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Final report

project

Institutions to support intensification, integrated decision making and inclusiveness in agriculture in the East Gangetic Plain

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1 Acknowledgments

We are grateful for the ongoing support of in-country colleagues who have buttressed our endeavours, particularly International Food Policy Research Institute (IFPRI) and Bangladesh Agricultural University (BAU). This project coincided with COVID19, resulting in severe impacts across the study region. The inconveniences experienced in Australia were trivial against the circumstances in south Asia and yet our partners continued this work in good faith and with professionalism. The numerous 'work-arounds' to achieve the outputs and outcomes related to this project are testament to the adaptability of our partners.

Similarly, the participation of our in-country expert panels cannot be understated. The pressures placed on the policy-making communities at this time were intense, and yet many found time to participate in this research project.

Our Australian collaborators also showed considerable adaptability and their expertise was key to the project's accomplishments. Our thanks are given especially to colleagues at The University of Western Australia (UWA) and the related input from collaborators at Manchester University.

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Finally, we offer our thanks to the review team that provided valuable feedback to the draft report in mid-2021. Their insights have substantially improved the value of this final report.

2 Executive summary

The future prosperity of the massive population of the Eastern Gangetic Plain (EGP) is at a crossroads. Rural poverty is endemic across the region and food insecurity is common. Against that background, Conservation Agriculture based Sustainable Intensification (CASI) in the EGP has been given a high priority by the governments of Bangladesh, India and Nepal, and significant investments have been directed at this goal over several years.

Agricultural intensification can also support other goals in the region, like raising the profile of women, but knock-on effects need to be understood and accounted for in advance. It is also the case that policies that ultimately seek to raise the welfare of the poor generally work more effectively when the institutions given responsibility for delivery are functioning appropriately.

This project was established to answer questions about how policies and delivery institutions might assist. The focus was on raising and stabilizing farmers' incomes in the EGP but the project also sought to explore and promote ways of simultaneously fostering agricultural intensification, integrated decision making and inclusiveness (i.e. the '3 I's').

The project had planned to assemble several sets of primary data that would inform policy-making communities and engage them in a critical discourse about the current settings. These data would reveal policy/delivery institution combinations that were deemed most effective and provide insights from farmers into the perceived acceptability of different policy/delivery combinations.

The primary data collection from experts in the policy communities was completed and analysis highlighted:

1. the important role of improving access to inputs and
2. strong support for the use of private sector institutions as a delivery mechanism.

The comparison data from farm households could not be assembled due to COVID19 restrictions. Accordingly, analysis was undertaken of several secondary data sources in an attempt to meet the objectives of the project. A reduced primary phone survey that focussed on specific topics was also used. Overall, the findings from the numerous studies generally confirm the view that access to inputs is a key challenge across many domains. For example:

- Water access in the region is intimately tied to energy and the way energy is priced matters. Leveraging diverse preferences around pumping technologies offers some promise for further developing groundwater markets and widening water access;
- Knowledge transfer to farmers offers promise on multiple fronts. However, its benefits are not universally accessible, with women particularly disadvantaged. There is scope for substantial gains from emerging extension mechanisms (like mobile phones);
- Policies that are seemingly focussed on risk reduction and seek to promote agricultural production with subsidies are leading to perverse impacts and require a re-think. Farmer adoption of conservation agriculture may also be enhanced by better accounting for farmers' risks. International support to enhance governance and financing systems can have important benefits that can flow through to agriculture.

The project has made progress in sharing these lessons. In addition, the innovative primary survey of farm households is poised for deployment in 2022 and this will provide high quality data to shape further dialogue in the region. The project also helps establish an agenda for future work, especially around the linkages between water, energy, agriculture and household wellbeing.

3 Background

Almost every analysis of the EGP for the past two decades has concluded that one of the most feasible paths for development is increased intensification of agriculture (e.g. Erenstein et al. 2008). This conclusion has been drawn against a background of:

- Growing population with accompanying high and rising population density.
- A large dependence on agriculture for livelihoods, albeit varying somewhat between the countries of Bangladesh, India (Bihar and West Bengal) and Nepal (e.g. 80% in Bihar compared to 55% in Bangladesh).
- Food insecurity and undernourishment for a non-trivial portion of the population (circa 16% in Bangladesh, 15% in India and 8% in Nepal).
- Marked inequalities with women particularly vulnerable.
- Small and fragmented farm landholdings usually operating at sub-optimal levels while using cultivation practices that jeopardize soil health.
- Challenges with managing floods and water shortages in the same year accompanied by declining water quality and depletion of groundwater in some locations.
- Generally poor physical infrastructure with significant limits to reliable and affordable energy and weak transport infrastructure that hinders market access and development.
- Mounting evidence that climatic stresses are increasing.

