks, by providing repairs and spare parts service and by continuously improving the sustainability of planters for the market.

Study on Policies and Roadblocks for Small Scale CA Farm Machinery Adoption

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1. Introduction

Bangladesh has a population of about 163.7 million and an area of 14.86 mha, of which 8.58 mha is cultivable land (BBS, 2018). Of the cultivable area, 7.19 mha (87%) is already cultivated (having cropping intensity 194%, BBS 2018) making it one of the most densely populated countries in the world. In Bangladesh, landholding sizes are small and still declining with no possibility to extend the agricultural land frontier (Hasan, Hossain, Islam, & Bari, 2013). The per capita arable land was reduced to 0.05 ha in 2013 from 0.17 ha in 1961 (World Bank, 2015a). So, Bangladesh needs to intensify agricultural production on available land to contribute to food security and development goals (Aryal et al., 2019).

Bangladesh has made great strides forward in achieving food security through the achievements of crops intensification and by adopting new technologies (including agricultural machineries), that have boosted the food production. At present, total food crop production in Bangladesh is 38.4 million metric ton (MOA, 2018), which provides self-sufficiency in rice production, but the projected demand of cereals will reach 43.82 million tons in 2030. So more needs to be done to sustainably maintain and strengthen food security to feed the rising population, by combating the situation of changing climate, soil health degradation, declining ground water levels, scarcity of farm labour and rising cost of production (Haque et al., 2018). Agricultural

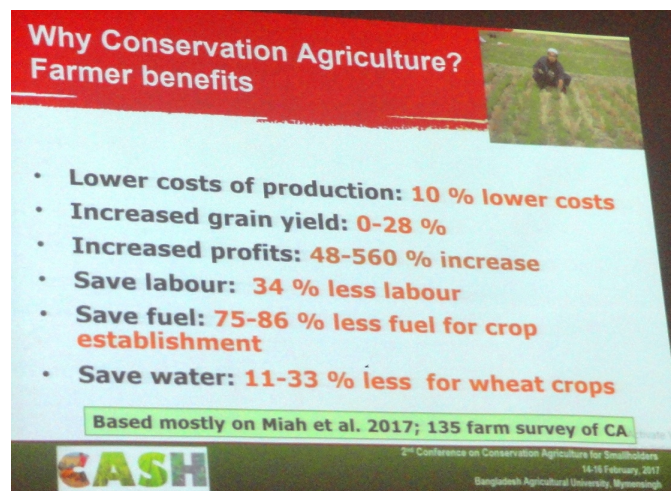


Fig. 1. Benefits of RCT/VMP over conventional Agriculture

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mechanization is the suitable way for the Bangladeshi farmers to boost the vertical expansion of agricultural production by minimizing the existing problems (Milon, 2015). Mechanization reduces the drudgery of farm labor, relaxes peak-season labor constraints, reduces costs of production, and can save crucial resources (Biggs & Justice, 2015). The Government of Bangladesh supports initiatives to address these challenges. Research over the last decades in Bangladesh has demonstrated that Conservation Agriculture (CA)-based production system could have a major role to reduce farm labour and production costs (Haque et al., 2018).

The form of cropping known as Conservation Agriculture (CA) involves minimum soil disturbance for placement of seed and fertilizer, retention of crop residues as a soil cover and diversifying crop rotations (Anonymous, 2017). The concept of CA is fairly new in Bangladesh, and there is still limited practice on small farms of CA especially in rice-based intensive crop rotations. Currently CA is being applied on about 180 million ha globally (Kassam et al., 2018). Although most of the CA area is being managed by large mechanized farmers, there are more small farmers practicing CA globally than large farmers. CA has greater potential in developing regions. In the past two decades, CA systems have begun to spread in Asia and Africa. The adoption of CA on small farms is just beginning to take off in Bangladesh. Since 2005, considerable research has been undertaken on developing CA for small farms in Bangladesh. The ACIAR-funded project (LWR-2010-080) on CA led by Murdoch University, Australia in partnership with BAU, BARC, BARI, BIRRI and CASPA helped to conduct many research projects on CA and farm mechanization and developed sustainable and environment friendly CA technologies. Research results confirm that for wheat, maize, pulses and oilseeds in minimum soil disturbance sowing is feasible by mechanized planters. Even jute can be successfully established by machine sowing. Research over the last two decades in Bangladesh has demonstrated that CA practices could have a major role in overcoming scarcity of farm labour and reducing costs of production and can boost up crop production (Haque et al., 2018).

It is really encouraging that the planters made in Bangladesh (e.g., Versatile Multi-crop Planter, VMP and BARI models) are now being commercialized to allow owners of power tillers (2-wheel tractor, 2WT) to plant crops with minimum soil disturbance and crop stubble retention. With lower costs of crop production, and the capacity to establish 2-3 times greater area of crops in the same time period, increased profits can be achieved with mechanized crop establishment. It

is estimated that practicing of CA can bring an extra Taka 43,500 ha⁻¹ per year for smallholder farmers (Haque et al. 2018).

From last few years, the ACIAR-funded CA Project led by Murdoch University, Australia in partnership with BARI, BARI, BARC Hoque Corporation, DAE and BAU has been trying to disseminate CA based Versatile Multi-crop Planter (VMP) in North-west region of Bangladesh (covering, Rajshahi, Nator, Bogura, Rangpur, Dinajpur, Thakurgaon and Ponchgor districts, see Fig. 2). Although the owners, operators, and users of VMP have positive opinion about the planter, however, the commercialization and adoption was not as fast as expected. With the funding support of ACIAR (LWR-2018-111), a study was undertaken to identify the blockages and barriers of faster adoption and dissemination of CA practice and VMP in Bangladesh.

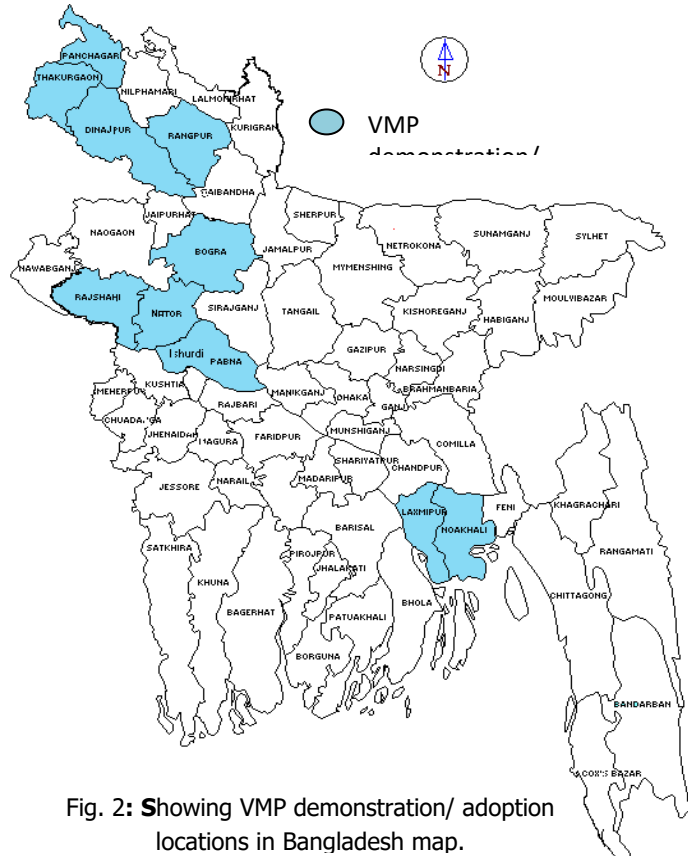


Fig. 2: Showing VMP demonstration/ adoption locations in Bangladesh map.

The specific objective of this study was to identify gaps in policy, capacity, and roadblocks for the adoption of CA-based farm mechanization on small farms.

2. Methodologies

Information for this study was collected by secondary and as well from primary sources using different data collection methodologies, as described below;

Consultations and Planning: Initial consultations were held with relevant experts of Murdoch University in Australia and the Executive Director of Hoque Corporation (manufacturer of VMP) to develop the study plan and implementation. During this phase, detailed protocols of different study tools (e.g. checklist, questionnaire etc.) were made and offered for review and comments.

Literature Review: For collecting information on existing situation of agricultural mechanization (past and present) literature review was undertaken for this study. Although studies on agriculture mechanization in Bangladesh are scarce and reports are often not readily available, we have reviewed technical papers and reports of different studies under GoB and NGO projects as well. It should be noted that there is no systemic procedure from any agency in Bangladesh to collect and monitor mechanization statistics; only project-based information is available.

Also we reviewed the existing policies on mechanization of Bangladesh agriculture in order to identify the roadblocks/limitations of existing policies for adoption of small-scale CA farm machineries.

Key Informant Survey: There are numerous key actors involved in research and development of CA machineries in Bangladesh and also working for marketing/adoption it in farm level. The involved actors are policy makers, researchers, manufacturers, NGO workers and extension personnel. Information was collected from key informants in the respective organizations by direct interviews using a predesigned checklists/ questionnaire (attached herewith). In this stage talked with;

- Policy makers of Ag mechanization like the Project Director of the Farm mechanization project of DAE, Chairman and members of Ag Mechanization Policy Development Committee of Bangladesh Government etc. A full list of people interviewed is attached.
- Researchers, manufacturers, marketing companies, and DAE personnel and identified the bottlenecks and barriers of adoption of small scale machineries at field level by interviews with the -
 - ✓ farm machinery project personnel and researcher in Bangladesh e.g. DAE, BARI, BRRI, BAU, RDA-Bogura, SRFSI & CSISA-MI of CIMMYT Bangladesh etc.
 - ✓ machinery manufacturers and marketing companies e.g. Hoque Corporation, Alim Industries, Janata Engineering, ACI Motors, Alam Engineering etc.

A list of key informant persons among researchers, manufacturers, marketing companies, and DAE personnel interviewed is attached as appendix table 1.

Focus group discussions (FGDs): Focus group discussions were carried out to capture the opinion of field level VMP adopter and users including machinery owners, Local Service providers (LSP) and final users (farmers). FGDs were conducted covering four Upazilas under 4

districts where VMP machines are operating in farmers' fields. Ten FGD was conducted with LSP/ owners and 10 with farmers/users as mentioned in the Table 1. About 3 to 7 farmers/users were present in each FGD and about 2-3 LSP/owners were present (with 2 exception where only one present) in each FGD.

Table 1. Location wise numbers of FGD conducted among LSP and users of VMP.

Upazila and District name	FGD with VMP owners/LSP	FGD with Farmers/Users	Total FGD
Durgapur, Rajshahi	5	5	10
Sibgonj, Bogura	2	2	4
Sadar upazila, Thakurgaon	2	2	4
Debigonj, Ponchagor	1	1	2
Grand total	10	10	20

In addition, information and comments on CA and VMP were also collected from DAE high officials in field level (AD, DD etc) from a CA workshop organized by Murdoch University and Hoque Corporation with the help of DAE and Regional Wheat Research Centre, Rajshahi during September 2018.



Fig. 3. Participant of DAE personnel, LSP/VMP owner, farmers and Researchers in an inception workshop organized by MU liaison Office in Bangladesh and Hoque Corporation

Mainly qualitative data were collected and presented in summary form. The

FGDs and study was conducted during October 2018 to November 2019.

3. Research and Development on Ag mechanization

Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Bangladesh Sugarcane Research Institute (BSRI) and Bangladesh Agricultural University (BAU) are engaged in research and development of farm machineries and technologies suitable for socio-economic and technological condition of Bangladeshi farmers. Some national and international organization like CIMMYT Bangladesh, iDE, Murdoch University, etc are also involved with this research and development process. Over time, a good number of farm machinery implements have been developed in these institutes. In the past, emphasis was given to improve the manual and animal operated equipment to increase their capacity and efficiency. With the availability of engines and the power tiller (2WT) at an affordable price

(after the trade liberalization in 1988), more emphasis was given on power operated machinery (Milon, 2016).

3.1. Development of tillage machineries on Conservation Agriculture

The use of 2WT for land preparation and rural transportation has increased rapidly in the country due to its versatile use, lower cost for tillage, lesser time required for cultivation and resulting in higher crop yields (Miah, 2000). Since the mid-1990s, research and development

Table 2. Existing population of different farm machineries in Bangladesh over years

Name of Machine/ units	Year				Remarks
	1977	1996	2012	2017	
Two Wheel Tractor (Power tiller)	2000	100000	>700,000	>713,182	Imported from China
4-WT	300	2000	>35,000		Imported from India
High speed rotary tiller (PTOS)	-	-	>5,000	>6,655	Locally made as well as imported from China
Weeder	-	-	>200,000		Locally made
Seed-cum-fertilizer distributor	-	-	+100		Locally made
Sprayer	-	-	1450,000		Locally made as well as imported from China, India
Combine harvester	-	-	160	1043	Imported
Reaper	-	-	200	3426	Imported
Open drum thresher	-	10,000	180,000		Locally made
Closed drum thresher	-	5,000	40,000	47,017	Locally made
Winnower	-	-	1,200		Locally made
Dryer	-	-	500		Locally made
Hand maize Sheller	-	-	12,000		Locally made
Power maize Sheller	-	100	2,000	15,000	Locally made
Deep Tube well	4,461	24,506	30,000		Imported
Shallow Tube well	3,045	325,360	1200,000		Imported
Low lift Pump	28,361	41,816	120,000		Imported
Strip till planter				175	Locally made as well as imported from China (excluding VMP)
Bed planter				456	Locally made
No till planter				13	Locally made
VMP				205*	Locally made

Source; Shoeb, 2015, DAE, 2013, Hossain, 2017 and Hoque Corporation. * up to 2018.

work on CA-based resource conservation technologies (RCTs) started with locally developed small machinery, like minimum tillage or no tillage planters, crop production on permanent bed systems, and residue retention. In this context, BARI, BRRI, and CIMMYT have been conducting research and development on resource conserving technologies in Bangladesh since 1995 in

collaboration with other NARS partners, NGOs, private sector and farmers in different parts of the country, with funding from various donors, particularly from USAID (Monayem et al., 2008).

