



**Improving water use for dry season agriculture by marginal and tenant farmers
in the Eastern Gangetic Plains**

Improving dry season irrigation for marginal and tenant farmers in the Eastern Gangetic Plains – A Set of Case Studies

Working Paper 2019



Australian Government

**Australian Centre for
International Agricultural Research**

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1. Individual Case Studies

1.1 New skills, new crops and reclamation of uncultivated land in Kanakpatti

Sundari Devi Chaudhary is now a member of the Rajaji Krisak Samhuha collective in Kanakpatti, Saptari. Prior to project intervention, Sundari cultivated paddy (monsoon), wheat and seasonal vegetables, such as onion, tomato and eggplant (winter), and pumpkin and bottle gourd (summer) on 4 kathha owned land and 14 kathha rented land. Some tomatoes, eggplants, pumpkin, and bottle gourd were sold, and the rest of the crops cultivated were for self-consumption.

In the 2015-16 season, she decided to join an all-women's group comprising of 8 members, believing that working in a group would help members to procure low-cost inputs, get work done in less time, gain agro-economic skills, and access infrastructure, such as a short tube well (STW) and electric pump.

Sundari's collective has split the land into two halves, with 6 kattha¹ being used for shared cultivation of paddy and wheat, under which members share inputs, labor, infrastructure and profits jointly. The other part of the land has been set aside as a part collective, where Sundari has been allocated her own plot to manage individually, yet she shares water infrastructure with the group (1 electric and 1 80W solar pump provided by project) and occasionally the group hires a tractor together for land preparation.

Sundari decided to cultivate tomato, eggplant, and zucchini across 2.2 kathha of land out of 17 kathha of jointly-leased land, knowing from experience that she had fetched more profit from these vegetables than from paddy. She bought local tomato seed from a local market located 1.5 km from the village. With the assistance of a new drip irrigation kit, she was able to plant tomato early in comparison to other farmers in the community, and receive a higher price for it. She sold the first batch of tomato, altogether 4-5 kg, at up to NPRs 50/kg, as opposed to the NPRs 10/kg had it been sold on season. Sundari also found that the drip kit saved time and water, explaining "*Thopa sichai se jair mai jaische, dyang se kono thina besi jaische pani kono bela kaam, besi pani se tamatar mair jaiche*" ("drip irrigation gets water in the roots. In furrow irrigation, some plants receive more and others receive less water. Excess water leads tomato plants to die"). Though she would like to use the drip system in her personal farm as well, she realizes it would be expensive to install.

Zucchini, which was her first crop in the part-collective land, which she had never cultivated before, alone fetched her an income of NPRs. 12,000 to NPRs 13,000. She

¹ Note: 1 khatta= 0.0338 hectare

explains her satisfaction with this income, “I was aware of the fact that the first season could fetch me less money. However, I am excited about the return.”



Using the profit received from eggplant, Sundari was able to repay the loan that she took from the group fund. She had taken a loan of NPRs. 5000 to pay for her daughter’s school expenses at Rajbiraj, a town 10 km from Kanakpatti.

She is actively thinking about which crops to plant for the coming year, and has optimism that the collective will continue to improve her livelihood, to increase her confidence to negotiate with her landlord, and to support her daughter’s education.

Sundari Devi Chaudary selling vegetables at Traffic Chowk weekly market

1.2 Cautionary tales for the group approach in Koiladi



Ram Mangal Mandal is the chairman of Ma Durga Krisak Samuha collective in Koiladi, Saptari. Prior to project intervention, Ram Mangal owned 5 khathha of land rented 30 khatta of land to cultivate paddy (monsoon), and wheat, onion, and ladyfinger (winter) for both self-consumption and sale.

Although he farmed vegetables such as onion and ladyfinger commercially, he did it in limited land. So, when he learned water infrastructure support and agronomic skill transfer were components of the project, he was happy to be part of the group to learn skills, cultivate on a larger amount of land, and sell the produce in the weekly Koiladi market. He has experience working in groups, as he is a member of the local market committee and an informal water committee, so it came as no surprise that the five other members of the collective, two women and three men, chose Ram to serve as the chairman.

After the installation of shallow tubewell and electric pump, the landlord started bargaining for more rent than what was agreed for. Although, Ram Mangal is the land manager or *kamtiya* for this land owner² and is comfortable with approaching the them, he could not do much in this situation. The landlord wanted the group to shift to sharecropping, whereby the landlord would retain 50% of the crop. This would have meant that any increase in productivity gained due to the farmers' efforts or incentives would need to be shared with the landlord, reducing the incentives for the group and potential income. Under the earlier agreed contract whereby the landlord is paid a fixed amount of grain, farmers benefit to a greater degree from increased productivity. This highlights an ongoing challenge of collective leasing, as once landlords observe increased productivity they are more likely to demand increased rent. Nevertheless it is hoped that the enhanced bargaining power provided by the group approach to tenancy will counteract this. Eventually the members were able to agree to an increase in the paddy and hay amount provided to the landlord, yet remain on a fixed rate contract³.

² As land manager, Ram suggests which farmer gets the land tenure on the village of the particular landlord.

³ The initial agreed rental was 30 maan paddy for one bigga land in a year (1 maan paddy= 40 kg paddy; 1 bigga= 0.16055846 hectare). They negotiated to increase the paddy amount up to 35 maan and pay half of hay as well.



Despite this conflict, during the first intervention season in the monsoon of 2016, the group started cultivating paddy on 0.507 khatta of land following a pure collective model, where land was jointly leased from a landlord and all inputs, time, and profits were shared equally. Ram

Mangal had hoped that joining a collective would alleviate some of the individual farmer's input cost and labor contributions. However, he found himself doing most of the group tasks. *"Most of the members say they are busy with work at other fields and did not show up on time. I could not let the crops without care. So, I went to Hanuman nagar to buy fertilizers and pesticides"*. He adds *"I and other male farmers sprayed the pesticides and applied fertilizer in the field."*

Due to difficulty in managing time, and anticipating an even greater challenge in managing the continuous labor requirement for vegetable farming, the group decided to become a part collective and to share a joint lease and an electric pump but to farm individual plots. Under the part collective, during the *rabi* (winter) of 2017, Ram Mangal cultivated cauliflower and cabbage in 2.5 khatta land. Unfortunately, a pest attack damaged his first yield and he could only make an income of Rs. 3000 from cauliflower and Rs. 3500 from cabbage. Despite the poor yield, he is excited to continue with the part collective model and has planted bitter gourd and sponge gourd for the summer of 2017.

Even after transitioning to a part collective, Ram Mangal still faces challenges with respect to labor sharing for the group activities. As the chairman of the group, other farmers expect him to take the lead on many activities, including hiring a tractor, buying fertilizer at Hanuman nagar, sharing knowledge, and helping some women to irrigate their plots. He shared with us that *"I feel overburdened with work occasionally."* All these activities require him to provide his personal time and, sometimes even, to make personal contributions. For instance, to pay for the tractor hire charge, money is collected among the members. However, not everyone has been able to give money at the same time and so he has had to make personal contributions to make up for these shortfalls. He believes he will be repaid, but he still does not want to continue taking this burden on himself.

Ram Mangal's story is an example of how labor sharing is a considerable challenge to the functioning of collectives, especially pure collectives, and that going forward timekeeping should be improved to ensure that responsibilities are shared among group members, without too much of a burden on one or several members.

1.3 Moving towards food security in Mahuyahi

Md. Sakruddin is the head of his 13-member family in Madhubani district of Bihar, India. Prior to joining the Kisan Samuh collective of Mauahi (Lohapipar tola) village, he was a landless tenant farmer cultivating paddy (monsoon), wheat, and lentil (*rabi*) on 1.5 bigha of land on a sharecropping basis, meaning that the land owner did not provide any input support and received 50% of the total crop yield.



Md. Sakruddin and a Sakhi staff member survey his field

He did not have easy access to ground water since he was dependent on other farmers for tubewells and diesel engines, and so his cropping decisions were based on rain/surface water availability. The lentil crop was sown on standing paddy crop to use residual moisture. In the wheat season he managed to apply only one irrigation by renting an expensive diesel pump with low water discharge. If there was rain in the months of March-April then he was able to cultivate moong crop, otherwise the land remained fallow during the summer season. After paying land rent he barely had sufficient food to feed his family for the entire year, so he would work as a wage laborer or seasonal migrant in Uttar Pradesh to earn cash and meet the food shortfalls.