Despite these challenges, the region has relatively abundant agricultural resources compared to some neighboring jurisdictions (e.g. Northern Mountains). The region has also benefited from significant research into testing options for agricultural intensification at field scale.

Intensification involves increasing the output from a given set of inputs and much of the work in the region has centered on the principles embodied in CASI, with emphasis on using soils more intensively, often in tandem with machines that reduce tillage and lessen the call on other inputs, like labour and water. But despite its apparent financial promise, the uptake of CASI remains shy of expectations and up-scaling and out-scaling have not always occurred.

A review of CASI and related development work by Joshi et al. (2017) suggested that there were major opportunities to enhance adoption of alternative farming practices in the EGP like CASI through improved institutional settings.

Better institutions are usually defined as having lower transaction costs – they add certainty and thus make the work of markets and government more effective. The lessons from New Institutional Economics also shows that when high-level policies are aligned with appropriate delivery institutions better outcomes occur. Reducing transaction costs in just a few areas can have a very large impact on agriculture in the EGP, with potential positive flow-on effects.

But questions remain about what are the ‘best’ policy/delivery combinations and can experts be engaged to critically review the existing approaches and look for better solutions? In addition, are the ‘best’ solutions acceptable to farmers?

The purpose of this project was to tackle these questions head-on but to do so in a way that encouraged the policy communities to be directly engaged. This approach hinged on the interaction with policy communities to generate primary data that could then be compared with the views of farm households.

To make the overall task manageable, the ambition was to build a set of insights from three related domains covering:

1. knowledge transfer to farmers
2. water rights (defined here as access to the benefits of water) for farming households, and
3. risk management for farm households.

These three strands of research were also overlapped with an interest in the impacts on inclusion, especially for women and tenant farmers.

4 Objectives

The overall aim of this project was to develop capacity within district, state and national agencies in the EGP to identify and consistently promote institutions that foster the '3 I's' (intensification, integrated decision making and inclusion).

The project originally had four main objectives:

1. To create an understanding within agencies of the existing institutions that influence farm level choices across local and district scales against specific national objectives.
2. To empirically evaluate the performance of different institutional designs across three domains (knowledge transfer, water property rights and risk management), using economic efficiency, equity and environmental sustainability as yardsticks.
3. To foster collaboration with and within district, state and national authorities by developing an agreed evidence-based framework for shaping institutions that promotes the '3 I's'.
4. To create institutional 'field sites' where the benefits of institutional change can be showcased and monitored beyond the life of this project.

In 2020 it was agreed that COVID19 had made Objective 4 unviable and the remainder of this report focusses on activities and outputs pertaining to the other objectives. For convenience, these are replicated from the project proposal below:

Objective 1 Activities:

- Map the overall institutions that influence farmers' incentives to change production in Bangladesh, India and Nepal, using expert local and regional knowledge.
- Create maps that reveal the institutional influence on particular segments of farmers, specifically, women farmers and tenant farmers.

Key outputs from these activities:

- An institutional map of jurisdictions reflecting the decision environment of 'average' farmers.
- An institutional map of jurisdictions reflecting the decision environment of women farmers and tenant farmers.

Objective 2 activities:

- Empirically measure the performance of institutions that aim to transfer new knowledge to farmers and detail the gender-sensitivity of different models of information transfer.
- Measure the impact of alternative institutions for water (e.g. landholders versus tenants; women farmers versus men) on the use of other inputs in agriculture and how limiting some rights can help sustainable management water at different scales.
- Empirically measure the performance of different institutional set-ups for helping farmers deal with risk with specific analysis of the effectiveness for different cohorts, including women farmers and tenant farmers.

Key *outputs* from these activities:

- A suit of statistical studies showing the relative performance of different institutional set ups (covering knowledge transfer, water property rights and risk management) from the perspective of the 'average' farmer, women farmers and tenant farmers.
- A synthesis of key findings that are (a) digestible to end-users (b) informative to media and other outlets.