Initial research and development of planting implements/ seed drill/ seeders for 2WT in Bangladesh started in 1995 through the introduction of the Chinese-made 2BG-6A seed drills (which was named variously as the Chinese Hand Tractor [CHT] seeder; Bangladesh Hand Tractor [BHT] seeder; PTOS, etc.). Since then, several types of single-pass planters/seeders were tested or developed to establish crops in Bangladesh including PTOS, bed planter, strip planters (sometimes called strip tillage planters), zero tillage planters (Haque et al., 2018).

Not all of these planters are suitable for CA planting. **The PTOS seeder** accomplishes three operations i.e. shallow tillage (up to 60 mm), placement of seed in a furrow and leveling which can be done in single pass. Although this planter is often called a CA planter or minimum tillage planter, research results confirmed high levels of soil disturbance with the PTOS as well as with a bed planter. Hence neither the PTOS nor the bed planter qualifies as a minimum soil disturbance planter (Haque et al., 2017).

Three local manufacturers have been involved in producing PTOS; Mahbub Engineering Workshop (Jamalpur), Rahman Engineering (Kushtia), and Alim Industries. Both Rahman Engineering Workshop and Mahbub Engineering Workshops were involved with the early research and development and manufacturing process of PTOS seeder for several years with BARI and CIMMYT. With the help of CIMMYT and WRC, Rahman Engineering in 2001-2003 manufactured several pieces of PTOS including lighter weight of 4 and 5 row versions of the planter. Around 2005/06 Mahbub Engineering first sold some of those seeders to some commercial farmers at Rajbari and Dinajpur under a BARI-CIMMYT project. Alim Industries made 150 PTOS with the incline plate in 2010-2011 for a sub-project of GoB's *Enhancement of Crop Production through Farm Mechanization Project*. All the locally made PTOS have been plagued by quality problems and therefore additional orders/sales have been slow to come. The production of seed meters has been beset with problems over the years. Rahman Engineering Workshop was the first to make fluted roller meters. WRC has also started producing flute roller type seeders. Almost all of the plastic parts of Mahbub Engineering Workshop's PTOS (including seed meter) are made in the plastic molding factory of Alam Engineering Workshop in Dhaka. Now other mold makers have started and there are now injection molding factories in Jamalpur,

Bogura and Dhaka making these parts. Many different parts go into making a PTOS (iDE, 2012).

3.2 Development of VMP

The PTOS has been the most popular attachment to the 2WT, but few of them are used for planting. The growth of the PTOS market has mostly been for tillage purposes as a high speed rotary tiller to prepare soil to transplant onion seedlings (Ref). Hence, commenced in 2006. another ACIAR funded project concluded that none of the planters imported or developed locally for 2WTs, including the PTOS, were capable of planting in all modes of tillage. Hence a new planter was developed that could be used for Single Pass Shallow full Tillage (SPST, like PTOS), Strip Planting (SP), Zero Tillage (ZT), Bed Planting (BP), and for Conventional Tillage (CT) using full rotary tillage, when driven by 12-16 HP 2WTs. A key aim of the development was for a planter whose seed meter could plant a wider range of crops and on which the setting up of blades, row spacing, seed depth and the calibration of seed and fertilizer rates could be accomplished quickly by the operator in the field. Incorporating features from a range of earlier planters for 2WTs, the Versatile Multi-crop Planter (VMP) was designed with capability for banding seed and fertilizer in four rows. The SPST, ST, ZT and BP by VMP saved 38, 82, 50 and 13% diesel fuel, respectively over CT. VMP saved 50-68% labor in land preparation, seeding and fertilizer application. The greatest savings were with SPST and ST, followed by ZT and BP (Haque et al. 2011).

Design features of VMP: The research and development of the 2WTbased VMP was carried out under ACIAR funding (Project LWR-2010-080) with seed funding from CIMMYT. The main functional parts of the current version of the VMP are: rotary shaft with attached blades; vertical disk type seed meter fitted in a seed box, fluted type fertilizer meter fitted in a fertilizer box; a toolbar frame; depth controller-cum-compress roller; driving seat for transportation; furrow opener, etc. (Figure 4). Haque et al. (2017a)



Fig. 4: The VMP attached with 2-wheel tractor in operation

reported the detailed fabrication of the VMP, although some further improvements have been implemented by the current manufacturer, Hoque Corporation. The VMP is powered by 8.95 to 11.9 kW Dongfeng (Figure 4), Sifang 2WT, or could be used with any other 2WT with similar power rating and hitching arrangement. The Dongfeng or Sifang 2WT have different but suitable hitching points to attach with the VMP.

Planting capacities of VMP: The VMP was designed with capability for seeding and fertilizing in lines for: 1) single pass shallow-tillage (SPST); 2) strip planting (SP); 3) zero tillage (ZT); 4) bed planting (BP) (for single-pass new bed-making or reshaping of permanent beds together with simultaneous planting and fertilizer application); and 5) conventional tillage (CT) using full rotary tillage following broadcast seeding and fertilizer spreading. On-station and on-farm replicated trials were conducted with different tillage options and seed calibration to assess its field capacity, fuel consumption, crop establishment and yield. Details of performance evaluations of VMP with major crops are elaborated in Bell et al. (2017) and Haque et al. (2017a).

A comparative description of all the available planters in the Bangladesh is given in Table 3.

Table 3. Comparative description of available planters for two-wheel tractors

Planter type	Main features	Comments
PTOS/SPST	The PTOS/SPST seeder accomplishes three operations i.e. shallow tillage (up to 6 cm), placement of seed and fertilizers (but the imported PTOS do not have fertilizer replacement capacity) in a furrow line by tyne/furrow opener and leveling which can be done in single pass. Soil is more pulverized with the PTOS/SPST. PTOS is the most widespread planter for 2WT in Bangladesh at this stage.	This is not a CA planting operation.
Strip Till Planter (VMP and BARI ST planter)	In each line, 2-4 cm wide and 4-8 cm deep tilled strips are made (that preserved about 80 % of untilled soil) in untilled flat land to place seed and fertilizers at the base of the strips by a tyne/furrow opener in single pass operation. However, if needed (for higher moisture and slow drying soil) the width of strips can be increased by increasing the curvature of the blades.	ST planting is a CA planting operation
Zero tillage (ZT)	Up to 10 cm deep and 6 cm wide slits could be made (about 80 % undisturbed soil) by tyne/furrow openers in untilled flat land by VMP. Seed and fertilizers are placed simultaneously behind tyne/furrow opener in a single pass operation. Seed and fertilizers were dropped in the furrow behind the opener and the following roller pressed soil down to ensure adequate seed/soil contact.	ZT is a CA operation

Bed planting (BP)	About 60 cm base width and 18-20 cm height of the bed can be made by VMP and seed and fertilizers can be placed in rows near the two edges of the beds in a single pass operation or in a single row (e.g., maize) in the middle of the bed. Soil is more pulverised with a Bed Planter.	Bed planting is not a CA operation.
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Source: Information used from Haque et al., 2018

4. Promotion of the Agricultural Machineries in Bangladesh

The national research institutes, such as BRRI and BARI have established linkages with a good number of manufacturers, capable of fabrication and manufacturing of agricultural machineries. These private manufactures receive technical assistance i.e. prototypes, drawings and expert services from the national research institutes mentioned above. NGOs are also promoting machines by organizing landless farmers as a part of poverty reduction campaigns. CIMMYT also supports mechanization in terms of demonstration and training (Milon, 2016).

Ministry of Agriculture has a goal to popularize the machineries that have been tested in different locations of the country and found to be suitable for specific socio-economic settings of the farming system. Therefore, in order to disseminate mechanization and irrigation technologies, the Ministry of Agriculture established an Irrigation and Farm Machinery Wing under DAE (MoA, 2006). Some specialized projects funded by GOB and donor agencies have been designed to provide special efforts for wider extension, adaptation and utilization of selected items of farm machinery. The salient features of some projects are given below:

4.1. Popularization of Agricultural Machinery (PAMP) Project, 2001-2006

Farm Machinery and Postharvest Technology Division (FMPHT) of BRRI implemented a GOB funded project on "Popularizing BRRI Developed Agricultural Machinery to Augment Mechanized Rice Cultivation in Bangladesh (PAMP)" in 21 selected agricultural blocks of 21 districts of Bangladesh during 2001-2006. The project conducted (i) farm level demonstration of weeder, reaper, power thresher and winnower, (ii) long term use of these machinery at the selected farmer's household during crop (rice and wheat) harvesting season, (iii) some demonstration were also carried out in the adjoining block of other districts as requested by the interested farmers and collected information on currently use farm machinery from the farmer's field (Milon, 2016).

4.2. Agricultural Services and Innovation and Reform project (ASIRP), 1999-2004.

Department of Agricultural Extension (DAE) implemented a project on "Agricultural services and innovation and reform project (ASIRP)" in 42 selected Upazila of 21 districts of Bangladesh during 1999-2004. This project was funded by GOB with FAO, World Bank and ADB. The project has been designed to conducted farm level demonstration of reaper and power thresher and water management technology.

4.3. Agricultural Engineering Technology Extension Project, 2005-2011

DAE implemented a GOB funded project on "Enhancement of Production and Rural Employment through Agricultural Engineering Technology" in 112 selected Upazila of 56 districts of Bangladesh during 2005-2011. The machineries that have been promoted were: Manual seeder, dry land weeder, rice-wheat reaper, open drum power thresher, rice-wheat thresher, manual and power maize sheller, and seed/fertilizer applicator. Moreover, few numbers of machineries were sold to the farmers on 30% subsidized prices.

4.4. Farm Machinery Technology Development and Dissemination (FMTD) project, 2010-2015.

BARI, BRRI, and DAE were implemented this project from 2010 to June 2015. There were 48 selected Upazilas of 24 districts of Bangladesh included in this project. The main objectives of the project were (Milon, 2016);

- ✓ create awareness among the farmers about the benefits of using BRRI and BARI developed farm machinery through field demonstration and training.
- ✓ impart training to machine operators, agricultural extension workers manufacturers and traders on operation, repairing/maintenance and manufacturing of BRRI developed farm machinery.
- ✓ motivate the farmers on the use of BRRI and BARI developed machinery for increasing timeliness of cultivation, reducing costs of crop production and postharvest losses; and
- ✓ strengthen research and development on farm machinery, postharvest technology and renewable energy resources.

A notable numbers of BIRRI and BARI developed machineries were sold to the farmers with 60% subsidized prices. About 9 and 5 types of machineries were developed and improved by BARI and BIRRI, respectively and about 3106 and 3212 numbers were sold (Table 4).

Table 4. Number of Farm Machinery development and sold under Farm Machinery Technology Development and Dissemination (FMTD) Project under BARI and BIRRI.

SI No	Name of Machines	Number	Name of Machines	Number
	BARI part		BIRRI part	
1	BARI high speed rotary tiller	280	BIRRI Weeder	2000
2	BARI seeder	14	BIRRI Open Drum Thresher	450
3	BARI bed planter	10	BIRRI Thresher (TH-7)	245
4	BARI dry land weeder	950	BIRRI Winnower	233
5	BARI reaper	45	BIRRI USG Applicator	300
6	BARI power thresher (with 12 hp engine)	243		
7	BARI winnower (with 0.5 hp electric motor)	74		
8	BARI USG applicator	1425		
9	BARI power maize sheller (with 9 hp engine)	65		
	Total	3106		3212

Source: BIRRI/BARI, FMTD project completion report, August, 2015.

4.5. Development and Validation of USG Applicator and Rice Transplanter (DUART) Project, 2010-13

Farm Machinery and Postharvest Technology Division (FMPHT) of BIRRI implemented a NATP funded project on "Development and Validation of USG Applicator and Rice Transplanter (DUART)" during 2010-2013. The main objectives of the project were; (i) to design and develop an user-friendly manually-operated USG applicator (ii) to modify and improve rice transplanter (iii) to validate and adoption of the developed technology to the end users.

4.6. KOICA-BIRRI Collaborative Research Programme, 2010-14

Farm Machinery and Postharvest Technology Division (FMPHT) of BIRRI is being implementing a KOICA-GOB funded project on "Development of Research Capacity of Bangladesh Rice Research Institute" during 2010-2014. The overall objective of the project was to enhance the capacity of BIRRI scientists, thereby positioning them with the knowledge and skill required to develop and adapt farm machineries suitable for the Bangladesh environment. The identified research areas

were: i) Development of hand-operated carrier, ii) Design and development of a head feed power thresher, iii) Improvement of existing engelberg rice milling system, iv) Development of farming tools for weeding and fertilizing application, v) Design and development of a hill dispensing seeder (Milon, 2016).