Md. Sakruddin is now a member of a five-person part-collective consisting of three male and two female members, a mix of muslim and yadav castes, all of whom are landless tenant farmers. This is the first time that he has been a member of any such group. As a

part collective, the group shares the costs of input procurement and access to and maintenance of a new shallow tube well and diesel pump set. This has reduced their irrigation cost from 120-150 hour to Rs 50 per hour, as they no longer need to rent a pump set. Importantly, the group also shares a joint lease and land rental is on a fixed cash basis i.e. Rs. 600/ per annum, rather than through sharecropping. This means that any increase in productivity due to their efforts goes direct to the farmer.

After the project intervention, he has cultivated paddy during kharif 2016 and wheat during *rabi* (winter) 2016-17 and Okra and Moong during summer 2017. He is able to produce enough food for his family and can even sell some produce to meet his family's cash needs, as his increased agro-economic knowledge has improved his confidence and bargaining power with traders and input suppliers.

Under the cash contract, and with improved irrigation, more produce stays with his family, and they have food security for most of the year, along with some surplus. Between that increase in food security and the decreased cost of irrigation, Md. Sakruddin no longer migrates for part of the year to meet the family's income requirements.

Sharecropping is a very common practice in Bihar, and the shift towards fixed rate tenancies through group leases could have broader implications for improving the livelihoods of marginal and tenant farmers across the region.

1.4 Engagement of landless non-cultivators in agriculture in Saptari

How would someone who has never farmed before find a way to start cultivating crops? The barriers are large – lack of knowledge about what seeds to plant, when, how, where to buy them and for how much, pest control, irrigation, access to land, and all the while taking a huge risk that, after all the time, effort, and cost, it would not be successful. For many, these barriers are insurmountable. Joining a collective, such as the ones formed under the DSI4MTF project, could serve as an entry point for people with no prior farming experience, people like Sushila Devi Ram.

When Sushila heard about the collective, she was excited by the prospect of learning agricultural practices that could augment her income from vegetable sales. Unfortunately, when she decided to join, the group was already formed, with land leased and divided among the members. Despite this, she attended the meetings and trainings organized by the group and was able to join when another member left the group. Sushila is now the treasurer of the Gadhi Mai Krisak Samuha part collective, comprised of 2 women and 4 men from the Dalit caste in Kanakpatti, Saptari, which jointly leases land and shares water infrastructure (1 electric and 1 solar pump). The group has developed its own protocols for managing shared resources and resolving disputes, such as developing a formal schedule to allocate pump usage to avoid water use conflicts that were arising from the initial strategy of “first come, first served,” which disadvantaged people like Sushila, who had to manage time between household activities, child care and agricultural work, without her husband.

Prior to joining the collective, Sushila carried out daily wage labor activities and her husband worked as an unskilled migrant in Saudi Arabia since 2015. Like many in the Dalit community in Kanakpatti, selling firewood was a main source of income. However, in the recent years, stricter regulations against forest encroachment made this livelihood source a difficult option, and is part of the impetus for Sushila’s husband’s migration. Going to the forest is restricted, selling at the market is prohibited, and collecting firewood itself is tiring and labor intensive. Other wage activities included weeding, transplanting and harvesting activities for which Rs. 200 was paid per day. Since Sushila did not cultivate any crops, consumption of staple grains and vegetables was dependent on the income made on a day to day basis. Availability of work was uncertain, and so was the consumption of food.

In 10 khatta (0.338 hectare) of the jointly leased land, Sushila now cultivates vegetables, which she is able to sell and consume herself. For instance, apart from consumption, she sold 30-40 kg of brinjal in winter 2016/17, earning around Rs. 3000 to Rs4000. She was among three in her group who showed interest in leasing additional land to farm in the monsoon of 2017. In the summer and monsoon of 2017, she planted bottle gourd, cowpea and ladyfinger in her plot. Land her group has leased is comparatively high land and can cultivate vegetable in monsoon season as well. She planted radish and leafy vegetables in the monsoon of 2017. Radish yield was 89kg and she sold 80kg, earning an

income of Rs 2492. While deciding what to crop, Sushila makes the decision based on not just income factor but the household consumption purpose as well. For winter 2017/18, she has planted brinjal and potato taking in consideration the consumption as well as selling side.

Sushila Devi considers the major benefits of being part of the group in terms of having access to self-grown vegetables for her and her two children to consume, and income and skill development. Prior to the project, she had no experience or understanding concerning farming practices or irrigation techniques. She recalls, for instance, over irrigating her crops during the initial intervention season, saying, "*jati pani dher pathaye, tyei dher tarkari falcha jasto lagtheo*" (I used to think, the more water I irrigate, the higher vegetables production would be possible). But, as the field officers instructed and trained her on irrigation, she has not run into this problem again. These trainings and frequent interactions have also helped build her confidence to speak her mind and raise concerns whereas, being a person from oppressed Dalit community and a woman, she did not have many opportunities to participate in social activities before. She is still hesitant to interact

with the landlord alone, but she says she is comfortable doing so in a group.

In some cases, such as with Sushila, collectives can provide the agronomic and skill development support necessary to start farming, leading to a more stable income as well as access to a more nutritional diet.



1.4 Emerging leader, Lalita Oran, sets examples for male out-migrant families

Lalita Oran, a 29 year old married woman from UC. She is illiterate but that has not stopped her from becoming the leader of a collective farming group in UC. This group pursues a model whereby small plots of land owned by members are consolidated and farmed jointly, with a sharing of labour, costs and profits.

Following training programs on conflict resolution, land preparation, crop selection, seedbed preparation, irrigation management, harvesting, linkage building, and marketing, she has grown confident to represent her collective. Prior to the project, she had long been working as daily wage labourer. Her husband Ramjesh Oran was a seasonal migrant labourer, often going to New Delhi for additional income.



Lalita busy with domestic activities

Lalita had positive prior experience with community groups through a savings and loan group she had been part of since 2007, and so she was eager to join an agricultural collective. Her group of 9 women collectively manages open field crops and poly house cultivation. Following the introduction of new crops like potato, cauliflower, spinach, and coriander and agroeconomic trainings, these vegetables have started to be grown for both own consumption and commercial sale.

During the last monsoon, they successfully cultivated spinach and coriander for the first time in the history of UC. Lalita and other women members are satisfied that they can manage new crops and earn better price. This time they successfully cultivated an early

variety of cauliflower (also for the first time in the history of UC) and sold it for Rs. 30 to 40 per kg, which is 5 times more than normal price during the normal season. The assured supply of irrigation water by solar and STW-shallow tube well has also reduced the risk of crop failure.

More than profit, the women have gained confidence. Lalita is very happy that she and Rita are leading the group and showing positive results. One year ago, male farmers had doubt about female farmers' abilities, but now they appreciate them. One male community member, had said, *"women in UC are capable to manage high return vegetables under poly house and open field crops like potato, radish, mustard, and wheat."* Lalita is also successfully operating the solar irrigation system. The participatory trainings, planning, and implementation has also led landless and landholding farmers getting to know one another and to a process of learning and sharing between them.

As a result of sustained and regular contact of the collective farmers with government officials throughout the project, 117 people have received their schedule tribe (ST) certificates and are able to access irrigation and other facilities from government. The ST certificates allow them access to a range of enhanced services and resources from the state.

Farmers outside the collective have taken notice of the collective's success. They are beginning to grow different crops during this *rabi* (winter) season, too. Lalita continues to be very confident about the outcome of the agricultural collective and that its activities will lead to a better life. Since Lalita joined the collective, the earning of the household has increased, it has also increased the confidence of both her and her husband to achieve cash income from agriculture. They have taken additional land on mortgage from another farmer, and are expanding their engagement in agriculture outside the collective. Within this context, combined with the challenges of migrant labour, the husband no longer migrates.



Lalita managing solar powered irrigation system



Lalita (second from right) with male farmers and CDHI surveying a radish field

2. Collective Case Studies

2.1 Ethical Community Engagement in West Bengal

There is abundance of water, both rainfall and ground water, but a dry spell renders the land infertile. There are technologies available and an elaborate extension system to deal with intermittent drought and compensate for and optimize productivity, but they are not affordable or accessible for the average farmers. The presence of premier institutions of science and scientists has not resulted in adequate knowledge transfer from lab to field. Social fragmentation, characterized by weak social networks and solidarity, renders institutional development difficult. All this leads the small and marginal groups to develop cynicism and lose confidence.