Objective 3 activities:

- Use systematic qualitative approaches to develop guidelines for institutional design that effectively transmit information about farmer adaptation across both men and women and in different settings.
- Develop guidelines for institutions that strike a balance between private and public interest in the use of resources, like water.
- Develop guidelines for institutional design that fosters coping with climatic and market risks.

Key *outputs* from these activities:

- A '3 I's' Framework based on consensus that guides the overall design of institutions across the EGP.

5 Methodology

The work was undertaken in the EGP and spanned the states of Bihar and northern West Bengal in India, Terai in Nepal and Northwest Bangladesh. The ambition was to mirror the regions covered by earlier Sustainable Development Investment Portfolio (SDIP) projects and thereby build a bank of evidence to assist in the analysis of CASI which was key in other programs. However, given the policy breadth of the project input was also sought from national experts beyond these regions.

Co-design foundation

The methodology itself was developed from several processes. First, interviews were undertaken with policy influencers in each country. This included bodies like the Planning Commission and agricultural development agencies. The interviews focused on the current policy settings and how local delivery was supported. Interviewees were asked to offer candid opinions about relative success, but this did not always yield clear responses.

Second, structured workshops were undertaken that brought together government officials, NGOs and researchers in the region. This was facilitated using the existing networks that had been established from the earlier SDIP-related works. Additional participants were engaged by the in-country partners with advice from ACIAR staff. The workshops were also attended by researchers embedded in other SDIP projects.

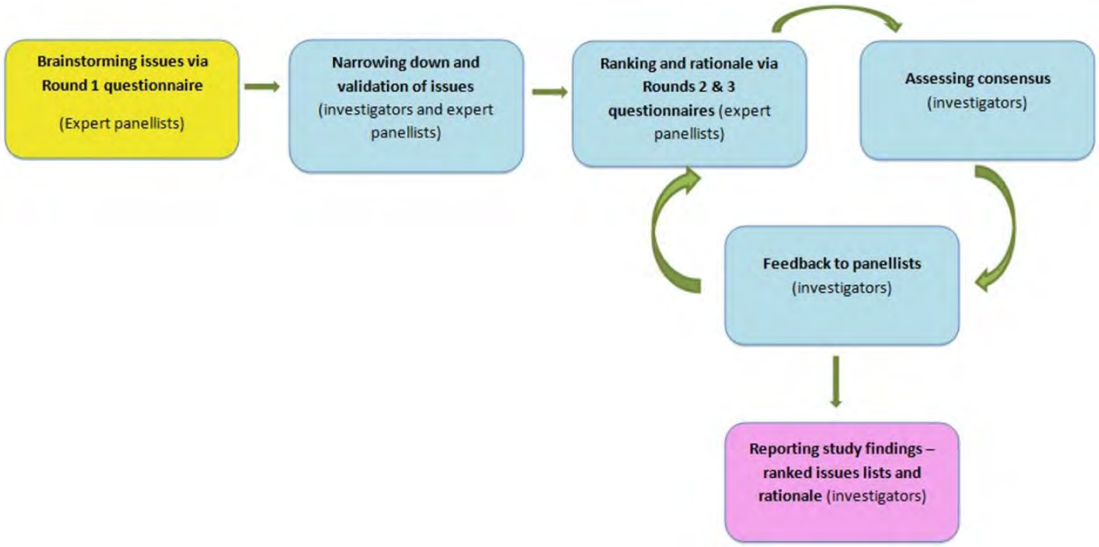
Conducted over consecutive days, the workshops explored the types of institutions currently in play and a wide discourse around what was working and what were the key challenges for those responsible for recommending policies and offering advice on their implementation. The workshops concluded with a ratification of an approach to interrogate this topic and an agreement to focus on farmer incomes and stability of incomes as the primary objective of interest to the policy community.

The methodology that was agreed had several phases.

Delphi

Given the objectives, the initial phase required a way of summarizing the institutional landscape. This was undertaken from an expert perspective using the Delphi method. Delphi is a structured means of interacting with experts to gather information and ultimately reach consensus. Importantly, the Delphi itself provides a vehicle for engaging with the policy community who are key end users of this work. Delphi is usually conducted over several rounds with information provided by experts interrogated by investigators and then put back to experts for validation. The standard Delphi approach is described in Figure 1.