4.7. Enhancement of Crop Production through Farm Mechanization Project, 2010-2012

DAE implemented this GoB funded project covering 35 districts of Bangladesh during 2010-2012 to increase crop productivity by solving the existing problems by mechanization. This project was mainly designed to sell agricultural machineries such as Power tiller, power thresher, maize sheller, tractor, combine harvester, sprayer and hand reaper to the farmers with 25% subsidized prices. With the subsidized price farmers are able to purchase their required Ag machinery as per their own choice from the local market. About 38,338 items of machinery were sold under this project including 150 pieces of PTOS. Moreover, this project has been designed to conducted farm level demonstration and training on agricultural machineries (Anonymous, 2010).

4.8. Enhancement of Crop Production through Farm Mechanization Project (2nd Phase)

To continue the earned achievement in 1st phase, 2nd phase of this project was started from July 2013 and was continued up to June 2018. It was implemented by DAE in 64 districts of Bangladesh with expected cost BDT 33943.96 lac funded by GoB. The main objectives of this mechanization projects were;

- Increase and sustain crop productivity through supplying farm machineries to farmers in labour and draft power shortage situations.
- Reducing crop cultivation cost, increase cropping intensity and to reduce post harvest losses.
- Increase efficiency of stakeholders related to farm mechanizations (e g LSP, mechanics, DAE field workers and officers, NGO workers etc.).

This project is mainly designed to sell agricultural machineries used for major crops (like rice and wheat) such as Reaper (rice, wheat), Power Thresher (rice, wheat), Combine Harvester (rice, wheat), Rice Transplanter, Seeder (PTOS) and Foot Pump to the farmers at subsidized

prices. **Under the 2nd phase, subsidy was raised to 70% in Haor and Coastal areas, and 50% in the rest of Bangladesh.** This project has also been designed to conduct farm level demonstration and training on agricultural machineries. In addition to that, it created 300 **“Custom hiring service centre”** of Ag machineries in 300 Upazilas (Anonymous, 2013).

Under this project, till June 2019, about 29,768 items of machinery were distributed under subsidy programme including 1,994 pieces of PTOS with power tiller. So far observed all PTOS machines, except few, were not using (remain ideal). The details machine numbers are like below in Table 5.

Table 5. Number of machinery distributed under DAE subsidy programme, July 2014 to June 2019.

Sl. No.	Year	Name of Machineries							Total
		PT	Power Thresher	Reaper	Combine Harvester	Rice Transplanter	Seeder (with PT)	Foot Pump	
01	2014-15	9530	883	0	0	0	0	0	10413
02	2015-16	3652	2474	348	0	0	102	328	6904
03	2016-17	-	1494	452	78	4	334	672	3034
04	2017-18	-	1573	1941	541	7	1197	0	5259
05	2018-19	-	1045	1769	769	114	361	100	4158
	Total	13182	7469	4510	1388	125	1994	1100	29768

Source: Farm Mechanization Project (2nd Phase) report, DAE, 2019

4.9. Project on Custom Hiring Service Centre of Ag Machinery at Farm Level

This project was started on July 2016 and continued up to June 2019. DAE have been executing this project under MoA with GoB fund. Due to shortage of labour (migrating to industry, others), climate changing impacts e.g. flood, hail storm, cyclone, drought, flash flood etc. resulting in crop damage, farmer losses their initiative to grow more. On the other hand, farmers become helpless during peak transplanting and harvesting time (of Aman and Boro rice) due to labour shortage. In these circumstances, mechanization is the only option to increase Ag productivity by minimizing the labour shortage. To combat these problems the objectives of this project were; (1) to popularize and make easy access of modern Ag machineries among farmers, (2) provide custom hiring services of Ag machineries to farmers with minimum hiring charge, and (3) extending Ag machinery services to marginal and small farmers (Anonymous, 2013).

Since there were already many custom hiring service provider for PT, Tractor, irrigation appliances and thresher, this project emphasized service provision for Transplanter, Reaper/harvester, Thresher and Seeder

Table 6. Type and number of machineries targeted for supply to Union Custom Hire Service centres.

Sl.No.	Machine and crop name	Number	Comments
01	Reaper (Rice & Wheat)	4000	The number of machinery supply for each Union are finalize considering the crop cultivation intensification in respective Union.
02	Rice transplanter	2500	
	Tray for raising seedlings of RT	4,00,000	
03	Mini Combine harvester (Rice & Wheat)	1000	
04	Power Thresher (Rice & wheat)	3000	
05	Power Maize Sheller	1000	
06	Seeder (PT driven)	1000	
07	Jute Ribboner	500	
08	Training for farmers, LSP, SAAO, officers etc.		
09	Distribution of Leaflet, Brushier, Poster		
10	Repair and Maintenance, Miscellaneous		

Source: Anonymous, 2013

In total, 4000 union councils were under this project having one service centre in each. A set of **one transplanter, one harvester and one thresher were given free** to each service centre with other additional alternate machineries as mentioned in the Table 6. The other machines are selected as per local agricultural activities. Hiring out cost was fixed at 50% less than the existing rate, covering 25% for repair & maintenance and the rest 25% for hiring cost for service provider. The proposed machineries supply schedule is outlined in Table 6.

The aims of the project were that: farmers and entrepreneurs in the rural area become aware of modern Ag machineries; they can become familiar with repair and maintenance needs of machinery, income and cost of custom hiring services; entrepreneurs for machinery sales and service provider in rural areas would be supported; farmers gain experience in how to grow seedlings for rice transplanter; and easy availability and maintenance of machineries helps to achieve profitable agricultural production systems (Anonymous, 2013).

Finally, 300 custom hiring service centres were opened in 300 Upazilas (one in each). For each service centre, 5 machines were supplied free consisting one mini combine harvester, one reaper, one rice transplanter, one power thresher and one PTOS machine (personal correspondence with Ag mechanization cell of DAE).

4.10. Expansion of VMP Machines

The VMP was designed and developed by Murdoch University-Australia during the period 2006-2015. Since then, Hoque Corporation have been manufacturing and further improving the VMP

with the technical assistance by Murdoch University. HC have been working to improve VMP design in regarding of its efficiency in response to farmers' demands, to sow various crop types in a range of soil types. And they also working as a commercialization development partner of VMP in SRA-CA project collaboration with MU, BAU, CASPA & ACIAR since September'2015 to December'2017 (1st agreement) and August 2018 to December 2019 (2nd agreement). HC is continuing to work as a commercialization development partner of VMP in another SRA-CA project collaboration with MU, funded by ACIAR, Australian government since August 2019. They are working also on its demand creation, value chain, operator training & follow-up, after sales services and spares availability.

Up to 2020, HC have sold 211 Units of VMP among farmers in Rajshahi, Naogaon, Natore, Bogra, Rangpur, Dinajpur, Thakurgaon, Panchagarh, Borguna, Khulna and Noakhali districts and exported 40 units in India, Myanmar, Vietnam, Ethiopia, Tanzania, Zimbabwe, Mexico, Uganda and Tajikistan since 2016-2018.

5. History of Policy Issues on Agricultural Mechanization in Bangladesh

5.1 Tractors and Power Pumps Import: The Government of East Pakistan started to import Tractors and Power Pumps (DTWs and Low Lift Pump, LLP) in the late 1960s as a part of 'Green Revolution' activities. Comilla BARD worked out a cooperative based model to promote the service of 4-wheel tractor (4WT) in the Comilla area (Lewis 1996) whereas BADC also installed DTW in the northern part of the country where farmers used to get the water free of charge (even through the employment of subsidies the program resulted in limited success (Hossain, 2009)). Irrigation system development and a cooperative-model were associated with the government promotion of 4WT since 1960s. However, small land holding coupled with further fragmentation of land impeded the wide-scale adoption of 4WT (Hossain, Lewis, Bose, & Chowdhury, 2007).

The Government of Bangladesh also allowed continued import of farm machinery after independence to help mechanize farming activities. Agricultural mechanization in Bangladesh thereby started with 4WT and DTW for irrigation (Pingali, 2007).

5.2 Restricted Ag machinery Import: Before 1988, the import of agricultural equipment was restricted. The '*Standardized Committee of Bangladesh*' was responsible for

controlling the quality of imported machinery including agricultural equipment and only a list of standardized machines required for agricultural operations could be imported.

5.3 Liberalizing Import Markets: In 1988, the Government of Bangladesh started liberalizing markets: it lowered the tariffs on machine imports, and dissolved the *Standardized Committee* (GoB, 1989) following a devastating flood that caused loss of a large population of draught animals (Milon, 2008). This policy change resulted in an import surge of low-cost small engines and engine powered machinery such as power tillers (2WTs), diesel pumps and other equipments into Bangladesh, primarily from China (Gisselquist, Nash, & Pray, 2002; Kienzle, Ashburner, & Sims, 2013; Mottaleb et al., 2016; Pingali, 2007).

After the trade liberalization in 1988, cost of these machines especially power tillers and minor irrigation pumps fell by 50%, resulting in increases of 400% in sales of diesel engines and more than 1000% in power tillers compared to sales three years before the liberalization (Gisselquist et al., 2002).

5.4 Mechanization in crop establishment and management: Mechanization in Bangladesh is now prevalent in land preparation. Almost 80% of land preparation including primary tillage uses 2WTs and/or 4WTs (Kienzle et al., 2013). However, mechanization of other agricultural field operations is still very low in Bangladesh and thus, adoption of other agricultural equipment such as bed makers, seeders, weeders, harvesters and winnowers is not common (Islam, 2009).

5.5 National Agricultural Policy (NAP), 1999: This is the first comprehensive document prepared by Ministry of Agriculture (MoA) since the country's independence in 1971. NAP has an overall objective, 18 subsidiary objectives and 18 programme areas. The overall objective is: "to make the nation self-sufficient in food through increasing production of all crops, including cereals, and ensure a dependable food security system for all." NAP also identifies 18 programme areas where actions or policies might be undertaken for achieving these objectives, agricultural mechanization is one of the programme area, emphasized to meet the deficit of animal draught power through import of machines and raw materials needed for local fabrication with tax relief, providing credit to both users and traders and encouraging formation of user groups /

cooperatives for owning or custom hiring of agricultural machinery to help mechanization. This was started to implement after 2005 by taking some specialized project on Ag mechanization.

5.6 Establishment of Irrigation and Farm Machinery Wing under DAE: Ministry of Agriculture has been taken decisions to popularize the machinery that have been tested in different locations of the country and found to be suitable for specific socio-economic settings of the farming system. Therefore, in order to disseminate mechanization and irrigation technologies, the Ministry of Agriculture established a wing on Irrigation and Farm Machinery under DAE (MoA, 2006).

5.7 Road map of Agricultural Mechanization; 2021, 2031, 2041:

Governments of Bangladesh have developed a road map policy for mechanization in the Agriculture sector to boost crop productivity by mitigating forthcoming challenges on the basis of SDGs of Bangladesh Vision 2021 and 2041. In the policy paper (which was approved in August 2016), it is mentioned that to achieve sustainable agriculture, mechanization needs to develop, with new implements/ machineries and that popularizing & dissemination of these to farmers are essential prerequisites. For more adoption and dissemination of appropriate machineries/ implements need to train LSP, strengthening manufacturers' capacity, improve loan facility with easy terms and condition and favorable import-export policy are the essential

Table 7. The present status (area coverage) and targeted machinery use goal fixed in the road map, 2021-41.

Sl. No.	Activities	Present status (%)	Target area coverage by machinery use		
			Short term (2021), %	Medium term (2031), %	Long term (2041), %
01	Transplanting	< 1	20	40	80
02	Planting	3*	25	50	80
03	Harvesting	2	30	60	80
04	Irrigation and water management efficiency	33	40	50	70
05	Fertilizer application	1	10	30	80
06	Weeding	2	5	15	30
..					
09	Maize harvesting	0	5	10	60
..					
13	Storage	10	20	40	80
..					
17	Conservation Ag technology	0.1	5	20	40

Source: Anonymous, 2016. *Planting mainly will cover by PTOS machine.

elements. Presently more mechanization is on tillage activities, irrigation, threshing and milling, but machinery use is limited on seeding/planting, transplanting, harvesting, drying, winnowing and in storing (Anonymous, 2016). The status of agricultural machinery use in different operations is shown in Table 7.

In the road map for Ag mechanization, targets and goals were assigned (Table 7). As land tilling, irrigation and threshing were already well mechanised, they were not included in the road map. The present status (area coverage) and targeted machinery use goal in the road map are given in Table 7. The targeted area coverage under CA will be 5% in 2021, 20% in 2031 and 40% in 2041.

To achieve the targeted goals in the Road map, there are 11 steps of working strategy and 12 highlighted activities. Among the 12 activities, the following are the major ones.

- Popularization of appropriate agriculture machineries by conducting demonstration, field days, experience sharing visit etc.
- Development help/incentive for Ag machinery purchase; **by giving incentive to farmers (30 - 60%), incentive to farmers in risk-prone and backward areas will be higher (70 - 100%).**
- Establishment of custom hiring service centre; by giving credit with low interest rate, build up physical structure, give incentive for Ag machinery purchase, establish custom hiring centre.
- Making Ag mechanization policy; there is a proposal to make a complete Ag mechanization policy and process for approval. MoA will make a specialized committee with the aims to write a policy paper on Ag mechanization. And will finalize it by incorporating views and suggestions of different stakeholders.