This is the context in which the DSI4MTF project began to work in West Bengal four years ago. The project aims to improve dry season agricultural productivity by establishing collectives to manage new socio-technical interventions. Collectivization is not a new idea in West Bengal. India has a long history of cooperative learning, and there has been a tradition of collectivization in societies with meagre individual resources. Indeed farmers in the North Bengal region themselves tend to work collectively during busy times in the agricultural cycle through exchanging labour with relatives and neighbours, most notably for paddy transplanting. However, experience with collectives, such as self-help groups and farmers clubs, has not always been positive in West Bengal, with unequal power relationships being exacerbated and ultimately leading to conflict and lack of faith and trust in the collective.

Indeed, farmers had development project fatigue. Community members would often quote, *‘several such initiatives have come and gone but our plight continues to be as they were for years. The researchers and researches have come about but nothing significant has happened. Our plight is going to be the same –no big change is anticipated.... If you are serious tell us clearly what the project is going to offer?’*

To overcome this historical experience, DSI4MTF partners have utilized an ethical community engagement framework throughout the project. Ethical engagement is seen as collaborative interaction and partnership between the researchers and the community, with each valuing the other for their wisdom, insights, value system, intellectual, creative and physical endowments in evolving and analyzing methodologies, strategies, process and outcomes. It upends the traditional knowledge production paradigm whereby the researchers produce knowledge and the people researched merely receive it. After two years of using this approach, we have found that this technique has created enabling conditions otherwise absent in achieving the project’s goals of land intensification, inclusion, and collectivization of farming communities in West Bengal.

For instance, after multiple community meetings community members were still skeptical about how this project would be different from others. But continuous engagement gradually brought them around. Night stays and training events, in particular, proved to be turning

points when the community became convinced of our commitment to them. We enjoyed warm hospitality and a promise to collaborate rather than be a recipient of doles.

Before those night stays, the project team in West Bengal **began with interactive meetings** with the communities to solicit their views on site selection and the project goals. During this initial engagement we observed that farmers were not optimistic about intensification considering the persisting dry spell, dependence on traditional technologies – such as manual and oxen driven ploughs and hired tractors/ power tillers – weak and indifferent extension services and blurred policy prescriptions. *“...Our crops suffer because of unpredictable climate conditions; we often suffer market fluctuations owing to unpredictable market. Minimum support prices and assurance against crop losses and glut are completely absent. Under such circumstances dreaming for a clear future is like day dreaming and a cruel joke”.*

A situation analysis of the two villages was carried out following an iterative interaction on village/community realities. The situation analysis included an analysis of the origin and evolution of the village, bio-physical characteristics, cropping pattern and intensity, climate change impacts, and livelihood dynamics. It also involved analysis at a community level of leadership dynamics, the presence of champion farmer leaders, while understanding gender relations. It assessed the history of conflict and cooperation, cultural practices and belief systems, and the present infrastructure in terms of agriculture extension and support systems.

The situation analysis followed a participatory and appreciative learning process as opposed to questionnaire survey methods. The process, carried out during extended interactions, attracted curious and enthusiastic attention and community members took extra pride in developing deep understanding about themselves and their community.

This revealed some knowledge that isn't captured well in survey methods, such as the sense of being a land-owner even without papers, as is the case in UC, where most farmers do not have land papers in their own names, but have enjoyed the agriculture land in a legal way for the last few decades. The composition of farmers is primarily small, marginal, and landless in West Bengal. We found that the average land distribution in Dhaloguri is 2.80 bigha (approximately one acre) per household and 6 bigha (2 acre) per HH at UC. Both communities suffer from dry spells of about 7 months (November to May). There are 62 members including 28 women (32%), 34 male (39%) and 26 landless (29%) involved in collective farming in UC-Uttar Chakowakheta and Dhaloguri villages. The crops are primarily monsoon paddy and jute in UC, monsoon paddy with some potato and mustard in Dhaloguri, with some farmers completely new to farming (wage laborers before).

We also found that, while extension services and pro- marginal policies are available from the Government – including institutional credit and input support, support prices,

insurance and marketing – the services are sporadic in nature and not systematically and practically available to the farmers.

The government is now in the process of providing land papers to the current land owners throughout West Bengal, and the collectives in both villages have organized themselves to apply for land entitlement documents, which will help them to access different facilities, including irrigation systems, seeds, and loans. Regular discussions about the challenges and opportunities regarding other local institutions, such as Panchayats, farmers clubs, self-help groups, and producers' groups, has improved understanding about the processes and procedures to access support, and has improved linkages with these institutions. For example, collectives in the both communities have now successfully applied for and received shallow tube wells through a government scheme.



SHG members and women members of collective farming groups come together to discuss learnings

2.2 Overview of Engagement Activities

The breadth and depth of community involvement is self-evident in the matrix below, which outlines our engagement activities over the past four years. Ongoing activities, including stakeholders' consultations, monthly meetings, regular review and planning meetings, and peer-group sharing helped to build trust and buy-in, as well as to embed learning. The participatory methods employed, too, were instrumental. For instance, farmers note that an Australian engineer, Mike, would always present new technology using a role play method that facilitated easy learning. Local technology specialists from UBKV and CDHI as well as overseas experts from University of South Queensland and IWMI, Nepal were always around to provide additional assistance, if needed. This proved critical during testing times, such as when the mustard seed did not germinate properly.

Type of engagement	DH frequency	UC Frequency	Purpose
Post inception farmers meetings	47	29	Enhancing knowledge and confidence for dry season cultivation. Slowly and steadily adopting new technologies.
Situation analysis	2	2	Engaged the farmers towards project and created ownership.
Focus Group Discussions	31	23	Issue based discussion on different topics and strengthened the internal governance.
Stakeholder's consultation	3	3	Action plans emerged from different agencies and convergence created. Also accessing government facilities.
Institutional development and capacity building	22	17	Strengthening the community based organization and engaging towards active participation. Relationship building with service providers.
Planning for technological location	6	6	Ensured the community engagement towards technology and proper installation of irrigation systems and equipment's.
Participatory crop planning	4	5	Cultivation based on farmers choice and introduced new crops.
Monthly meetings	27	24	Common decision making and trust building.
Review workshops and night stays	4	4	Reviewed the outcomes, introduced innovative ideas and trust building between community and project team.
Exposure visits – between collective villages and outside villages	3	3	Enhancing confidence and adopting new technologies. Improved relationship between farmers and service providers. Also learning from Dhaloguri farmers.
Bi-monthly meetings in Jalpaiguri –peer-group learnings	3	3	Learning from each other about crops, market value, and technologies built confidence to promote the crops in dry seasons.
Special events	2	5	Participated in international women day and enhancing the aspiration level. Directly communicated with higher authority of government line departments and jointly organized the caste certificate distribution programme. Almost all tribal members received the certificate to access government facilities including irrigation systems. Interacted with scientists from SIAGI project.

Monthly meetings were devoted to identifying performance, institutional functioning, and any necessary remedies. These meetings have been extremely useful in identifying high and low points and redirecting the interventions in ways the community found most

useful. Crop planning has brought together agricultural scientists and farmers to share their experience, deliberate around issues, and discuss possibilities.

At the end of one cropping season (2016), one such meeting was organized in both Dhaloguri and UC to analyze performance of the collective farming and to share a community dinner. The meetings continued long into the night, planning for the early variety of the next crop. The farmers in both the villages showed an interest in expanding coverage and variety. They also discussed important aspects of wage parity between male and female farm laborers, and why women have traditionally been getting a lower wage rate even under government prescription. It was unanimously decided in one of these meetings to adopt equal wages '*at least under collective farming*' to begin with.

Field visits have helped farmers see new opportunities in their fields. There were field demonstrations and intensive interactions with the scientists of the horticultural research station in Mohitnagar (Jalpaiguri). The research scientists were quite impressed with their inquisitiveness and shared with them the technical feasibility of various horticulture varieties. The farmers returned well enthused. The scientists from the research centre also visited the two villages and observed their bio-physical characteristics. They recommended various horticulture varieties which could add to the diversity and improve economic returns.