Figure 1: Steps in a Standard Delphi Analysis



The Delphi was managed by CI Cooper at UniSA although input and recruitment was vested in partners in country. Since Delphi is relatively uncommon in a development context there was some adaptation of the technique anticipated. This centered primarily on the recruitment process going beyond the usual online/email invitations to experts.

The second round of the Delphi was expected to generate a ranking of the effectiveness of policies and institutions using a Likert scale. However, one of the limitations of Likert scales is that they allow people to rate all items the same - for example as ‘very important’ or ‘very unimportant’ - with little or no discrimination between items.

Best-worst scaling with experts

The next phase of the project thus sought to harness the evidence from the Delphi and apply a more discriminating process to reveal what institutional set ups (i.e. combinations of policy and delivery) were most effective at raising and stabilizing farmers’ incomes. The recruitment process again allowed for engagement with the policy making communities on the topic of institutional reform. The discriminating technique adopted was the Best Worst Scaling (BWS) method.

BWS is a form of discrete choice experiment. BWS forces respondents to discriminate between the items (in this case policy or institutional options) under consideration, and it allows researchers to investigate underlying preferences via the choice tasks. Respondents are presented with a sub-set of items and asked to choose the best and worst from that sub-set. In this case experts were asked to choose the most effective and least effective way of raising and stabilizing farmers’ incomes.

The BWS design would focus on all items identified by the Delphi as being relevant. However, a challenge emerged insomuch as all institutional elements were deemed important/relevant and these comprised a mixture of both policy and delivery components. To cater for this, the BWS

was redesigned such that it was divided into two tasks. The redesign was achieved with input from Prof Dan Rigby at Manchester University.

The first task asked experts to discriminate which policies would be most effective at raising and stabilizing farmers' incomes. The BWS survey was dynamically programmed to capture these results and present the respondent with only the options hey selected as most effective. Respondents were then asked to rank the delivery apparatus that would best accompany the selected policy instrument.

The design of the BWS survey was a major undertaking. BWS experiments that are not thoughtfully designed and tested can yield very little information of use. Nomenclature was repeatedly developed and tested with in-country collaborators. Several pilots were also administered. The design process was shared across the research team with specific tasks assigned against expertise. CI Burton was responsible for the statistical design that sits behind the programmed survey. The item refinement and description (including graphics) were managed by UniSA however IFPRI and BAU input was critical. The loading of the instrument into *Sawtooth* software was undertaken by CI Burton and CI Cooper and managed by them as data started to become available.

Best-worst scaling with farm households

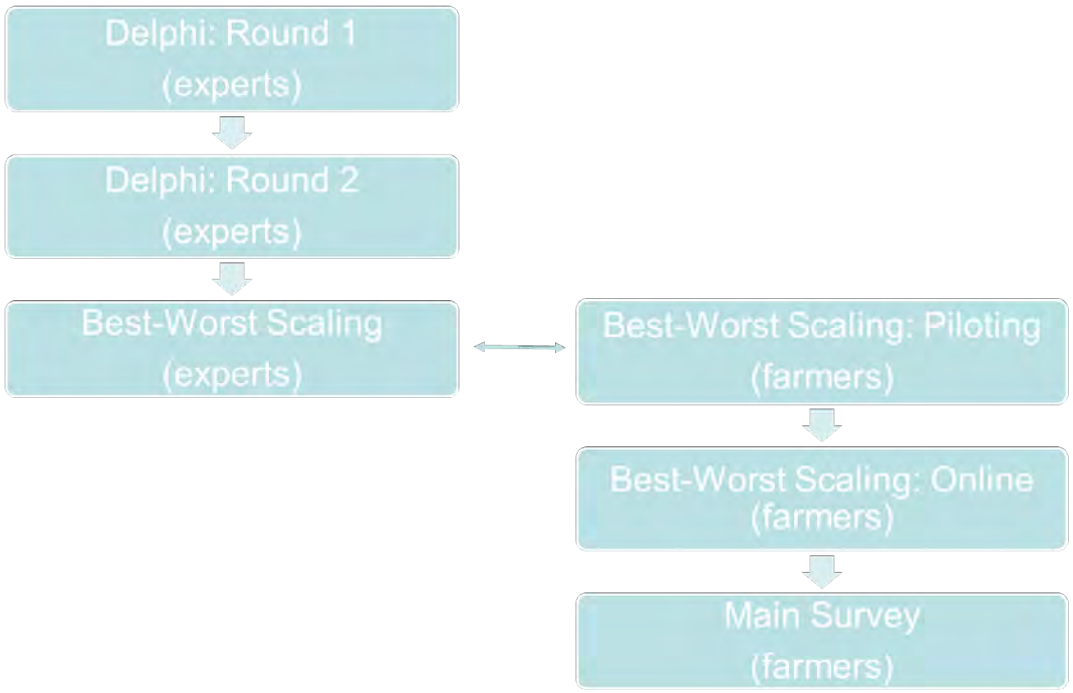
An important output from the BWS that was applied to experts was that the ingredients for the overarching institutional mapping were now assembled. This allowed progression to the next phase of the method – the development of a survey instrument to be administered to farm households. The purpose of administering a similar survey to farm households was to explore synergies and differences between the views of farmers and those of experts. This was tackled by having an 'institutional component' embedded in a broader survey (see below). The institutional component of the survey would again present farmers with policy options (with examples) and ask them to indicate which they most favored (as opposed to experts who were asked which is most *effective*). As with the expert BWS survey, the second stage would then ask respondents to express a preference on delivery mechanisms, using the dynamically revealed choices in the initial stage. Unlike the survey of experts, the information in this survey was translated into local languages with the intention of administering the instrument using trained enumerators and mobile tablet devices.