The 12 activities will be implemented through 23 development projects, executed by government institution/department under the Ministry of Agriculture as per their own mandatory working area. All the projects will be executed on short-term, medium-term and long-term basis, with a budget allocation of BDT 2100 cror, BDT 2485 cror and BDT 2785 cror, respectively. One proposed project was on 'development and popularization of conservation agriculture technologies for crop production' (mentioned in sl no. 10).

5.8. National Ag Mechanization Policy 2020.

As per proposal / suggestions in Road map, MoA published National Ag mechanization policy 2020 for Bangladesh in January 2020 (MoA, 2020). The overall goal and objectives of this policy are;

Goal:

- ✓ Facilitate the adoption of farmers' favorite Ag machineries considering socioeconomic condition, small farm and land size, and land suitability.
- ✓ Make the Ag works and occupation more efficient, easy and risk free considering different changing environment and variable weather conditions.
- ✓ Prompt Ag mechanization with the aims to make profitable, commercial and sustainable production systems.

Objectives:

- a. Enhance uses and adoption of low cost and profitable Ag machineries at farm level.
- b. Increase Ag productivity through increasing efficiency of Ag labourer.
- c. Increase the usage of machinery, electricity and renewable energy resources for crop cultivation for increasing crop yield.
- d. Increase overall crop productivity through increasing cropping intensity.
- e. Strengthening research and development activities on Ag machineries.
- f. Enhance/ motivate local Ag machinery manufacturer and will help them for their existence in the competitive market situations.
- g. Arrange special credit facilities with easy terms and conditions for Ag machinery importer, manufacturers, local service providers (LSP), and for farmers for enhancing Ag mechanization process.
- h. Create an authorized legal institution for standardizations of locally made and imported Ag machineries and spare parts.
- i. Strengthen mechanization for horticultural crop cultivation in addition to field crops.
- j. Empower Ag machinery service providing systems, training, multipurpose use and repair and maintenance systems.

In the policy paper there are 19 subsectors starting with introduction and ending by conclusion.

In the paper there are some policy issues about Conservation agriculture in subsector 09.

Conservation Agriculture (CA)

By adopting CA systems can easily maintain soil fertility and soil moisture, can save production cost and time, reduce green house effect and can increase cropping intensity. To achieve these goals following steps will undertake.

- a. Steps will take to motivate farmers to cultivate crops with zero till, minimum tillage considering soil and land type. And works will be done to popularize crop residue incorporation after crop harvest.
- b. Arrange training for the farmers, LS on proper use and maintenance of CA based machinery with the aim to extend the adoption of CA.
- c. Proper steps will be taken to innovate and development of appropriate machineries for crop residue management.
- d. Different steps will be taken for development and expansion of CA based technologies for improving soil organic mater and reduces soil erosion.
- e. Will increase financial incentive, credit facilities and developmental helps for increasing CA base machinery adoption and extension.
- f. Will enhance the use of digitalized systems for water saving technology extension and for irrigation water measurement.

6. Review of Current Policies

- 6.1 Before 2005, there was no explicit set of actions to guide the nature and extent or to set goals of agricultural mechanization in Bangladesh (Milon, 2016).
- 6.2 Except for assigning low tariffs for import of machines, other items mentioned in the 1999 Agricultural Policy, especially encouraging local manufacturing, have not enjoyed any follow up action (Milon, 2016).
- 6.3 The DAE activities before 2010 gave emphasis on adoption and dissemination of tillage and irrigation machineries with some emphasis on thresher, reaper and hand seeding machine. The use of 2WT for land preparation and rural transportation has increased rapidly in the country due to its versatile use, low cost for tillage; lesser time required for cultivation and higher crop yields (Miah, 2000). Before 2010, there

were no programmes on the training of the users, traders and service providers to maximize the benefits of mechanization and to increase longevity of the machines.

- 6.4 Through DAE project on 'Enhancement of Crop Production through Farm Mechanization Project', the 1st phase which started from 2010, has been disseminating tiller, thresher/Sheller, combine harvester, seeder (BARI model PTOS) and reaper to the farmers with 25% subsidized prices and modified the subsidy rate in 2nd phase of the project to 50 - 70% (depending on location). **In this project, no machinery was related to CA** (Anonymous, 2010, and 2013).
- 6.5 In Road map policy on agricultural mechanization included CA activities. There is proposed target area coverage on CA in the Road map activities and was a proposed project on CA (Anonymous, 2016) but practically no steps was not yet taken by DAE, GoB to execute the proposed project on CA and to disseminate or popularize CA machineries like ST seeding machine.
- 6.7 Some international organizations (like Murdoch University, Australia, CIMMYT Bangladesh) with some limited amounts of project support, tried to popularize SP machine like VMP in some selected area of Bangladesh with the support of DAE and research organizations.
- 6.8 MoA has published a policy paper 'National Ag mechanization policy 2020' in January 2020. There is a *section on Conservation agriculture* where highlighted the importance and necessities of CA to compensate the existing problems and protect the natural resources. Highlighted 6 activities on CA, is suggested to follow. So far observed, not yet taken any practical steps to carry out these activities.

7. Opinion of Stakeholders

7.1 Opinion of VMP users/Farmers

The farmers, those have been using VMP machine for planting different crops in different locations, provided feedback through the FGDs. Information was collected about the performance of this VMP machine as well knowledge about CA, and their suggestions for further improvement of VMP and to increase dissemination of this machine. Farmers' FGDs were held

at Durgapur in Rajshahi, Sibgonj in Bogura, Sadar upazila in Thakurgaon and Debigonj at Ponchagaor. At these locations, farmers are using 2WTs and 4WTs for tillage operation and some are using VMP for some specific crop seeding. All of the farmers using version-12 of VMP machines except few, they have version 11.

At Durgapur, Rajshahi farmers are using mainly 2WTs, sometimes Bed Planter and VMP. They are using VMP for planting wheat, lentil, mustard, maize and in a few cases, Boro. Hiring charge of a VMP was Tk. 1,350-1,500/acre (BDT 3,335- 3,700 per ha). At Sonatala, farmers are using VMP for seeding mustard, wheat, lentil, maize and chili. At Thakurgaon, farmers are using VMP for planting wheat, lentil, and mustard and at Ponchagaor, mainly planting groundnut.



Fig. 5. FGD with VMP users at Durgapur, Rajshahi

The users mentioned that VMP machine performed well, can do 5 functions at a time like strip plowing, making furrow, fertilizer & seed dropping in line + soil covering, and laddering. The specific advantages of planting by VMP machine, as mentioned by farmers were;

- ✓ Save seed quantity
- ✓ Seed spacing/seed dropping is good for all crops except groundnut and chili (depends on driver's efficiency).
- ✓ Germination is good for all crops as it drops seed in a specific depth
- ✓ No need to drive away birds after planting
- ✓ Less plowing and seeding cost. Very useful for groundnut planting, as in conventional systems for ground planting, farmers are using country plough (CP) which is now scarce to manage and costly.
- ✓ Easy to give irrigation, required less time
- ✓ Less labour required for crop management like seeding, weeding, harvesting etc.
- ✓ Less rat attack due to line sowing and un-pulverized soil.
- ✓ Plants become strong, more tillering, less lodging tendency especially for wheat.
- ✓ Give higher yield.
- ✓ More weeds in initial stage, needs to use herbicide.

- ✓ The VMP machine is not available as and when necessary. In maximum case, only one VMP machine is available for custom hiring in one location. The LSP could not cover farmers demand on time.

Farmers expressed similar advantages of CA as for VMP relative to conventional tillage. In addition to that, CA increases soil health and reduces soil erosion, according to farmers.

Suggestions: More VMP machines need to be available. In order to continue to create demand, there needs to be more block demonstration, field days/farmers rally etc. at planting and tillering time to motivate farmers. To achieve satisfactory weed control, farmers need training and awareness raising about safe and effective herbicide use. Availability of good quality herbicide in respective areas is also essential.

7.2 Opinion of VMP owners/LSP

The VMP owners cum local service providers (LSP) shared their experience, and gave suggestions for more dissemination and adoption of VMP.

Purchasing price and Incentive of VMP: For promoting VMP, from the initial stage, Murdoch University through project support have been giving incentives to the purchaser and farmers. Incentive is given to the purchaser for covering certain planting area. (Incentive is BDT 50 per 33 decimals planting; equals to BDT 375 per ha). The incentive indirectly ensured some level of market and reduced risk which encouraged people to purchase VMP and farmers to try the VMP planting service. In addition, the project is arranging bank loan for farmers to purchase VMP machine. Initially in 2015, incentive was more (50% of total price) but has decreased in the following years.

Table 8. VMP price and subsidy structure over the years.

Year	Price paid by purchaser(Tk)	Incentive received (Tk)
2015	30,000	30,000
2016	45,000	15,000
2017	49,500	10,500
2018	40,000	20,000
2019	35,000	25,000

Incentive rate per unit sale was minimum in 2017 (Tk 10,500.00 per unit of planter) and was again increased from 2019 in present project period (Table 8).

Crop planting: The major crops they planted are mustard, lentil, wheat, maize etc. at Durgapur (Rajshahi), wheat, maize, mustard, chili etc. at Sonatala (Bogura), wheat, maize etc. at Thakurgaon and groundnut at Ponchagaor. Except these crops, some LSP planted radish at

Ponchagaor, T. Aman and Boro rice at Durgapur. They mentioned that performance of rice was not good.

Planting area coverage: The planting area covered by each LSP depends on the drivers' skill and planting demand by farmers. In some areas, farmers were not familiar with or motivated about VMP performance (like at Sonatala and Debigonj). Land suitability and cropping patterns also limit the use of VMP. Where farmers predominantly plant Boro rice (for availability of irrigation facility), the VMP planting scope is limited. On average, each LSP covered about 10 acres (4 ha) planting with some exception in Rajshahi (one LSP covered 25 ac (10 ha) and one at Thakurgaon covered 35 ac (14 ha) in each of last 2 years.

The hiring charge ranged from BDT 3,000.00 to 3,750.00 per ha, is varying location to location. But in each location hiring change was same for all crops. VMP owners/LSP mentioned that about 2 to 2.5 hrs time required for planting per acre (5 to 6.25 hrs per ha). Both the LSP and farmers have no reservations about hiring charges.

7.2.1. Opinion about VMP machine:

- Have no major problems in the latest version (V-14). Seed controlling device for respective crop seed is easy to handle.
- The fertilizer box is made of metallic sheet, which become rusted after 2-3 years use.
- The furrow openers are not heavy/strong, become bending after 2 years use. Hoque Corporation mentioned that they have solved the fertilizer box and furrow openers' problems in latest version (V-14).
- Weight of the machine is more, required more energy to handle/drive it.
- Spare parts are not locally available, supplied by Hoque Corporation when required.
- Expert technician for repairing is not available in respective location. It takes about 3 to 4 days for repairing and spare parts supply by HC.
- VMP should be driven slowly with 1st gear to maximise planting efficiency (seed dropping, seed depth, residue handling), no riding system.



Fig. 6. FGD with LSP/VMP owners at Debigonj

- Wide of the machine is short (60 cm, covering 4 rows only) resulting long time required for planting.
- Need skilled driver to run this machine.
- No seed device is available for ground nut and for small seeds like chili.

7.2.2. Suggestions:

- The fertilizer box might be made of plastic, which will reduce the weight also.
- The furrow opener should be of strong metal.
- Need to develop seeding device for ground nut and chili.
- Need to reduce weight and increase wide of the machine (may be 6 rows) if possible.
- All types of spare parts needs to be available



Fig. 7. Interviewing with VMP owner at Thakurgaon

- locally. Small business entrepreneurship needs to be developed location wise. HC is trying to develop a service providing point in each VMP concentrated district (at least) from where LSP can receive required services.
- Skilled mechanics also need to develop by involving local PT mechanics by giving training to them (HC is trying to do this).
- Refreshment training for the drivers/LSP is required.
- Need to provide VMP machine servicing after 1-2 years of working. Although HC mentioned that this training and machine servicing activities are doing by them but still need to be strengthen for quick service.

7.2.3 Socioeconomic issues:

- The previous price (in 2015) and incentive system for planting area coverage (up to 50% incentive of base price) was more attractive to the LSP but the present price is seems high to them. They suggested to increasing the incentive like before, which will encourage farmers to purchase the machine and increase dissemination of this machine. Some of them also mentioned that as Government is giving 50% subsidy on 2WTs and PTOS why not for VMP. It will be helpful for them if VMP will also receive the 50 % subsidy.

- VMP is now on-work in the dry season for non-rice crops, covering only 1.5 to 2 months. If it will use for DSR (direct seeding rice) then it is possible to work for 7-8 months. More demonstration on DSR is essential.
- Farmers are not familiar with VMP/ST practice: they are habituated to use multiple ploughing passes for crop establishment. It is very essential to motivate farmers with more local level demonstrations, field day/ farmers rally (during planting and before maturity stage).
- The LSP are not familiar with fertilizer recommendations: they depend on farmers for choosing the basal fertilizer dose (especially TSP, MP). If there is poor yield due to low TSP and MP, farmers may blame the VMP (they assumed that due to VMP planting the yield was low).

So it is very essential to update LSP's knowledge by giving them crop wise fertilizer management training in addition to technical training (also need to know crop wise seed rate and herbicide use). Supply of leaflet covering crop wise fertilizer dose may also help them.