In addition to sharing knowledge with outside villages, bi-monthly joint meetings facilitated knowledge sharing between the collectives. Beginning in February 2017, farmers from the two villages gathered together at CDHI for shared reflection and future planning. They presented their respective key learnings, and discussed evolving perspectives, and plans. They have shared cropping choices for the subsequent seasons, discussed methods of potato cultivation, and decided what additional trainings they needed. Aside from project-related issues, farmers also use this time to share other family and personal issues and concerns. This improves and strengthens the quality of their networks and social capital. The occasion is also an opportunity for sharing their visions of the future and well-being.

Special events are useful for the community to revisit their own activities and to gain inspiration from others, and to strengthen linkages with government agencies. During one event, a photo competition was organized depicting community engagement. The UC women had to judge the photographs for their focus and depiction, allowing them to assess community engagement strategies and water management themes from a different perspective.



Collective members irrigate a cabbage field



Special events by SIAGI team members



A scientist and farmers discuss transplanting and follow-up plan



Exposure visit to CPCRI (a wing of ICAR) in Jalpaiguri

From indifference to active participation

When one would visit the UC village, people would tend to ignore and nod yes to any proposal for action only for it to be subsequently forgotten. The farmers expressed their disillusionment with all the past promises by various state and non-state agencies. They did not look welcoming the team and in a way showed collective gestures of disapproval- 'you better go' was the mood.

During one visit the CDHI team arrived at one of the community places at UC and initiated informal conversation.

The member: What is the issue?

The farmer: The project does not offer anything –only talk and talk and plain talk!

The member: Can you cite some concrete example?

The farmer blurred: My land has lots of weeds?

The member: So? what do you want? Let us discuss. There was silence and in the meanwhile a farmer joined the group with a robust cucumber in his hand and a woman with fresh sweet gourd.

The member: You have good potential for growing vegetable! What other crops do you have?

Community members together: We have paddy but not so much. This year the crop is not so good!

The member: Let us resume the discussion over weeds –so the weeds in your field-who should have cleaned it?

(Again some reflective moment)

A different farmer offered an anecdote-‘When you play football and the ball has to be shot in the goal post-who should do? Whom should we wait to shoot the ball?-there was laughter and sarcasm and the farmer with weeds quipped –‘of course the player and in the same spirit I should clean the weeds from the field.’

This offered a good environment for extending the discussion. The researcher team offered to visit further and join the community in understanding the situation. UC today is a model with increasing crop diversity, mobilization for entitlements, and frequent community convenings. Today farmers meetings attract overwhelming participation of the community members.

Has ethical community engagement led to improved inclusivity and intensity of production?

The physical data over the last three years cropping seasons does suggest an incremental rise in cropping intensity in both villages although the intensity is not yet substantial.

Out of six sites, in total, land coverage has also increased in four sites. Two sites in Dhaloguri village almost doubled their cultivation. In both villages, farmers are increasing cultivable land in Rabbi and summer season as well as increased crop intensification, though this is happening in small scale.

Table 1: Site wise land coverage (Sq. meter) in both village.

Season	DH site 1	DH site 2	DH site 3	Total land (Sq. m)	UC site 1	UC site 2	UC site 3	Total land (Sq m)
Rabi (winter) 2015-16	6674	7822	6836	21332	00	1183	00	1183
Pre-kharif	5024	6250	6733	18008	6733	2361	1687	4729

(summer) 2016								
Rabi (winter) 2016-17	11556	11294	6298	29148	15257	8773	6348	30378

The picture is not as clear for what this means in terms of farmers' incomes, with some net profit and some net loss seasons across each of the sites in each season. Incomes are hard to measure, with home consumption and distribution among the neighbours and relatives an important part of household food security and the cultural economy often calculated while considering profit. It is also very dependent on fluctuating market prices. Still, although farmers are yet to reap a large profit, they are enjoying doing experiments with new crops and new technology. The current levels of planning show clear intent toward adding more crops and varieties.

While the monetary assessment is not clear-cut, the shift in attitudes has been stark. Farmers now say, *'it feels better to see new crops are flowering and fruiting'*. They also have a longer-term view, past the summer paddy. With the change in the cropping pattern due to available irrigation facilities, and the exposure visits and knowledge sharing, preferences are starting to change toward early variety of spinach, capsicum, cucumber and late maize. The performance of mustard and wheat coupled with the availability of institutional support has encouraged the community to go for processing and organized marketing as a strategy for expanding the value chain. Although transitioning from subsistence to commercial agriculture is rife with challenges, they are also keeping an eye on local markets for sometime in the near future. Right now, the increase in vegetable production and household consumption is benefiting children, who get first priority.

Communities are planning for more fields to be brought under new crops and technologies. Landless women plan to lease land for maize in Dhaloguri, and have been encouraged by male farmers. UC women are determined to have better vegetable cultivation, using the protected farming technologies, and farmers from both the villages seem prepared to access institutional support to consolidate their current initiatives and to expand them. Women are chairing meetings, and actively participating in decision making and farming activities. The opinions of those with smaller landholdings, too, are respected. Consider the case of Bilal from DH. He does not have large land ownership compared to Mrinal, the active secretary of the farmers club. But the meetings are considered incomplete without his presence.

Collectivization is context and culture specific, strongly related to existing socio-political and economic realities. But, in West Bengal, ethical community engagement has helped build solidarity and constructive action. It has also encouraged farmers to understand the

climate, environment and market related risks. As a result, farmers can make crop choices and mitigate various risks in a better way. They have a transformed confidence and outlook on their future.

2.3 Greater trust of tenants by Mahuyahi landlords

Tenant farmers, those who rent but do not own land, often have a precarious relationship with their landowners, not the least because there is often a significant social and economic disparity between the two. Recognizing this power imbalance, what can be done to support farmers in obtaining a fair land lease? Lessons from Mauahi, in Bihar, provide an example of how the group strength of the collectives can increase their bargaining power, while also showing how NGOs can act as a third party to mediate these negotiations.

After seeing the success of the other groups in the community, another women's group came into operation in the Kharif of 2016, at their own initiation. Sakhi supported them in agricultural production planning and technical guidance, and gave some support with seeds. However, when the DSI4MTF project tried to support a newly formed collective, composed of 5 women from the *Paswan* Dalit community cultivating 2 hectare of land, to negotiate a joint lease in Mauahi, they found that landlords were suspicious. They wanted nothing to do with formal agreements with these potential tenants, since most tenants until then had been Muslim or Yadav. They were afraid that the Dalits would encroach upon their land, and this fear was not entirely unjustified, given that Dalit-supported campaigns in nearby villages had planted red Communist Party of India (CPI) flags and claimed land as their own.

Sakhi, the project NGO working with the collectives, took a facilitating role and the landlords ultimately agreed to give land through a contract with Sakhi. The landlords realized that they would actually get a better income from leasing out to the tenants through fixed cash amounts, rather than fixed crop amounts, with the reliability of a multi-season contract. After Sakhi withdrawal from the tenancy arrangement from the monsoon of 2018 the farmers themselves were able to take land on rent directly from the landlord.

This group was able to use its collective strength to negotiate with the landlord. While they were cultivating 1.2ha of land, they were actually approached by the landlord who requested if they could take on more land, given that they had been reliable tenants. The collective members felt their bargaining power could be increased if they negotiated jointly with another group (a smaller youth led collective). They therefore arranged a lease for 4.45ha of land for both groups (1.6ha for youth group), and negotiated the rent down from Rs12,000 per bigha to Rs10,000.

Now there is a broader shift towards fixed rent tenancy in the study villages, as landlords realize it is more productive and tenants can take more profit home. Landlords from

Nanour, a nearby village, are also now asking Sakhi if they can lease out some land. Having a respected 3rd party involved in negotiations can help to mediate disputes and assuage fears, leading to outcomes that benefit all parties.

2.4 Crop farmers form a fishery group in Saptari, Nepal

(“Teach a farmer to fish?”)

A year ago, if you had told the DSI4MTF Saptari fishery group that their first sale alone would amount to almost Rs 10,000, it would have felt like a distant dream. The group formed when members of crop-farming groups established in Saptari under the DSI4MTF project decided to organize themselves into a fish farming group with the aim of diversifying livelihoods, making the most of the large pond which was present on their collectively leased land. While crop-based farming has been a livelihood activity for a long time in Saptari, Nepal, these farmers tried their hand in fishery for the very first time in March 2017.