The data from this part of the survey would then allow analysis of policy/delivery combinations on two fronts. Specifically, it would reveal what combinations were most effective in the eyes of experts and what were most acceptable to farmers. Focusing effort on this subset was likely to yield better results and help progress the discussion with state and national officials on better targeting interventions.

The responsibility for the BWS component of this farmer survey was shared along similar lines to the expert BWS instrument. The BWS component was programmed into *Qualtrics* along with the other components of the survey. The piloting of the BWS survey with farmers was assigned to BAU.

The various phases of the methodology and their linkages are depicted in Figure 2.

Figure 2: Phases of Methodology



Main survey with farm households

In addition to gaining general insights into institutional design, the project sought to explore institutional themes across specific domains – namely, knowledge transfer, water rights/access and risk management. Also, the project had sought to explore inclusiveness in detail across each of these domains. Given the geographic spread of the work and the commitment to work across so many domains, a method was adopted to assign some elements of the main survey in full to specific geographic areas. This had the advantage of keeping the survey instrument manageable while also collecting sufficient data from across each jurisdiction to explore issues with pooled data. Specifically, this pooled data would help us understand the extent to which integration was being considered when choosing policies and institutions.

This design of the main survey of farmers is illustrated in Figure 3.

Figure 3: Design of Main Farmer Survey by Domain of Interest

	Best-Worst Scaling: Institutions preferences	Water rights: Pump preferences	Knowledge transfer	Risk management	Gender (Empowerment)
West Bengal					
Bihar					
Nepal					
Bangladesh					

The design in Figure 3 indicates that the BWS questions related to institutions would be administered in full across all jurisdictions.

In the context of water rights/access, the decision was taken to focus on groundwater extraction. West Bengal offered opportunities to explore the relationship between changes to energy cost and pumping behaviors and there was also scope to delve into the increasing role of women and their interface with pumping technologies. This component of the survey was managed primarily by CI Cooper and CI Crase and formed the foundation of a higher degree research project undertaken by Lountain.

The knowledge transfer section of the main survey focused on the part of public and private extension services. Here the interest was to empirically trace the potential on-ground impacts of different forms and degrees of knowledge transfer. This component was developed by BAU collaborators with the intention to deploy an extensive module in Bangladesh and a truncated version in other locations.

The risk management elements were managed by CI Connor at UniSA with support from CI Kishore at IFPRI. Again, the intention was to have a more extensive version applied in one jurisdiction (Nepal) and a more concise version elsewhere. The key dimension of this component sought information about self-assessed risks as well as risks related to adoption of specific technologies.