Mr. Khurshed Alam from Ponchagaor is a pioneer of VMP owner cum service provider. In the 1st year of his machine purchase (2018), he planted about 30 acres (12.15 ha) of groundnut and earned about BDT 36000.00 in one season. He mentioned that farmers could save about BDT 2100.00 per acre for G nut planting by VMP compared to conventional systems.



Fig. 8. Photo of Mr. Khurshed Alam with his VMP machine

Opinion about CA over conventional tillage: Owners cum LSP have positive opinions about CA. They mentioned that CA reduces cost of tillage, seeding, weeding, harvesting etc. Reduced seed quantity, irrigation water requirement, fertilizer requirement, and reduces pest (rat) & disease infestation. CA improves soil health and reduces soil erosion. Plant becomes vigorous due to line sowing. But in CA practice there is a need to use herbicide for pre-planting weed control.

7.2.4 Suggestion on policy issues:

- Bank loan facilities for purchasing 2WT and VMP need to be continued. (Presently the farmers availing 80% bank loan facilities for purchasing VMP and PT, LWR-2018-111

project make arrangement with National Bank Limited, Rajshahi branch for advancing loan to farmers).

- Present incentive on VMP purchase (incentive given by LWR-2018-111) needs to be continued. It should be 50% like before.
- Requesting the inclusion of the VMP in the government subsidy programme on agricultural machinery purchase. (Government of Bangladesh gives 50% subsidy on 5 categories of Ag machineries including PTOS+PT, Reaper, Power Thresher, Combine harvester, Rice Transplanted, and Foot Pump through DAE project on "Increasing crop yield through farm mechanization").
- Farmers are not habituated to use CA, so more motivational programme will help to increase VMP use and adoption. Establishment of more demonstrations and more field days, farmers' rally, motivational meetings with farmers and LSP by involving DAE, researchers will help more in increasing VMP use and adoption.
- To promote after sale service to LSP/owners, need to develop a service centre in each concentrated VMP using area.

7.3 Opinion of Extension personnel of DAE and BMDA

At Rajshahi, Thakurgaon, Panchagaon and at Bogura, meetings were held with the DAE personnel at district level, including Upazila and field level closely working with Murdoch University (MU), HC (Hoque Corporation), research personnel (at Rajshahi only) for adoption of the seeding machineries at farmers' field. The seeding machineries discussed were Bed Planter, PTOS and VMP.

The Barind Multipurpose Development Authority (BMDA), Rajshahi has been implementing 20 projects including around 16 districts of Rajshahi and Rangpur divisions during last nine and half years. The main activities are to create irrigation facilities for increasing crop production by intensive cropping specially in dry season. As a part of increase crop productivity programme, BMDA purchased and distributed 30 VMP machine in Rajshahi area. For lack of close supervision, few of them are under work. BMDA have taken initiative to bring all VMP under work from 2018-19 dry seasons.

7.3.1. Opinion about VMP:

- It's a unique, very good machine.
- VMP showing new dream to agriculture sector, its demand is increasing day by day.
- Doing 4 functions at a time, plowing/furrow making, fertilizer dropping, seeding, and land leveling.
- Good for crop cultivation under conservation agriculture. Need less plowing (one plowing), reduce water use.
- Quick seeding is possible; reduce turnaround time (TAT).
- This VMP machine reduces cost of tillage, seeding, fertilizer, irrigation etc.
- It facilitate line sowing, which helps to manage crop easily (weeding, time saving in irrigation, harvesting) and reduces rat problem.
- For weed control, need to use pre and post seeding time herbicide, need to do more work on it.
- It is difficult to use VMP in high moist soil and in dry hard soil like in Barind area.
- Spare parts and mechanics are not instantly available in respective location. Takes time (3-4 days) to repair it if needed.
- Not available in all locations (especially where have feasibility).
- VMP is too heavy, have no seating arrangement for driver during seeding.

7.3.2. Suggestions for more dissemination/adoption:

- In initial stage, performance of the machine should be optimized to attract farmer's interest. Good performance depends on good driving, so the use of a skilled driver for demonstrations is very very important. Hence there is a need to develop skilled drivers by giving intensive training to them. Although HC is doing that with the project help of Murdoch University, it needs to strengthen more.
- Spare parts need to be available in respective locations. Experienced technicians / mechanics need to be developed by giving training to local interested entrepreneur. HC is trying to do these problems as mentioned early.
- The VMP need to do further improvement to reduce weight.
- Need to establish more demonstration on different dry crops as well for direct seeding Boro rice (DSR) and maize, which will help to popularize this machine and will increase the working period (round the year).

- After planting groundnut by VMP, hand plowing can be done in between two lines for weed control, which save labour.
- DD, DAE, Nator seeing bright future of VMP, helps to save environment (like soil and water), save cost of cultivation and increase yield and profit.

7.3.3 Socioeconomic and policy issues:

- At present, famers at all possible locations, are not familiar with CA and VMP, hence extensive motivational programme including demonstration, field day/ rally with involvement from DAE will help to popularize the machine. Bangladesh liaison office of Murdoch University under SRA project trying to motivate farmers by arranging more training, field day/farmers rally, the same could be applied for VMP use covering larger areas.
- In total, VMP helps to achieve present GoB goal like increasing crop yield by keeping environment well (keeping soil health, saving water), saving cost, saving labour etc. and increase farmers' profit. So, increase adoption of VMP is essential covering major crops like Boro rice and maize.
- AD, DAE, Rajshahi suggested to establish more demo covering more districts. At Rajshahi area, underground water level is going down day by day. So more demo with DSR will helpful in Rajshahi area.
- Presently VMP sale systems with bank loan arrangement need to be continued with easy terms and conditions. Technical supervision and arrangement of bank loan need to be increased more. Presently HC and field level supervisors of respective Bank are doing these.
- Present incentive program by the VMP project needs to continue.
- Try to include this VMP machine in government subsidy (50%) program on agricultural mechanization. This will be better if government can take steps to give planting incentives rather than subsidy especially for CA machineries. It will help to ensure more use of CA machineries.
- More involvement of DAE field level worker/supervisor will helps to enhance more adoption of VMP. They could be jointly involved with researchers, HC's personnel.

7.3.4. Rural Development Academy (RDA), Bogura: The Rural Development Academy (RDA) at Bogura has been working for dissemination of VMP together with BP and Rice

Transplanter from last few years under *Water saving technologies dissemination project*. And they are trying to popularize VMP machine among farmers which will enhance the dissemination and adoption of this machine. Mr. Mozaharul Hoque, Assistant Director, CIWM, RDA Bogura shared some observations about VMP which are as follows;

- The VMP machine is more heavy to drive, need to deduce some weight (if possible), which will help driver to drive the machine smoothly.
- Need to develop entrepreneurship, which helps to disseminate this machine.
- Government ongoing subsidy programme on machine purchase (GoB giving 50% subsidy) discourage farmers to purchase it, so try to bring VMP under GoB subsidy programme on agricultural mechanization.
- Or present incentive programme by the VMP project (given by MU, Australia) should be continued. Planting incentive is better than subsidy; incentives ensure more use of VMP.

7.4 Comments of Research personnel

Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), and Bangladesh Agricultural University (BAU) are engaged in research and development of farm machineries and technologies suitable for socio-economic and technological condition of Bangladeshi farmers. In the mean time quite a good number of farm machinery has been developed in these institutes. Views of scientists working on farm machinery developments of different institutions are given below.

7.4.1. Bangladesh Agricultural Research Institute (BARI):

Scientists of FPM engineering division of BARI developed different CA based small machineries attached with 2WT like Bed planter, ST planter and ZT planter for multiple crops. And also modified and improved PTOS machine (which was originally imported from China). Alim Engineering, Alam Engineering, Janata Engineering etc. are fabricating different parts and machine, and supplied to different agencies and farmers under DAE subsidy programme.

Opinion about ST: As PTOS machine is now available; PTOS can easily convert to ST. So cost can be reduced by this way. *This ST machine is not well known, farmers are not interested to use this machine due to weed infestations. Still have scope to improve this machine. A*

comprehensive joint program with researcher, private manufacturer, NGO worker and DAE can helps to improve the machine as well can create popularity among the farmers which push up demand for this machine. Establishment of more demo in famers fields with joint effort also helps to create demand of this machine.

RWRC, Rajshahi: Regional Wheat Research Centre (RWRC) of BARI has been working for development and adoption of Ag machineries like PTOS, ST, BP, ZT etc. at Rajshahi region. They have long experience to modify/improve different seeding machineries and as well working for adoption/ dissemination of these machineries by doing different adoptive trials at farmers' field from over last 15 years. CSO, RWRC, Rajshahi opined the following opinion.

Opinion about VMP:

- The VMP is a very good machine for different crop seeding on line. Doing 4 functions at a time, plowing/furrow making, fertilizer dropping, seeding, and land leveling.
- VMP conserve soil and reduce soil erosion. As Bangladesh is going for more crop intensification (cropping intensity is increasing day by day), pressure on soil is increasing, conservation agriculture (CA) can helps to conserve the soil, VMP is more helpful in this circumstances.
- CA through VMP can save soil micro organism and increase soil fertility.
- VMP machine reduces cost of cultivation (like tillage, seeding, fertilizer, irrigation etc.)
- As it seeding on line, enhance good germination, good plant health and increase yield.
- It also reduces labour use (for seeding, weeding, harvesting etc.)
- It is difficult to use VMP in high moist soil.
- Spare parts and mechanics are not instantly available in respective location. Takes time to repair it if needed.

Suggestions for more dissemination/adoption:

- Farmers are not aware about CA and VMP use. To popularize this machine, need to establish more demonstration, organize more field days/ rally, FGD etc. involving DAE, research personnel, NGO workers.
- At present, VMP mainly used for dry season crops. More demonstration on Direct Seeding Rice (DSR) in Aman and Boro/Aus season will helps to popularize and increase adoption of this VMP machine.

- Spare parts need to be available in respective locations. For giving quick repairing services, technicians / mechanics need to be developed by giving training to local interested entrepreneur.
- The VMP need to do further improvement such that can run in high moist soil.
- For good seeding, skill operator is essential; it could be developed by giving practical oriented training.

Socioeconomic and policy issues:

- VMP price seems to high, the subsidy (incentive) programme by the VMP project need to continue.
- Bank loan arrangement for purchasing VMP need to continue with easy terms and conditions.
- Need to increase after sale service by Hoque Corporation (the only manufacturer of this VMP).
- Try to include this VMP machine in government subsidy (50%) program on agricultural mechanization under DAE.
- More involvement of DAE field level worker especially SAAO will helps to enhance more adoption of VMP.
- Regional Wheat Research Centre (RWRC), Rajshahi have been working on development and adoption of CA based machineries like PTOS, ST, BP, ZT etc. They are doing different adoptive trials of CA practice on different crops including DSR in farmers' field. CSO, RWRC, Rajshahi opined that for good seeding, skill operator is essential; it should be developed by giving practical oriented training. By arranging more demo, farmers training, field days, orientation program/ group discussion etc. popularity of ST machine will be increased.

7.4.2. Bangladesh Rice Research Institute (BRRI):

Farm machinery division of BRRI has been working to develop farm machineries for farmers. Research activities are going on to develop power tiller mounted reaper, multi-crop seeder, etc. They are trying to develop a seeding machine for rice but not yet finalize. They are also working to develop a unpuddled rice transplanter under financial support of Murdoch University, Australia. This machine is under test. *Dr Abdur Rahman, CSO (FMD) mentioned that ST*

machine like VMP is suitable for non-rice crop seeding, they are also trying to match it for rice seeding. Weed infestation is main problem for direct seeding practice; need to motivate farmers by explaining the benefit and conservation of soil and natural resources (water, fuel) and make available quality weedicide in CA practice area. By establishing more ST demonstration in the suitable area involving DAE, research, manufacturers and NGO partner may helps to disseminate the ST/VMP practice. If possible, VMP should bring under govt. subsidy programme.

7.4.3 Bangladesh Agricultural University (BAU):

Department of Farm Power and Machinery under Faculty of Agricultural Engineering and Technology, Bangladesh Agricultural University, Mymensingh have been working to develop new agro-based implements and also doing improvement of existing agro-machineries/ implements. Now, through different project support, they are working to test the fitness and improve and modify the machineries like ZT, ST, BP, PTOS, VMP etc. Considering present demand they are also working on reaper and rice transplanter.

Professor Monzurul Alam mentioned that previously Ag economist, researcher, planner and ag engineer are thinking to adopt labour intensive technology, as abundant farm labourer are available in rural area. But the situation was changed, now only 40% labourer available for ag work which will be in near future reduced to 20%. By increasing education level, living standard and industrialization, young generations are migrating to cities and to abroad. For boost up crop production by reducing cost and mitigating labour crisis, there is only alternative to adopt agro machineries in each stage of crop cultivation, harvesting and post harvest operations. Accordingly govt have taken a road map policy for ag mechanization in 20013. Follow on of this policy; have taken a mechanization project with giving 50-70% subsidy to famers for purchasing tillage, seeding, harvesting and threshing implements. In addition to all other research organization, BAU also continuing research to improve the seeding and reaping/threshing implements. For increasing farmers profit by reducing cost and to conserve natural resources and environment, time is come to increase the adoption of CA-based technology like VMP/ ST, ZT.