The group, composed of 14 women and 1 man formed a Pond Management Committee and agreed upon lease terms with the landlord, a fish feeding schedule, and construction of a bamboo house to guard the pond at night. After two training sessions led by the fishery officer from Department of Agriculture Development Office (DADO) Saptari, the group purchased fingerlings of different species (Rehu, Naini and Common Carp) from a fish farm in the neighboring district of Lahan and put them in the pond, a rehabilitated surface water pond already located in the village.

Unfortunately, despite the well-coordinated work among the members, the continuous and heavy monsoon in 2017 led to gully formation and soil erosion, severely damaging the pond intake. The members learned early on that the true test of collective action is during such uncertain times.

In response, the Pond Management Committee organized a meeting and carried out urgent repair work. Farmers gathered together and worked for two days to divert flood water to avoid further damage. They added soil in the intake area and installed two 6-inch diameter polythene pipes to channel the water into the pond. Support from the Department of Irrigation at Rajbiraj and the landlord were crucial. Farmers contributed labor and got material cost support for the piping through reimbursement by the Department of Irrigation. The landlord provided the necessary soil for repair work.



One of the members observing the pond after the repair work

This coordinated effort has started showing results. The group's first sale earned Rs 9950 by selling 49.75 kg of fish for Rs 200/kg at the village market, an encouraging indication that fish farming could serve as an important source of supplementary income for the members, who also continue to crop farm. Two tables depicting details of expenses and income made from fishery is given below:

Expense details		
Date	Particulars	Amount (NPR)
1st April 2017	First round fingerlings and fish feed purchase	8385
16th February 2018	Second Round fingerlings purchase	2500
7th April 2018	Pond lease for March 2017 to March 2018	17000
14th April 2018	<u>Labour</u> and fishnet cost for the first harvest	2600
18th April 2018	<u>Labour</u> and fishnet cost for second harvest	1000
27th April 2018	<u>Labour</u> cost for third harvest	500
20th May 2018	Third Round fingerlings purchase	7500
23rd June 2018	<u>Labour</u> and fishnet cost for fourth harvest	3190
Total		42,675

Income details				
Date	Quantity sold (kg)	Rate (NPR)	Income (NPR)	Remarks
14th April 2018	49.75	200	9950	Fish size was small and sold among the group members and neighbours . Fish produce was also used for consumption by members. Hence, the rate per kg is lower
18th April 2018	5.5	250	1375	Locals from the village came to the pond to purchase directly
27th April 2018	8.8	250	2200	Sold to a fish trader
2nd June 2018	16	250	4000	Locals from the village came to the pond to purchase directly
22nd June 2018	110	225	24750	Sold to a fish trader
Total			42,275	

Although the investment and revenue are almost the same at this point, it is encouraging that the group has reached a breakeven point early in their first season. More sales are anticipated in coming days, and they have also initiated conversations with a trader in order to access a larger market for future harvests. Moreover, some of the income benefits are not captured, such as some of the fish the members personally consumed (and, therefore, did not need to purchase elsewhere).

The group has come a long way since the pond damage in 2017 and farmers are excited to move forward. They collected Rs 500 from each member and purchased the next batch of fingerlings.

2.5 Landlord, tenants and power hierarchy: A tale from Koiladi

Saptari district of Nepal is characterized as the land of “*unequal land distribution*”, where a few landlords own large plots of land, while there are many tenant and marginal farmers who have no or small land holdings. In a country where agriculture is the major source of livelihood for 68% of the population, unequal access to land brings a lot of challenges for the marginal and tenant farmers, including in negotiating lease arrangements.

In Kanakpatti and Koiladi villages, the two main kinds of rental arrangements are *thekka* and *bataiya*. *Thekka* is the one time rent paid to the landlord in cash and *batiya* is sharecropping whereby 50% of the crop yield is distributed to the landlord. The general practice of having a land leasing document is uncommon in Nepal, where most renting is informal. In practice, this means that landlords can remove tenants from their land or renegotiate terms at any time.

As the intervention was in the process of rolling out in Koiladi, a formal land agreement was made between the landlord and the 6 members of Koiladi Group 2 under the project. The rental arrangement was fixed through *thekka* system. However, soon after the electric pump was installed in the leased intervention land, the landlord, Mr. Murari Singh, started demanding more rent from the group and a switch in the contract arrangement from *thekka* to sharecropping. The project team and farmers negotiated with the landlord a new agreement whereby a portion of land was decided on *thekka* (leasing) and another portion on *adiya* (share cropping).

While this caused delays in implementation, the collective was still able to crop for all three seasons, as opposed to the traditional cropping pattern of paddy cropping in monsoon, partial cropping of wheat/oilseeds in winter and fallow during the summer season.

Lease arrangements have also been complicated by the ongoing challenge of lingering fears of land reform, given the context of the political change over the past 10 years. The landlord’s son mentioned, “*yo samuhako manchhe haru le jamin uniharu naam ma huncha aba vancha re*” (meaning, “these group members are heard saying our land will be transferred in their name”). These fears meant that the landlord was not interested in continuing to lease the land to the collective after the contract ended in March 2018.

There is some precedence for legal promulgations decreasing the security of marginal and tenant farmers in the past. For instance, the fourth amendment to 1964 Land Reform Act provisioned that tenants would have ownership over 50% of land that they leased. Materializing this policy required a formal agreement between the landlord and the tenant, and thus did not get carried out in practice, but the legalese was enough to prevent landlords from leasing land to the same tenant for a long time period, either leasing to different tenants or leaving fallow.

This project, as well as future efforts to increase the security of marginal and tenant farmers, will need to actively consider the impact of governance changes, and engage landlords in conversations to allay their fears, to have them contribute to the work, and to make sure tenants are aware of their rights.

2.6 A change in marketing strategy by small and marginal farmers

If you had gone to the Rudrapur, Nanour, and Andhrathadi markets of Bhagwatipur or the Rampur Chowk and Babubarhi markets near Mauahi prior to 2015, you would have seen the commotion of thriving vegetable markets, but you would not have seen any higher caste farmers from the villages of Bhagwatipur or Mauahi. They faced the twin challenges of limited marketing experience and the social taboo against higher castes going to the market, even if doing so would ensure them a better price than traditional practices of using a trader/middle-man.

Traditionally, vegetable marketing has been done by a particular community called “Kujra” (a Muslim community), and also, more recently, by “Koiry” (a Hindu sub caste belonging to kushwaha community), both communities with poor social and economic statuses. The majority of the farmers in Bhagwatipur and Mauahi were apprehensive that their social status would decrease if they were associated with the Kuira community, saying, “If we start doing this practice [selling vegetables at the market], then people of our society and our relatives will call us Kujra.”

This social taboo recently became a greater challenge, as farmers have significantly increased their vegetable production as a result of access to water infrastructure – including a solar pump with drip and sprinkler and a group-owned diesel engine to reduce the hiring cost – agro-economic training, and increased cultivation areas through the DSI4MTF project. Prior to this, the farmers of Bhagwatipur and Mauahi villages used to cultivate paddy during *kharif* season and wheat during *rabi* (winter) season, sometimes growing moong crop during the summer season, dependent on water availability; but, they were rarely able to cultivate vegetables. Farmers then sold their grain produce to local traders who came to their doorstep, at a price lower than the market rate. At the time of sale, farmers are often not aware of the prevailing market rates and the traders take advantage of this.

After several discussions at monthly meetings, the project made some inroads in changing the perceptions of farmers regarding the acceptability of direct marketing. These discussions included introducing collective members to other farmers who were selling vegetables directly. For instance, In Bhagwatipur village, Mr. Jugut Yadav earned significantly more than the collective in both 2016 and 2017 from the same amount of land while cultivating the same vegetables and incurring the same irrigation costs because he sold the produce directly, rather than to the vegetable vendor, as the collective had done.

Mr. Jugut Yadav, a member of the collective who started direct selling, used existing relationships with customers to whom he used to sell milk to market his new vegetable produce, and he now has 6 families as regular vegetable customers. Over the course of

the project, many farmers, like Mr. Yadav, realized that they could earn more by selling directly to consumers rather than selling to the vegetable vendor.