Comments on VMP/ST: *This seeding machine is good for conservation agriculture. It is able to reduce cost of cultivation (by reducing seeds, water, labour for plowing/ planting, weeding*

etc.). And it also conserves natural resources like soil and water. But farmers are not aware about CA planting, they are habituated to use more plowing. And as well this VMP machine is not suitable for all soil type and all agro-environment (different locations). In the planting time, need to fill up at least 2/3 portion of seed box by seed. And finally remain some seed unused. Not yet any customer sale business model to helps customers and after sale service. Spare parts and expert technician are not easily available in respective location.

Professor Alam mentioned that *there is scope to improve the VMP machine for different soil and agro-environment. Need to improve seeding box that ensure seeding with minimum seeds. Spare parts and after sale service should be ensure by developing micro business entrepreneurship model in the local area by motivating machinery sellers and workshop owners. Skill operator and technician need to be developed by giving training. Farmers, extension workers' awareness need to be developed by organizing field days, farmers' rally, FGD during planting time and in crop maturity stage, with the aims to show the practical scenario of crop cultivation without more plowing. Investment on awareness development work will not do by manufacturer, NGO. This should be done or leaded by govt. agencies like DAE by taking big project. But the involvement of manufacturer, researcher, NGO worker in the whole process is essential.*

CA tillage systems need to be included in govt Ag mechanization policy. A follow up CA based machinery (like VMP, ST, ZT) adoption project will help to increase the CA based machinery adoption in Bangladesh. Involvement of all research institutions, manufacturer, and related NGO will help to identify the bottleneck and enhance the adoption of CA machineries. Government can helps to develop high capacity industries for manufacturing CA machineries.

7.4.4 CIMMYT Bangladesh:

Under different project, CIMMYT Bangladesh has been trying to disseminate tillage and irrigation machineries in farmers' field. Through CSISA-MI (Cereal Systems Initiative in South Asia- Mechanization and Irrigation) project, they are trying to disseminate irrigation appliances (especially magic pipe) and PTOS, BP machine in the southern part of Bangladesh. In the northwest Bangladesh (Rajshahi, Rangpur), mechanization for small holders has been promoted by the SRFSI (Sustainable Resilient Farming Systems Intensification) project of CIMMYT Bangladesh. The SRFSI is a regional five-year multi-partnership project (May 2014 – June 2019) managed by CIMMYT with DFAT funding, through ACIAR across eight districts covering 3

countries namely India, Nepal and Bangladesh. The aim is to reduce poverty in the Eastern Gangetic Plains (EGPs) by improving productivity, profitability and sustainability of small farmers while safeguarding the environment. In Bangladesh SRFISI has promoted the PTOS and BP (BARI models) by involving BARI (OFRD), DAE, RDRS etc.

The project has succeeded in providing various capacity development activities through direct and indirect convergences, to over 101,000 people at all levels (32.63 % female), including farmers (women and men), service providers, researchers, and development and policy professionals across eight districts (including Rajshahi and Rangpur in Bangladesh) from three participating countries (India, Nepal and Bangladesh). Farmers are experiencing more economic benefit with CASI (Conservation Agriculture based System Intensification) technologies. The profitability of growing wheat maize, rice and wheat – rice and rice- maize system irrespective of locations were higher than that of the conventional system. Three years results also reveal that besides profitability there has been a significant reduction in irrigation water use (9% & 15%), energy use (11% & 10%) and GHGs emission (13% & 12%) in rice-wheat and rice-maize systems, respectively for using seeding machineries (PTOS, BP). However, PTOS and BP (BARI model) machines are currently being manufactured and marketed by several companies; and are attracting the DAE subsidy for Ag machinery project (Anonymous, 2018).

Dr. TP Tiwari, country representative of CIMMYT Bangladesh suggested to *reduce VMP weight, need to strengthen after sale service, create CA environment and need to work more on awareness building among farmers, DAE personnel, LSP etc. by giving more training/orientation, demonstrations, field days, FGD etc. This machine should be under subsidy programme and government policy on CA and CA tillage is very very essential which will helps to promote its adoption.*

7.5 Comments of Manufacturer

Under the National Network, The National Research Institute, such as BARI and BRRI have established linkages with a good number of manufacturers, capable of fabrication and manufacturing of agricultural machineries. These private manufactures receive technical assistance i.e. prototypes, drawings and expert services from the national research institutes like BARI and BRRI. CIMMYT Bangladesh also supports mechanization in terms of demonstration and training.

7.5.1. Janata Engineering, Chuadungga:

Mr. Oliullah, proprietor of Janata Engineering has long experience to work with BARI and has experienced to manufacturing/ assembling Bed Planter (BP), Zero Till (ZT), and PTOS machine. He is now importing some of the parts from China and assemble PTOS machine and sells it directly to farmers and as well to DAE and through Metal Engineering, ACI Company, Mahhub Engineering under subsidy program. In addition to that he also importing Reaper and Rice Transplanter from China supplied to DAE under subsidy project. The statistics are in Table 8.

Table 9. Number of different RCT machineries manufactured/assembled and supplied to others by Janata Engineering, Chuadungga.

Name of the machinery	Working/ developing	Since last 5 years		Comments
		Total No. procured/ delivered for project	Total no. sold directly to LSP	
Bed Planter	BARI model	100	16	Use only for bed making, not seeding
Zero Till	BARI Model	7	0	Farmers are not interested to use due to more weed
PTOS	BARI Model	1040*	240**	Using for tilling purposes
Reaper	Imported	111	86	Demand is increasing
Transplanter	Imported	11	0	Demand is increasing

* Supplied directly to DAE (824 No.); through Metal Engineering (75 no.), ACI (100 no.) and Mahhub Engineering (40 no.) under subsidy project.

** Sale directly to farmers in Rajbari, Faridpur, Pabna, Seraj gonj and Magura.

Opinion about ST/ZT: It is a resource conserving technology no doubt. It saves seeds, water and conserves soils. Reduce seeding and irrigation costs. Optimum soil moisture condition is important for seeding by ST/ZT machine. And technically skilled driver is very essential, which is lacking everywhere. Weed infestation more, need to use herbicide before and after seeding. Farmers are not fully aware about ST/ZT machine.

Suggestions for more dissemination/adoption: Further improvement in the machine is needed. Skill driver cum mechanics need to be developed by giving training to local interested person. By involving DAE, researcher and manufacturer need to establish more block demonstration to popularize this machine. More ZT use in Govt farm should increase; will helps to firmness of this machine. May include in Govt. subsidy programme.

7.5.2. Alim Industries Ltd:

Alim Industries, Nutun Bazar, Dhaka is one of the big agricultural machineries manufacturing, trading and importer in Bangladesh. Alim Industries Limited was established in 1990 at the South Surma, BSCIC Industrial Estate. To provide complete machinery Based Agricultural solution to farmers, to improve research, develop and manufacture better agro machineries, they have performed and demonstrated with their own machineries throughout the whole country, round the year. And they also assemble some machines after importing spare parts from China and Vietnam. The major tillage machineries, they have, are Alim Power Tiller, Alim VMP, Alim PTOS, PTOS (BARI model), Alim Bed Planter, Alim Rice Transplanter, etc. They have also different types of Reaper, Thresher and Dryer. They developed R-W power thresher, which is very popular among the farmers, and sold about 12,500 pieces directly to famers and also through govt subsidy program during last 5 years. Alim Industries in conjunction with the iDE/ACIAR project has produced 20 VMPs and supplied to them. Alim has own design power tiller (with disc harrow), suitable for hoar area, manufactured and sold about 2500 pieces in hoar area. In addition to that they also importing Reaper and Rice Transplanter from Vietnam and China supplied to DAE under subsidy project.



Fig. 9. Alim VMP seeding machine

Opinion about ST: They have **Alim VMP** machine for strip till seeding (see Fig. 9) but have no any market. *They viewed that farmers are habituated to give more plowing for crop cultivation to control weed and better crop performance. Benefits of conservation agriculture (CA) and ST are not well known to famers. Still have scope to work with this ST machine (VMP). Alim can contribute for disseminating this ST machine if include them in a mega RCT project. Establishment of spread demonstration evolving Alim Industries with DAE and researcher can helps to popularize and dissemination of this machine. After final development of a machine, they opined that the machine should be open for all manufacturer for multiplication, which helps adoption and dissemination the machine.*

7.5.3 ACI Motors:

ACI Motors, Tejgaon, Dhaka is one of the largest agricultural machinery import, trading and manufacturing companies in Bangladesh. ACI Motors was launched in 2007, to propagate a systemic change in the agricultural sector through increased mechanization of the agricultural process. To fulfill this vision, ACI Motors is striving to provide "Complete Farm Mechanization Solution" to farmers by offering a wide range of agriculture machineries - Tractor, Power tiller, Reaper, Mini Combine Harvester, Rice Transplanter etc. covering the full cycle from land preparation and cultivation to crop preservation (<https://acimotors-bd.com/overview>). They are doing research, developing and manufacturing agro machineries, importing and assembling some machinery after importing spare parts from India, China and South Korea. The major tillage machineries are ACI Power Tiller (Imported from China), Power Tiller Operated Seeder (ACI inclined type), ACI Tractor (Sonalika, imported from India). In Bangladesh, they have 8 sales and service centers, 300 nationwide dealers in PT and pump segment, 35 dealers and more than 300 network partners in Tractor, 56 authorized parts centre and 28 authorized workshops. ACI have credit and after sale service programme for tractor sale. With only 30% cash down payment they are providing tractor to customer and the rest amount will recover by 30 equal monthly installments. They also provide 1 year free warranty and life time after sale service (by cost sharing basis). ACI involve some NGO like Jagoroni Chakra (Based in Jessore), TMSS, SEAF and Mercantile Bank limited for selling the tractors. Last 5 years, they sold about 55,000 pieces PT and 750 pieces seeder directly to famers and also through govt subsidy program under DAE. They also sold about 10,000 tractors directly to farmers. In addition to that they importing Reaper and Rice Transplanter from South Korea supplied to DAE under subsidy programme.

Opinion about ST: Ag. Engineer Mr. Yeasir Ibne Ahsab, Product Manager of ACI Motors Ltd. Mentioned that *right now, they are not thinking about machine for conservation agriculture because it has no market demand. Farmers are not habituated and not know about CA. But he had experience on ST VMP machine, by this machine multicrop seeding is possible as it has separate seeding device for individual crop seed. It save seeds, cost and reduce labour and irrigation water use. Mr. Ahsab opined that still there is scope to improve the VMP machine, seed device for small seed like chilli, mustard, jute etc. ACI is working with tillage machineries marketing and adoption covering whole Bangladesh with their dealers, network partners, spare*

parts sellers and LSP at village level. They can use their setup for demand creation, adoption and marketing of VMP also if they got the responsibility from the authority like MU and government. Before that need to seat all the stakeholders together and make a roadmap of work plan and march up together with 'decided concrete message' to motivate farmers.

7.5.4 The Metal (Pvt.) Ltd.

The Metal (Pvt.) Ltd., Gulshan-2, Dhaka is one of the big agricultural machineries manufacturing industries and importer in Bangladesh. The Metal (Pvt.) Ltd was established in 1987, the sister concern of Project Builders Limited (**PBL**). PBL is the well reputed & renowned construction company in



Fig. 10. Metal Bed Planter

Bangladesh. The Metal is doing research, developing, manufacturing & trading of agro machineries and also assembling some machines after importing spare parts from China, Korea and India. The major tillage machineries are Tractor (Taffee and Eicher; imported from India), Metal Power Tiller (imported from China), Metal Rice Transplanter, Metal Combine Harvester (imported from Korea and China) etc. Metal Engineering also manufacturing and marketing different small size implement like PTOS, Bed Planter (Fig. 10), Potato Planter, Potato harvester, different types of Thresher etc. Metal have nationwide sale and service centre in 38 locations, one training centre, where they trained up LSP, technician and marketing staffs. They have also a big engineering workshop where they are manufacturing different types of agricultural implements and machineries (like BP, PTOS, Potato planter & harvester, thresher etc.) with the collaboration of BARI and BRRI.

Metal have credit and after sale service programme for tractor. With only 30 to 35% cash down payment they are providing tractor to customer and the rest amount will recover by 36 equal monthly installments. They also provide 2 years free warranty and life time after sale service (by cost sharing basis). Last 5 years, they sold about 8,000 Tractors, 1,500 PT (from last 2.5 yrs) and 70 pieces seeder, 68 pieces BP directly to farmers and also through govt subsidy program under DAE. In addition to that, from last 2 years, they sold Rice Transplanter about 15 units and Combine harvester about 50 units to farmers through DAE under government subsidy programme.

Opinion about ST: Mr. Amitave Paul, Ag Engineer, working under Metal Engineering, mentioned that *strip till machine VMP is good but has more weight, labourious to drive, have no driving seat, takes more time to seeding. Not yet developed spare parts market and good technicians, now controlling by VMP machine supplier company (Hoque Corporation) from Dhaka. He suggested to reduce weight and add seating arrangement. Metal Engineering is developing a 4 wheel tractor based seeding machine. It will be easy to drive, have more capacity. They try to add a furrow closer after seeding which helps to hold moisture, resulting good germination.*

He opined that farmers are not habituated to use ZT, ST, BP. Need to motivate farmers by establishing nationwide demonstration by involving DAE, research and manufacturing organizations (including Metal Engineering). For that a mega project on CA financing by government will helps in adoption of CA machineries. If they got opportunities to work with ST machine, they can use their established sales and service centres and LSP to spread these machines.

7.5.5 Alam Engineering:

Alam Engineering, Warri, Dhaka has a small workshop at Vajohori shaha road, Warri, Dhaka. In the beginning time they worked with CIMMYT Bangladesh and manufactured VMP as per CIMMYT advice. That time about 120 VMP units were made and supplied to CIMMYT Bangladesh Office. Now they are not involved with VMP but if got further responsibility, they can do again the job. They have no any field experience about the adoption problems of VMP but felt that need to reduce the machine weight and have



Fig.11. Mr. Alam supervising works in his workshop

scope further improvement. Now they are manufacturing different types of **seed device** for PTOS and ST machine as demanded by BARI, Janata Engg, Mahbub Engg, RFL etc. companies. So far about 10,000 seed device unit they made (for different crop seeding like wheat, maize, pulses, mustard etc) and supplied to them. Except seed device, they have been making **Fertilizer Replicator** for BRRI, BARI and DAE. *They feel that Govt support is essential for*

creating demand for CA machineries and as well to develop big size manufacturer in Bangladesh.

7.5.6 Hoque Corporation:

Hoque Corporation, Aftabnagor, Badda, Dhaka-1213 is a registered proprietorship business established in 2009. They are working with smart, effective and small holder farm machinery manufacturing, promotion, adaption, training, research, export, import and supply. Working as a Farm machinery commercialization development partner with different national and International organizations, Universities and Financial institutions in agriculture sectors. Originally VMP design was developed by Murdoch University-Australia. Hoque Corporation have been manufacturing VMP from 13th version with the technical assistance by Murdoch University. Working to improve VMP design in regarding of its efficiency in the context of farmers demand, various seed and soil types. Also working as a commercialization development partner of VMP in SRA-CA project collaboration with MU, BAU, CASPA & ACIAR since September'2015 to December'2017 (1st agreement) and August 2018 to December 2019 (2nd agreement). They are working also on its demand creation, value chain, operator training & follow-up, after sales services and spares availability.

Up to 2020, They have sold 211 Units of VMP among farmers in Rajshahi, Naogaon, Natore, Bogra, Rangpur, Dinajpur, Thakurgaon, Panchagarh, Borguna, Khulna and Noakhali districts and exported 40 units in India, Myanmar, Vietnam, Ethiopia, Tanzania, Zimbabwe, Mexico, Uganda and Tajikistan since 2016-2018. Hoque Corporation already received award from Government and International organizations for their outstanding performance in agriculture farm mechanization promotion in Bangladesh. Md. Mizanul Hoque, Proprietor & CEO of Hoque Corporation, mentioned that they have manufacturing capacity of about 600 units of VMP per year (Reff. Personal correspondence with Mizanul Hoque, CEO).

8. Factors Limiting Dissemination/Adoption of VMP

Conservation Agriculture is a win-win approach that reduces operational costs, including machinery, labour, and fuel, while increasing yields and utilization efficiency of natural resources. Conservation Agriculture helps farmers to reduce production costs while maintaining or increasing crop yields, and improving soil health. In total, VMP helps to achieve present GoB

goal like increasing crop yield by keeping environment well (keeping soil health, saving water), saving cost, saving labour etc. But there are many factors which limit its adoption. From formal and informal discussions with key informant groups, it was identified different factors affecting the adoption and dissemination of VMP, a brief summary of which are given below.

8.1 The socioeconomic limiting factors:

- **Lack of awareness:** about CA benefits among major stakeholders (e.g. Farmers, Extension specialist, development workers, etc.) due to limited promotional activity and awareness build-up of CA technology by public and private sectors. In general, farmers are not well known about VMP/ST practice, they are habituated to use more ploughing for crop cultivation. Therefore, demonstration plots on farmer's fields are the opportunity for them to gain experience with CA and show farmers how the system works. Farmer to farmer extension has been the most effective way of transferring knowledge and experience about CA to other farmers. A farmer with experience in CA is much more credible in front of his/her peers than anybody else. So more demonstration, field day/ farmers rally (during planting and before maturity stage) will be helpful for motivating farmers. DAE, HC and researcher are jointly can took responsibility to organize the demo and farmers rally. Sufficient fund allocation for extension activities is essential to build up awareness among stakeholders.
- **Proper weed management and crop establishment:** Pre-seeding weed control is often more difficult in CA based practices. For weed control, farmers need to use herbicide in pre and post seeding, but farmers have shallow knowledge on safe and effective use of herbicides and scarcity of quality herbicide also exists in local markets. In Conventional Agriculture a farmer can rely on general tillage implements to kill most weeds before sowing. Post emergence weed control in conventional cropping is now increasingly reliant on herbicides. In CA the farmer needs to be able to identify each weed individually and know which herbicide, cover crop or management practices can be used to control it. Farmers, LSPs and field level workers knowledge on proper weed management needs to increase/ update by giving training/ orientations.
- **Limited utilization of VMP:** Local service providers showed less interest to purchase VMP machine because it is very difficult to make the machine business profitable due to

limited use of machine (Daily low coverage, seasonal business, limited opportunity for multipurpose use). So limited use of machine hampered out scaling of CA and as well VMP. VMP is now on-work in dry season for non-rice crops, covering only 1.5 to 2 months. Machines are not been used in multipurpose as a result of year-round business is not possible. If it will use for DSR (direct seeding rice) and maize then possible to work for 7-8 months.

While CA systems and practices are now well developed and tested for non-rice crops, the adoption of CA in rice-based systems remains a challenge. Rice area occupies about 80% of the total cropped area of Bangladesh. The Boro and Aman rice occupy about 4.7 and 5.05 million ha, respectively (BBS 2017). Soil puddling is the common field preparation practice for rice seedling transplanting but it is time consuming, capital intensive, and degrades the soil physical condition. Direct seeding rice, specially for Boro rice, can solve all the problems as well increase working scope of VMP. Ex WRC had the good experience and positive results on direct seeding Boro rice in Dinajpur high/medium high land situation. More research and development work on it will help with scaling up the VMP use.

- **Un-skilled machine operator:** Sometimes poor germination due to unskilled machine operators de-motivates farmers to use further VMP machine. Skilled machine operator and knowledge of optimum soil moisture content both are important for good germination. LSP should have knowledge on moisture content of the soil, too dry and too moist will decrease germination. Practically-oriented training for LSP covering technical knowhow about soil and crop management will help to solve these problems. Refreshment training for LSP and machine owners in every year before season will help to increase drivers' efficiency, skill and quality. Although HC is continuing to organize refreshment training but these are not sufficient, it should be strengthened.
- **Shallow technical knowledge of LSP:** The LSPs are not well known about fertilizer recommendation; they depend on farmers for using basal fertilizer dose (especially TSP, MP). If yield is not good due to low TSP and MP, farmers may blame the VMP (they will assume for VMP planting yield became low). So it is essential to update LSP's knowledge by giving them crop wise fertilizer management training in addition to

technical training. Supply of leaflet covering crop wise fertilizer dose, seed rate etc. can also help them.

- **Unavailability of functional markets:** Functional national markets and dealership networks of manufacturers have not yet been developed for CA machinery. The promotional and marketing activities for VMP services are currently limited to selected areas in Rajshahi, Noakhali and Panchagargh. It was felt by LSP and users interviewed that there is lack of wider scale promotional activities in creating demand for VMP services at the field level. Spare parts, mechanics and maintenance services are not instantly available in all respective feasible area. Presently controlled by HC from Dhaka centre. It should be decentralized; HC is trying to develop technician/mechanics in each VMP using districts. It should be strengthened further.

The private companies especially ACI Motors, Metal Engineering etc. are working on marketing and adoptions of several agro based machineries and have nationwide sales and service centres. Their marketing and adoption services are covering whole Bangladesh with their dealers, network partners, spare parts sellers and LSP at village level. They can use their setup for demand creation, adoption and marketing of VMP also if they got the responsibility (in addition to Hoque Corporation) from the authority like MU and government. Before that need to seat all the stakeholders together and make a roadmap of work plan and march up together with 'decided concrete message' to motivate farmers.

8.2 Limitation on Policy issues:

- Except some national research organization (like BARI, BRRI, etc.), GoB has no CA based specific technology dissemination policy programme. DAE had executed some mega projects on ag machineries dissemination, but have no any room for CA based machine like ST, ZT, VMP etc. (except PTOS, which is not CA machine) although have project plan to disseminate CA based machineries. So, need to add CA machineries with its dissemination programme in any future project/ activities under DAE.
- In Bangladesh, government subsidies are available for a range of machinery but limited support is available for CA machinery. Government ongoing subsidy programme on

machine purchase discourages farmers from purchasing the VMP without subsidy (Government of Bangladesh giving 50% subsidy on 5 categories of Ag machineries like PTOS+PT, Reaper, Power Thresher, Combine harvester, Rice Transplanted, and Foot Pump through DAE project on “Increasing crop yield through farm mechanization”). So there may be merit in bringing the VMP under GoB subsidy programme on agricultural mechanization. This will be better if government can take steps to give planting incentives rather than subsidy especially for CA machineries. It will help to ensure more use of CA machineries. And present ‘incentive’ programme by the VMP project (given by MU, Australia) should be continued.

- Bank loan facilities for purchasing Power Tiller (PT) and VMP need to continue. (Presently the farmers get 80% bank loan facilities for purchasing VMP and PT. Hoque Corporation and Liaison Office of Murdoch University make arrangements with National Bank Limited, Rajshahi branch for advancing loan to farmers)
- Benefits from increased adoption of CA by farmers are primarily reduced cost of crop production (input savings), more timely sowing and water savings. Government policies to create an enabling environment will accelerate the adoption by farmers and create incentive for the private sector to take a lead role in commercialization of CA through mechanization.
- Comprehensive participation of all stakeholders for technology out scaling is not sufficient, it should be strengthen further. Coordination among machine manufacture, research, and extension personnel in the field level, as well in decision maker level, will enhance out scaling and enrich the LSP’s performance.

8.3. *Limitation of VMP machine:*

- The VMP field capacity/efficiency and daily coverage is not more. The operating speed of VMP is slower since it runs in first gear and the seeding coverage per time is 4 lines. Driver should have to walk behind machine when seeding.

So further modification/improvement of VMP by increasing width up to 6 lines (like PTOS, if possible), will help to increase its capacity/ working efficiency, help to increase LSP's profit.

- VMP has more weight, tedious to drive, and takes more time for seeding. Need to reduce weight, which will help driver to drive the machine smoothly. An imbalance weight of the machine is also creating problems in planting time. Back side has more weight than front side. Drivers are using extra load in front of the machine for smoothly driving. In addition to these, VMP has some shortcomings, which need to improve for better service. The additional shortcomings are;
 - It is difficult to use VMP in high moist and in dry hard soil like in Barind area.
 - The fertilizer box is made of metallic sheet, which becomes rusted after some years use.
 - The furrow openers are not heavy/strong, become bending after few years use.
 - No seed device is available for ground nut and for small seeded crops like chili.

Possible options for decreasing the weight of the machine would be by changing the metallic fertilizer box by a plastic box, reducing weight of roller, etc. Working efficiency of the VMP can be increased by solving the above-mentioned limitations, research and development is needed to further refine CA packages and adapt them to different regions.

9. Policy Intervention Needed

To address these key blocks and catalyze scale, a new mega project is essential to support innovative approaches and new partners, including govt. (DAE, Research), private sector manufacturers and NGO workers & organizations to help with awareness buildings, increase business skills, and other key areas. Other efforts to accelerate scale include strengthening links between farmers and service providers and intensifying leveraging of public sector programs, like the govt. agriculture mechanization Program under DAE.

The VMP machine is still having scope to speed up adoption. Further improvement of the VMP covering limitations and increasing its width size (if possible) will help to increase LSP profits

which enhance more adoption of this machine. More research and initiative is need to taken for its adoption/uses for major crops like Maize and Boro rice planting (Direct seeded rice planting is possible by VMP). It will help LSP for more profit earning by utilizing VMP in 3 crop seasons.

Inclusion of VMP in government subsidy programme will help more dissemination/ adoption. Follow up supervision after sale should also be increased for proper utilization of this machine. For that need to talk and convince the government policy makers and administrators under Ministry of Agriculture.

Capacity building is a key component in the complex process of achieving development outcomes of the project. Strategic partners need to enhance their capacities to accelerate awareness rising on CA, improve proper application and to enable sustainable and responsible scaling of CA innovations. Quality services cannot be expected under a scaled-out programme without a strong capacity building component embedded in the project to improve knowledge, skills and understanding, which led to increased efficiency.

For improving in depth knowledge on CA, need to include special subject on CA in under graduate and post-graduate courses of public and private Agricultural universities.

Commercialization of the technology for adoption of CA is needed to spread the benefits to small farmers. The private sector is a key partner by supplying planters through dealer networks, by providing repairs and spare parts service and by continuously improving the sustainability of planters for the market.