Not all first attempts were successful, though. From Mauahi village, Md. Sakruddin was not able to sell even a kilogram of lady's finger (Okra) at the market and fed his vegetable produce to his cattle, instead, joking, "Even my buffalo not eat that Okra." Other farmers still opt to use vendors out of shyness, social status, and tradition. For these farmers, the project has provided access to information about market prices, to help the farmers to negotiate better prices with the vendors. But, there is a general trend amongst collective members toward direct selling of their vegetable produce, which has improved the returns that farmers have seen.



2.6 Their mustard may have wilted, but their spirit kept flowering! UC farmers' response to vulnerabilities

Should misfortune, such as crop failure, befall poor communities, what happens? Is the response different if farmers are part of a collective group? In a normal Indian social milieu, the immediate post failure scenario may begin and end with 'blame' –finding some scapegoats and explanations, such as the common refrains: 'it was all due to factors I am not responsible for' or 'they' did not do it, they should have done it'. Scientists would mine more data and pie-diagrams, and administrators would pass some orders suggesting not to repeat such mistakes. The matter would end with farmers ruing their fate and government officers closing their files till such catastrophe happens again.

In Uttar Chakuakheti, a tribal village of Alipurduar, West Bengal, nothing of that sort happened. When the mustard seed that the site 1 and 2 collectives – established as part of the project – had planted failed to germinate this year, the farmers lost no time. They immediately contacted the project's social and bio-physical scientists, who in turn ran to the field, stood behind the farmers, listened to them, shared their insights and agreed to do something urgently. There was a spirit of pro-activity, hopefulness, and confidence engendered through the engaged approach taken between the farmers and the project scientists. Everyone quickly agreed to replace the mustard with maize and summer paddy, and worked out the cost sharing arrangement necessary to do so. This quick replanting ensured that farmers are still able to harvest crops this season, both for personal consumption and for commercial sale. The maize was less successful due to grazing animals, yet the paddy performed well.

This story suggests that farmers can overcome misfortunes and crop failures not through financial and physical compensation, but instead through empathy and solidarity. At times of crisis, farmers need to be more intensely listened to and their views more deftly understood.

Social capital is an important endowment to depend upon and institutional and policy support is essential to help the poor negotiate with multiple vulnerabilities. The tribal communities of Uttar Chakuakheti (UC) have been taking on their existing vulnerabilities with resolve. Supported under the twin research initiatives DSI4MTF and SIAGI (sponsored by the Australian Centre for International Agriculture Research-ACIAR), the communities are collaborating with the research initiatives to promote socially inclusive sustainable agriculture intensification especially involving the small, marginal and tenant farmers during dry season. Two local organizations, UBKV and CDHI, who were coordinating the research in West Bengal for DSI4MTF, assisted with community facilitation beside a team of scientists that provided agro-economic and collective group management guidance and support. These interactions were iterative, and driven by what the collectives prioritized, from type of crop to the best way to handle labor sharing. Through this collaboration, over the past four years of the project, communities have

started actively managing new shallow tube wells and solar pumps, planning a yearly calendar of detailed activities and responsibilities, and planting different crops.

One of those crops was the mustard. From 2017, zero tillage farming with maize and wheat was experimented. Given the success of those crops, the community decided to try zero tillage with mustard as well. UC witnessed a never before feat of planting these two crops, mustard and maize, exactly on time, with no delay. The farmers felt confidence, and excitement about the potential new bumper harvest. The team from UBKV, too, felt pride about the major agroeconomic breakthrough of zero-tillage mustard, and that the farmer-friendly approach and confidence spreading to new crops.

However, two weeks after sowing, Tapan, one of the farmer-leaders from UC, remarked, 'sir the mustard in the neighbouring plot is doing better than the zero-tillage'. Rattled upon hearing this, scientists from UBKV and CDHI went the next morning to UC. This visit, and subsequent discussions with farmers, reassured them that they were not alone, and that sometimes things go wrong, but that shouldn't stop them from experimenting.

Plot to plot visits were organized, rows and depths were examined and questions discussed. The germination was different for the different plots and also within the same plot. The density of plants differed as well. Having analyzed the situation, however, there was an agreement to replace the plots with the cultivation of maize and summer paddy. The community considered these challenges as learnings. There was for instance, cross-fertilization of knowledge across the groups. In site 4 the mustard had done well, and group 1 and 2 they learned that their crop had been tilled too deeply. The farmers had contributed, out of their last years' saving, to the sowing of mustard and it was financially difficult to make a new investment. After a series of discussions, a cost sharing arrangement was agreed upon which the farmers and the project respected.

The farmers attended a training program led by UBKV, even coordinating schedules in advance to ensure that no farmer was left behind and timeliness in reaching the venue. They then lost no time in transplanting. The project team was there in the field to celebrate the sowing of summer paddy and the local government official (ADA)⁴ made it to the field to personally observe the interventions and inform the farmers about the other resources available from the state. This catalyzed their application for subsidized tubewells and sprinkler systems. Inputs were also provided to the farmers such as seed and fertilizer.

⁴ Additional Director of Agriculture, Alipurduar. Our effort at having network with the Government Officers has always been positive. Earlier the District Magistrate and the Sub-Divisional officer proved instrumental in arranging for the caste certificate of the tribal communities. Subsequently, irrigation pumps are being arranged under another government program. Visit of the ADA signifies a major shift toward out-scaling.

Where does this story lead us to? We find that the science and scientific data must begin and end with the community as originator and interpreter of scientific realities. This challenges the traditional paradigm between researcher and researched, which assumes that the researcher produces knowledge and the researched is the recipient. Instead, the approach taken by these joint research initiatives stresses that researchers should: provide early and often invitations to collaborate, evolve joint protocols, facilitate interface with authorities, celebrate achievements and outcomes, listen to those traditionally marginalized, and capture data and voices.

Our understanding is that humans have the indomitable potential to deal with their miseries and crises. Our work with the tribal communities in UC deepens our conviction of the self-efficacy of the poor and the ways this efficacy can be created, including through building social capital through collective farming and improved linkages with local organizations and government support.

2.7 Supporting landless woman through collective farming and dry season agriculture

In the Eastern Gangetic Plains, where livelihoods depend on agriculture and women play a pivotal role in ensuring food security and uplifting the household socio-economic status, there is a great challenge of empowering the rural women. Techno-managerial, socio-economic, and water scarcity limit women's access to water for agriculture. In this context, a project funded by the Australian Centre for International Agricultural Research (ACIAR) was initiated to work with communities across Nepal, India and North West Bangladesh, to research and demonstrate improved collective farming systems for marginal and tenant farmers and improved water management and irrigation practices using efficient systems appropriate to the needs of these communities, including women.

At the site Karjeepara of Dhaloguri village the project is working with a group of eight members consisting of four male marginal farmers, one male landless member and three landless women members. The members chose to name this group KrishiAnkurSwanirbharGosthi. Access to land and irrigation affects agricultural success and agriculture underpins many livelihood strategies; thus, the project provides a significant opportunity to improve the livelihood outcomes of the previously landless women.



Prior to the start of the project, most of the land was left fallow during the dry season except rain-fed paddy and winter potato in some patches. Direct pumping from a nearby river through very inefficient delivery pipes was the only source of irrigation to grow winter potato. With assured access to irrigation water – with one shallow tube well, one 4 HP diesel pump, one drip irrigation

system for protected cultivation, and one solar irrigation system – as well as numerous exposure visits, trainings, and practical demonstrations on crop management approaches, the group of farmers started growing crops even during the dry seasons.

Farmers and project scientists came together to consider experiences, soil, climate, and season, and prepared a crop calendar. In the last dry season (winter of 2016-17) a total area of 10 bigha (1 ha = 7.5 bigha) was brought under rabi field crops and winter vegetables. Women were instrumental in making these decisions, as they became active participants in the regular group meetings.

Water management techniques such as the reduction in the length of furrows for potato, corrugation irrigation to vegetables, and cultivation of low water requirement crops were all piloted successfully. The group has already grown lady's finger, capsicum, spinach, coriander leaves, and cauliflower. This year the farmers are growing a variety of winter vegetables using furrow or corrugation irrigation methods and using solar pumps as well as diesel pumps. These interventions have reduced the risk of crop failure and the overall cost of cultivation while enhancing crop productivity. This higher crop productivity and ensuring a timely harvest has led to improved incomes for collective members, including women. The farmers group has earned Rs. 5000 from the protected structure by cultivating and marketing off season vegetables. One woman member, Jharna Karjee, individually earned Rs. 625 from this sale.