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11. Attachment

Appendix Table 1. List of key informant persons among policy makers, researchers, manufacturers, marketing companies, and DAE personnel interviewed

Sl.No.	Name of Key Informant	Designation	Institute/ organization
01	Dr. Md. Monzurul Alam	Professor, Department of FPM	BAU, Mymensingh
02	Dr. Md. Ayub Hossain	CSO, FMPE Division	BARI, Gazipur
04	Dr. Md. Arshadul Hoque	PSO, FMPE Division	BARI, Gazipur
05	Dr. Md. Abdur Rahman	CSO and Head, FMPHT Division	BRII, Gazipur
06	Dr. Md. Kamruzzaman Milon	PSO, FMPHT Division	BRII, Gazipur
07	Dr. Md. Ilias Hossain	PSO & in charge, Regional Station	BWMRI, Rajshahi
08	Dr. TP Tiwari	Country representative and Liaison Officer	CIMMYT Bangladesh, Dhaka
09	Mr. Md. Mozaharul Hoque	Assistant Director	RDA Bogura
10	Mr. SM Mostafizur Rahman	Additional Director	DAE, Rajshahi
11	-----	Deputy Director	DAE, Natore
12	ASM Sayem	Ag Engineer	Durgapur, BMDA, Rajshahi
13	-----	Deputy Director	DAE, Rajshahi
14	Dr. Bimol Kumar Paramanik	Upazila Ag Officer	DAE, Durgapur, Rajshahi
15	Mr. Md. Shah Saidur Rahman	District Ag Engineer	DAE, Rajshahi
16	Mr. Md. Anisur Rahman	Upazila Ag Officer, Sadar	DAE, Thakurgaon
17	Mr. Md. Oliullah	Proprietor	Janata Engineering, Chuadungga
18	Mr. Md. Humayun Ahmed	General Manager (M & S)	Alim Industries, Nutun Bazar, Dhaka
19	Engr Mr. Yeasir Ibne Ahsab	Product Manager	ACI Motors, Tejgaon, Dhaka
20	Mr. Amitave Paul	Ag Engineer	The Metal (Pvt.) Ltd., Gulshan-2, Dhaka
21	Mr. Md. Alam	Proprietor	Alam Engineering, Warri, Dhaka
22	Mr. Md. Mizanul Hoque	Proprietor and CEO	Hoque Corporation, Aftabnagar, Badda, Dhaka-1213

Note: Except these, discussion was carried out with;

Mr. Nazim Uddin, PD of Ag mechanization project of DAE, Khamerbari, Dhaka
 Prof. Dr. A Satter Mondal, Chairman of Ag mechanization policy making committee, MoA
 Dr. Wais Kabir, Ex EC, BARC and Member of Ag mechanization policy making committee, MoA
 Dr. Sultan Ahmed, MD, BARC and Member of Ag mechanization policy making committee
 Prof. Dr. Hamidul Haque, Department of Farm Power and Machinery, Faculty of AET, BAU
 Dr. Aminul Islam, CSO, BRII regional Station, Rajshahi
 Upazila Ag Officers of Sonatala, Bogura; Godagari & Potia in Rajshahi; Boda, Ponchagaor, etc.

Appendix Table 2: Policy reforms in the 1960s to 1990s

Year	Public sector	Private sector
1961	Agriculture Development Corporation (BADC) rents LLPs to farmers on an annual basis	Farmers pay the rental fee and fuel at 75 percent subsidy
1962-67	Water Development Board (BWDB) installs and operates 380 DTWs with four-cusec pumps in the north-western region	Farmers pay the rental fee and fuel at 75 percent subsidy
1972	BADC starts renting STWs to farmers' organizations	Farmers manage operation of the tube wells
1974-75	BADC starts selling STWs to individual farmers with subsidies; Bangladesh Agriculture Development Bank provides credit for the acquisition	
1977-78	BADC abandoned tillage machinery extension in 1977-78	
1979	Private sector allowed to import and distribute STWs, with credit facilities from commercial banks	Private sector starts workshops for repair of irrigation equipment
1980	Import duty on STW sets is reduced to 15 percent	Private sector starts manufacturing of pumps
	BADC stops renting LLPs and starts selling new and used LLPs to farmers' cooperatives	
1981-82	BADC starts offering rental DTWs for sale at subsidized prices with credit from commercial banks	Workshops and repair facilities for irrigation equipment grow
1984-87	Sale of STWs in the north-western region and formulation of Groundwater Management Ordinance; the private sector's import of small diesel engines is banned in response to drawdown of aquifer during the 1983 drought	Private sector trade limited to a few standardized engine brands; sales of STWs drop due to restricted installation within specified zones and spacing regulations
1985-87	In 1985-87, the government established a workable foreign exchange market and ended many nontariff barriers (nontariff barriers continued for diesel engines for irrigation and power tillers).	
1988	In 1988, the government eliminated import taxes on standardized (approved for agriculture) diesel engines and power tillers.	Private sector import accelerated.
1989	In 1989, the government ended standardization, allowing import without taxes for all 3-20-hp diesel engines and all power tillers.	
1987-89	Private sector bans on small engine imports are removed, import duties are eliminated, standardization requirements for equipment are abolished, and tube wells boring restrictions are withdrawn	Private traders start importing cheaper STWs from China; multiple engine brands and sizes enter the market.
1990	BADC starts clearing out its stock of irrigation equipment and stops monitoring boring of equipment	Market for engines, pumps, and spare parts spreads; repair works mushroom all over the country

Annexure 2

At the beginning of the survey, FGD, individual meetings, below introduction will be followed:

Sample Oral Consent Script

Dear Respondents

My name is ----- . On behalf of Bangladesh Agricultural University, Hoque Corporation, Conservation Agriculture Service Providers Association, and Murdoch University, Australia, I am conducting this survey/FGD/meeting. This survey/FGD/meetings aims to determine the policies and roadblocks for small scale CA farm machinery adoption in Bangladesh. It also tries to explore factors hindering adoption of CA machinery recommendations for finding out the most effective strategies for farmers in guiding the use of CA machineries. I would like to ask you for assistance in participating in the survey/FGD/meetings. Your participation in the survey/FGD/meeting is voluntary, and it will last approximately 1/1.5/2 hours. Please be aware that no special support will come to your household as a result of your response to the questions. Any information you provide will be used for study only and will be confidential. We will only share it with the SRA Project research team and data may also be made available to other researchers, but not in a form where you could be identified. During the survey/FGD/meeting, you can leave questions unanswered or end the interview at any time. If you have concerns after the survey, you can withdraw your response later by contacting our offices.

The information that you provide is very important to the study. As such, please do your best to be as open and honest as possible.

Do you agree to proceed with this interview? Yes (1) No (2)

Based on the agreement the research will use below questionnaire



Pilot Project on Commercialization of Small Holders' CA-based Planters in Bangladesh

(Capture the learning and opinion of stakeholders and identify the bottlenecks and barriers of adoption of small-scale machineries at field level)

FGD with machinery owners/Local Service Providers

1. Group address: village _____, U/C _____
 Upazila _____ District _____

2. Participants number in FGD _____, One Mob. No. _____

Name of the participants

a. _____	f. _____
b. _____	g. _____
c. _____	h. _____
d. _____	i. _____
e. _____	j. _____

3. Name of the machineries they are using for tillage? Name _____

4. Information about VMP.

Purchased year	Actual purchase price Tk	Subsidy/loan (if any) Tk
a. _____	_____	_____
b. _____	_____	_____
c. _____	_____	_____
d. _____	_____	_____
e. _____	_____	_____

5. Opinion about price (given the price of VMP, how do you rate it affordability?). How valuable of the VMP considering its price?

6. If you would like to buy a VMP, but the price is too high for you, what is the alternative? Suggestions for overcome the higher price.

-
-
7. If you observed technical problems, please explain in detail what are the technical problems of the machine (VMP)
- a. Seed dropping _____
 - b. Breakages _____
 - c. Operating Weight _____
 - d. Turning _____
 - e. Transportaion _____
 - f. Spare parts _____
 - g. Repair maintenance _____
 - h. Any other _____
 - i. _____

8. Suggestions for overcoming these problems

- a. _____
- b. _____
- c. _____
- d. _____

9. If you are providing planting service to others, please comment on

- a. Payment on time
- b. Acceptance of performance
- c. Acceptance of service cost
- d. Number of farmers serviced per seasons
- e. Area coverage
- f. Farmers' preferred planting methods
- g. Reside handling capacity
- h. Typical residue level
- i. Time taken in setting for individual fields/crop
- j. Time taken to one field to another (average per day)

10. The suggestions to overcome/improve these situations

- a. _____
- b. _____
- c. _____

11. Perception about CA tillage and Intensive tillage

CA Tillage by VMP		Intensive Tillage	
Advantages			
1 Increase soil fertility	% respo	1 Less weed infestation	% resp
2 Reduce tillage cost		2 Less pest infestation	
3 Required less fertilizers		3 Easily available	
4 Required less time for irrigation		4	
5 Reduce soil erosion		5	
6 Higher yield		6	
7		7	
Disadvantages			
1 More weed infestation		1 More tillage cost	
2 More pest infestation		2 Decrease soil fertility	
3 Not easily available		3 Required more fertilizer	
4		4 Required more time for irrigation	
5		5 Soil erosion	
6		6 Harmful for beneficial insects	

12. Suggestions on policy and financial issues which enhance dissemination of CA based tillage machineries like VMP

- a. _____
- b. _____
- c. _____
- d. _____

Many thanks for cooperation



Pilot Project on Commercialization of Small Holders' CA-based Planters in Bangladesh

(Capture the learning and opinion of stakeholders and identify the bottlenecks and barriers of adoption of small scale machineries at field level)

Interview with Researchers/Manufacturer

Name _____, Designation _____

Office address: _____, _____, _____

District _____ Mob. No. _____

1. What are the tillage machineries they are developing/manufacturing

Name of the machinery	Working/developing	Since last 5 years		Comments
		Total No. procured/delivered for project	Total no. sold directly to LSP	

2. Opinion about VMP/CA (please write name here _____ based tillage machine

j. Positive side of the machine

k. Shortcoming of the machine

- Seed dropping _____
- Handling residue _____
- Crop emergence _____
- Crop density and performance _____
- Price of a VMP _____

l. Availability of spare parts _____

m. Repair and maintenance problems _____

n. Others (if any) _____

3. Suggestions for further improvement to overcome these problems

e. _____

f. _____

g. _____

h. _____

4. The problems faced to disseminate VMP/ _____?

5. Suggestions for overcome these problems or to improve the situation

6. The socioeconomic problems of adoption of this machine

a. _____

b. _____

c. _____

7. Suggestions to overcome/improve these situations

d. _____

e. _____

f. _____

8. Suggestions on policy issues which will enhance dissemination of CA based tillage machineries like VMP

e. _____

f. _____

g. _____

h. _____

Many thanks



Pilot Project on Commercialization of Small Holders' CA-based Planters in Bangladesh

(Capture the learning and opinion of stakeholders and identify the bottlenecks and barriers of adoption of small-scale machineries at field level)

Interview with DAE officials

1. Name _____, Designation _____
 Office address: _____, _____, _____
 District _____ Mob. No. _____

2. What are the tillage machineries you working for?

Name of machinery	Working for	Disseminate last 5 yrs (No.)
f. _____	_____	_____
g. _____	_____	_____
h. _____	_____	_____
i. _____	_____	_____

3. Opinion about VMP

o. Positive side of the machine

p. Shortcoming of the machine

q. Availability of spare parts

r. Repair and maintenance problems

s. Others (if any)

4. Suggestions for further improvement of VMP by overcoming these problems

i. _____

- j. _____
- k. _____
- l. _____
- m. _____

5. The problems faced to disseminate VMP?

6. Suggestions for overcome these problems or to improve the situation

7. The socioeconomic problems of adoption of this machine

- d. _____
- e. _____
- f. _____

8. The suggestions to overcome/improve these situations

- g. _____
- h. _____
- i. _____
- j. _____

9. Suggestions on policy issues which enhance dissemination of CA based tillage machineries like VMP

- i. _____
- j. _____
- k. _____

Many thanks



Pilot Project on Commercialization of Small Holders' CA-based Planters in Bangladesh

(Capture the learning and opinion of stakeholders and identify the bottlenecks and barriers of adoption of small scale machineries at field level)

FGD with VMP User/Farmers

1. Group address: village _____, U/C _____
Upazila _____ District _____, Mob no. of leader _____
2. Participants number in FGD _____, Name of the participants

k. _____ l. _____ m. _____ n. _____ o. _____	p. _____ q. _____ r. _____ s. _____ t. _____
--	--

3. What are the machineries they are using for tillage? Name _____

4. Name of the crops where used VMP for tillage (last year)

Crop name	Area (dec) coverage	VMP hiring charge (TK/ac)
j. _____	_____	_____
k. _____	_____	_____
l. _____	_____	_____
m. _____	_____	_____
n. _____	_____	_____

5. Opinion about performance of the VMP machine

Positive opinion:

- a. Germination _____
- b. Cost saving _____
- c. Labour saving _____
- d. Grain yield _____
- e. Water saving _____

f. Profit _____

g. _____

Negative opinion

a. _____

b. _____

c. _____

6. Suggestions to improve the situation (mentioned in negative opinion)

7. Perception about CA tillage and intensive tillage

CA Tillage by VMP		Intensive Tillage	
Advantages			
1 Increase soil fertility	% respo	1 Less weed infestation	% resp
2 Reduce tillage cost		2 Less pest infestation	
3 Required less fertilizers		3 Easily available	
4 Required less time for irrigation		4	
5 Reduce soil erosion		5	
6 Higher yield		6	
7		7	
Disadvantages			
1 More weed infestation		1 More tillage cost	
2 More pest infestation		2 Decrease soil fertility	
3 Not easily available		3 Required more fertilizer	
4		4 Required more time for irrigation	
5		5 Soil erosion	
6		6 Harmful for beneficial insects	

8. Overall suggestions for more adoption of CA based tillage machineries like VMP

l. _____

m. _____

n. _____

o. _____

Many thank