Jharnaha also grew confident enough to take on the responsibility of being the group's cashier, organizing and distributing funds and benefits among the group members in an efficient manner. Taking part in all of the meetings and trainings has increased her knowledge of the scientific cultivation practices of dry season field crops and winter



vegetables, enhancing her confidence to be a group leader and to take risks to select and grow new crops and use different methods.

Krishi Ankur Swanirbhar Gosthi group, led by Jharnaha, has taken Rs. 50000.00 as a loan from government bank and invested on land to

expand their cultivated land area. Dhaloguri farmers also received eight irrigation systems from Water Resources Development Department, Govt. of West Bengal due to active involvement of small and marginal farmers like Jharna Karjee.

The successful implementation of cooperative farming approach provides opportunities



to build the confidence and skill set of women, as well as improving access to improved irrigation, with its potential to improve nutritional intake and supplemental income. As the women expand their operations, more emphasis should be given to developing linkages between the farmers and sellers or Farmer Producer Organisations.

3. Technology case studies

3.1 Drip Irrigation in Saptari and Bihar

It is always a challenge to introduce new technology in a new community. Although the chances of success are low to begin with, DSI4MTF's commitment to continuous engagement and learning with stakeholders has meant that introducing drip irrigation into Saptari and Bihar communities has resulted in real change – improvements in water efficiency and crop yield, reduced labor, cost, and time expended during irrigation, and, crucially, ownership of the new technology.

Prior to the project intervention, the 8 farmers from Rajaji Krisak Samuha collective, in



Drip kit installed at the intervention plot of Rajaji Krisak Samuha, group 1, Kanakpatti, Photo by: Andrew Reckers

the Kanakpatti village of Saptari, depended on monsoon water for irrigation and used flood and basin irrigation techniques. Whether a crop had been irrigated adequately was determined through visual measures. Farmers believed that the crops would grow well if they irrigated in abundance and so they often ended up over-irrigating the crops.

Rice-wheat cropping system dominates the agriculture in the Gangetic Plains of North Bihar, as

well, and the vast majority of the land remains fallow during the dry season.

Farmers in each collective had limited knowledge of efficient irrigation techniques, as well as limited access to tube wells or pumps. Drip irrigation technologies were entirely new when the project introduced them.

In both locations, the project started with several trainings followed by on-farm demonstrations in farmer's plots. The trainings were conducted by a local NGO, iDE, in Saptari, and included field visits to other farms using drip systems in Bihar. Then small drip systems were installed⁵ with the participation of farmers, so as to increase their understanding of the systems. A small drip system covers 50 square meters with the

⁵ 6 small drip kits were installed in different plots of the farmer's fields in Saptari, and four in Bihar.

capacity of a 50 liter drum, which suffices for about 80 plants. In both sites, farmers were advised to use solar pumps with drip system together.

Both collectives expressed overall satisfaction with using the drip technology, with it saving time, labor, water, and cost, and allowing crops to be grown during dry season. In Saptari, no respondents indicated they were unsatisfied, and 91% were either satisfied or very satisfied, as opposed to 9% who were only fairly satisfied (Figure 1).

Sundari Chaudary, from Rajaji Krisak Samuha collective, says, *“It requires less effort and saves time. Since water is directly applied in the plant roots not elsewhere, weed growth was controlled.”* All the farmers surveyed in Bihar also agreed that the weed problem was reduced significantly when drip irrigation was applied⁶ and that the drip irrigation system reduced irrigation time. Respondents in both locations indicated that they could do other activities while fields are irrigated now. In Bihar, farmers said, *“I do not have to stay in the field with the spade for the entire duration of the irrigation.”* and *“Irrigation is just at a button push.”* Sundari said, *“I fill the water tank/drum connecting with solar and engage in other work while field is being irrigated. I can either do another work or take rest.”*

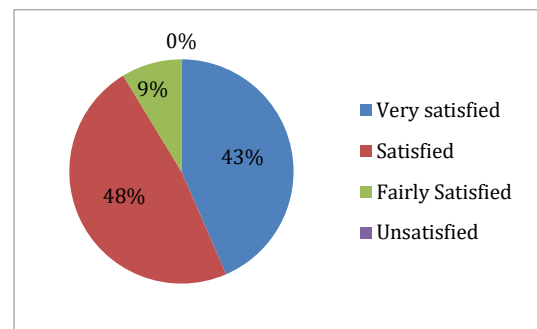


Figure 1 Portion of Saptari collective members satisfied with drip irrigation

While farmers in both locations found the drip system easy to use, several farmers in Bihar indicated difficulty reading the pressure gauge to monitor the flow and pressure in the irrigation pipes, and additional training was required to resolve that challenge.

The project also made sure that farmers participated in water use efficiency tests carried out in each location, boosting the understanding of the farmers about the system and their confidence in its effectiveness. These tests have shown a water efficiency of 90% in Saptari⁷ and 30-35% saving of water in comparison to furrow method of irrigation in Bihar, considerable improvements over canal or flood based irrigation. Fertilizer efficiency has also increased by mixing fertilizer with water in the drum, reducing the time needed to manually apply as well as the amount of fertilizer required. Janaki Devi Chaudary, of Rajaji Krisak Samuha collective, notes, *“Instead of 3 kg, 700 gram urea [fertilizer] is sufficient for 1 khatta of plot when I use with drip system.”*

⁶ polythene mulched plots were also used in Bihar, which likely contributed to decreased weeds

⁷ Where is this from? Elsewhere it says, “An estimate based on the data from the project area shows that the technology saves nearly 63 % of water as compared to furrow system”

Realizing the benefits of drip irrigation, farmers in Nepal have invested in bigger drip systems for subsequent seasons. Out of twenty three farmers in Kanakpatti, nine are using drip kits with sizes ranging from 100 - 500 m². Janaki raves, *"it irrigates my field in less than 30 minutes with a full 1000 liters tank. It is a tremendous benefit that I can irrigate more lands with less water."* Even farmers, such as Pulkit Chaudhary, who were initially reluctant to take up the drip system, have started using it. Pulkit explains, *"I saw that the technology offers multiple benefits. It irrigates a large number of plants in less time and drops water in plant root zone without any losses."* All the farmers surveyed in Bihar said that they are recommending this system to other farmers.

Some fears, such as it being too complicated of a system to use and too limited in size to have an impact, were easily overcome when farmers saw the effectiveness of the drip system. Still others can be overcome with training and technical support, such as confusion about how to read a pressure gauge. But other challenges will be more difficult to overcome, including initial cost and local availability.

Farmers have not seen vendors yet who can supply these systems or provide after sales service. Spare parts are also not available even in district headquarters. Neither is there awareness of these systems generated through public media or advertisements. To overcome these challenges, groups in Bihar are to be linked with ATMA so that farmers get subsidy and other support directly from the agriculture department.

Farmers in both locations also repeatedly identified the issue that the initial cost of a drip system is quite high at around Rs 10,000, which discourages investments by farmers. To overcome the cost limitations, the project provided 40% funds to buy systems up to 500 sq.m. However, there are questions about what system can be put in place to encourage adoption after the project ends.

Some landless farmers were also emphatically opposed to installing these systems on land rented from a landlord for fear of bearing a monetary loss should their tenancy be terminated.

We have found that farmers are becoming aware of this technology and its benefits, and have been very satisfied with the outcomes, if adopted. Drip systems show a high potential for improving irrigation efficiency in water scarce areas, like Kanakpatti and Bihar. However, there is a need for this equipment to be promoted by local agricultural development agencies, who can facilitate the supply of materials and offer technical support.



Figure 2 Drip kit drum being filled using Sunflower pump.



Sprinkler irrigation in the wheat crop



Training farmers on operation and maintenance of drip and sprinkler system



Brinjal cultivated on drip irrigation



Drip system set at Janaki Devi Chaudary's Cowpea field

3.2 Establishing mains electric pumping in Koiladi

For the 4 women and 2 men in the Shiv Parbati Krishak Samuha collective, access to an electric pump is the difference between having vegetables and not having vegetables. Before the project, poor financial condition of the group members prevented them from purchasing water pumps for irrigation. So, they would cultivate paddy in the monsoon season, and use a canal that would have water for a few months following monsoon to cultivate wheat and potato. Vegetable planting would require renting a pump for Rs. 150 to Rs. 250 for an hour, a prohibitive cost for most of the group members. As a result, vegetable was planted in the kitchen garden merely for consumption purpose.

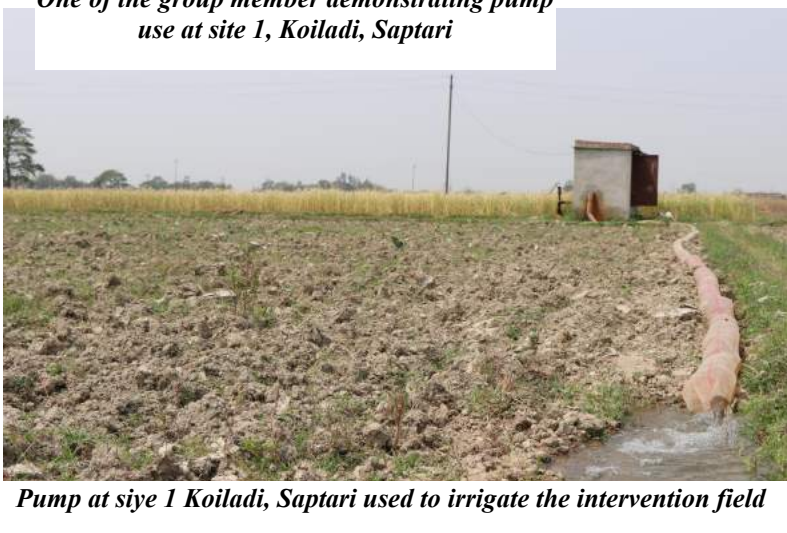


One of the group member demonstrating pump use at site 1, Koiladi, Saptari

After forming the collective, members leased an area of 0.8112 hectare and shared access to 1 tube well and 1 electric pump provided by the project. Both men and women farmers were trained on how to use and maintain the electric pump and delivery pipe. Farmers have started cultivating vegetable for the first time in Koiladi. In Rabi 2016, they cultivated cauliflower, cabbage, onion and garlic.

The project helped the collective to navigate local legal requirements, including that a pump application be submitted to the Electricity Office at Hanumannagar for an electricity meter.

The members collectively agreed on an irrigation schedule and have already modified it to better meet their needs, after realizing that more than one farmer could easily irrigate his or her crops in a day. They have also collectively overcome challenges related to the pump breaking twice, and some women members are willing to collect money or



Pump at siye 1 Koiladi, Saptari used to irrigate the intervention field

contribute from the monthly saving fund to handle any future repairs. Additionally, the project has provided training on pump operation, as well as repair and maintenance so that more of the maintenance can be done within the collective, rather than needing assistance at the district level.

The group is a part collective, where they share water infrastructure, inputs contribution and leased land, but they farm individual plots. Farming individually means the task of irrigation is done by individual farmer. And, while there are still some reservations about gender roles, as irrigation has traditionally been the domain of men, everyone in the group is allowed to operate the pump. As women have gained more confidence through trainings and skill development, they have started challenging opinions that question their ability to participate. For instance, when a male farmer, Shiv Kimar Mandal, questioned whether women in the group could operate the pump well, stating, *“How can women operate the pumps? Women may damage the motor (“motor jalaille sakbi”). If motor does not draw water after the switch is turned on, they will not know what to do,”* one of the women members, Jaja Devi, responded, *“Women are operating pumps by themselves now, how can you say we cannot do it?”* She adds, *“As we learn more, we will be able to do it.”* Uprooting such culturally produced belief is a gradual process, but empowering women to speak for themselves goes a long way.

For members of the collective, access to the new electric pump has ensured access to water in the dry season, which in turn has opened the possibility of enhancing livelihoods through commercial vegetable farming and improved nutrition.

3.3 Drip and sprinkler irrigation is changing gender roles in Bhatwatipur

Whenever we ask households in Bhatwatipur who the farmers are, the answer is, undoubtedly, the name of the male members of the family, even when male out migration in Bhatwatipur means that 60-80% of total agricultural activity is done by females. Farming is considered a man's activity.

The introduction of drip, sprinkler and solar operated irrigation equipment, under the DSI4MTF project, has changed this. Previously, men were required to start the diesel pumps and lay the pipes, which was very physical work that required practice. The drip system, on the other hand, is solar-powered and can be started by pressing a button. This is not to say that women would not be capable of learning to lay the diesel pipes, but the drip system provides an easier entry point to challenge some traditional gender roles.

But doing so, even with a drip system, is not easy. When two collectives first formed in Bhatwatipur, with a total of 2 males and 11 females all from the Ram community, both groups were initially dependent on the male members for land preparation, fertilizer management, and irrigation. Male members would provide their time only when it was convenient for them, which caused delays and some members suffered losses as a result. Still, women were hesitant to take on the use, operation, and management of equipment until a series of trainings built up their confidence. Now they are farming on their own. During this dry season all the agriculture activity is done by the 5 women of the group and within the last 5 months these members earned a profit of Rs 3000 each and they have 8000 in their box for this year's agriculture activity.

3.4 Technology case study 2: Ridge and furrow

In Bhagwatipur, potatoes are an essential crop for household consumption. Farmers use the local varieties of potato, which have small sized tubers but high storage capacity (shelf life) without refrigeration. Potato has traditionally been cultivated on a flatbed without applying irrigation water, in order to avoid stagnation in the field, which leads to early rotting. Unfortunately, relying only on residual soil moisture results in significantly lower yields of potato) relative to similar yield in irrigated plots.

The ridge and furrow method, popular in many other locations in India, entails applying water in small furrows between ridges about 15-20cm wide that lift the potatoes out of the ground a bit to avoid stagnation and improve aeration. The project introduced this method in the Rabi season (Oct-Feb) of 2015-16, demonstrating the processes of land preparation and potato plantation and holding many rounds of discussions.



Figure 3 Potatoes in ridge and furrow cultivation

Other farmers who were not part of this intervention, and were skeptical about this technology because ridge and furrow left more space unutilized, which they thought would result in reduced yield and economic loss. But the ridge and furrow technique and provision of improved seed led to good harvests of potato, with yields of up to 11000 kg/ha. This was an impact the farmers could easily visualize. What was the normal yield before the intervention? The normal yield of potato (local variety) is 4500-5500 kg/ha.

Those negative comments have stopped, and, during the Rabi season of 2016-17 onwards, the entire potato in the village was cultivated using the raised bed method. Now most of the other farmers in Bhagwatipur have also adopted raised bed cultivation.

3.5 Solar pump installation in Uttar Chakhoakheti

Solar powered shallow tubewells were installed in 2016 in Uttar Chakoakheti. There was no irrigation facility available before and the land used to be fallow in the winter. Now potato has been planted for the first time, and mustard has been planted as well. Solar does not incur an additional operating cost, although the upfront costs are high. Solar is nevertheless easy to operate for farmers and requires limited monitoring during the irrigation process, unlike diesel pumps which are prone to operating problems. It also requires less maintenance, and doesn't require priming. It saves considerable time, as farmers operating the pump and can be involved other activities while land is being irrigated. With access to water, farmers are able to start farming early: for example paddy land preparation was done early in the monsoon with support of supplementary irrigation, allowing the farmers to start vegetable production earlier than other farmers in the region, and get thus sell when the price is higher. Another benefit is that water used from the solar systems can be used for drinking as well.

There were however challenges in upscaling the systems in Uttar Chakoakheti. It is an expensive system and thus it will be difficult for other farmers to take it up without a significant drop in the price. Farmers also found it challenging sometimes to irrigate given that water can only be extracted during the sunlight period, and even with cloud, discharge can be low. Repair and maintenance can be difficult also if any problem arises as there is no manpower in the village who know how to repair solar systems.

Solar has considerable potential, and can be utilized most effectively with proper crop planning, and if it can be used to irrigate a larger area – at present it is not being used to its full capacity in terms of command area, and thus they are not receiving an optimal return. If one was to outscale this technology mobilizing farmer investment, a full utilization is necessary to justify the high start up costs.

One option is to sell water to nearby farmers to raise funds for the group, and this is taking place in group 3 of Uttar Chakoakheti, with a group of affiliate members who are not part of the production group who also use the water. Storage tanks could also be made to use water for irrigation when there is no sun, it is also important to look into options to supplement the solar with another energy option such as mains power, during periods of low sunlight. More efficient water usage should still be promoted because farmers may use more water than is necessary because it is free.