The inclusiveness module of the survey employed components of the women's empowerment in agriculture index (WEAI) along with other items drawn from the literature and related to institutional design. This module was developed by CI Cooper with support from other collaborators. Given its prominence in policy across the EGP, the extended version of this module was to be deployed in all locations.

Once modules were developed separately, they were then synthesized. This allowed for the removal of overlap and improved the 'flow' of the survey instrument. This was undertaken by CI Crase and CI Cooper with support from the team. The final instrument comprised five sections detailed in Table 1.

An important consideration in the survey design was understanding how integration was occurring in the field (i.e. the third of the 3 I's). For example, the data in the survey would allow the team to interrogate linkages between knowledge transfer, the adoption of risk management practices or empowerment of women.

Table 1: Components and Focus of Main Survey to Farmers

Survey section	Topic	Key issues
A	Socio-economic details	• Gender, household makeup and relationships, employment • Use of ag inputs (current and historical) → child gender influence • Access to capital • Access to credit • Income
B	Preferences for policy/delivery institutions	• Introduce objects • BWS of objects • Follow-up
C	Farm decision making	• Leadership and community influence • Farm production and income decision making • Characteristics of the dwelling
D	Knowledge transfer	• Sources of information that shape the use of different technologies • Contact with ag extension
E	Risk behaviors	• Self-assessment of risk: – in general, farm management, finance, health • Risk in context of a specific technology

		– Seed adoption and use – Stubble retention

An initial sample target of 500 household was set for each jurisdiction. In some cases, purposeful sampling was anticipated (e.g. in the water access survey there was an interest in tenant and women famers, so the intention was to ensure there was adequate coverage of these groups). The survey was translated into the local languages and local enumerators were to be trained in the uploading and downloading processes to allow remote monitoring of data input. The advent of COVID19 halted the deployment of the main survey instrument beyond the piloting phase, although the survey itself is a major asset for further research.

The altered approach to the project caused by COVID19 is described in part 7 of this report.

6 Achievements against activities and outputs/milestones

Objective 1: To create an understanding within agencies of the existing institutions that influence farm-level choices across local and district scales against specific national objectives.

No.	Activity	Outputs/ Milestones	Completion date	Comments
1.1.1	Recruit sub-project steering committee members across 3 domains (knowledge transfer, water rights and risk management) with regional coverage.	Terms of reference established for each sub-project committee with representation for each jurisdiction including broad coverage of agricultural issues and policies and some sensitivity to needs of women and tenant farmers	Yr 1 m1	**Completed**. This was completed during the inception meeting in Nepal, October 2018.
1.1.2	Select project steering committee from sub-project committees	Terms of reference established and committee formalised with geographic representation and capacity to consider all 3 Is	Yr 1 m1	**Completed**. This was completed during the inception meeting in Nepal, October 2018.
1.1.3	Generate Delphi panel for developing the overall institutional mapping		Yr1 m3	**Completed**. This was partially completed during the inception meeting and finalised in the following months - December 2018. A snowballing approach meant that the panel grew organically throughout the course of the project.
1.1.4	Administer initial rounds of Delphi for generic institutional map	Institutional map of jurisdictions reflecting decision environment of 'average' farmer	Yr1 m4	**Completed**. First round took place in a group format in Bangladesh, June 2019 while face-to-face and an email approach was used in other countries. Recruitment in India proved problematic.

1.2	Administer later rounds for refining map to specific cohorts (women and tenant farmers)	Institutional map of jurisdictions reflecting decision environment of women farmers and tenant farmers	Yr1 m4	**Completed but not deliverable**. The second round of Delphi was successfully administered and key institutional items identified. It proved difficult to recruit a sufficiently large sample of women into the Delphi to draw inferences about expert opinions as they relate to gender. This was taken up in the BWS instrument that was subsequently used to force a more discriminating institutional map to emerge. Some specific insights relating to female experts are reported in Cooper et al (forthcoming).

PC = partner country, A = Australia – Note: all activities shared across PC and A

Objective 2: To empirically evaluate the performance of different institutional designs across three domains, using economic efficiency, equity and environmental sustainability as yardsticks.

No.	Activity	Outputs/ Milestones	Completion date	Comments
2.1.1	Review, establish and agree on performance metrics/ yardsticks	An agreed performance measure framework covering efficiency, equity and environmental sustainability	Y1 m1	**Completed**. This was completed during the inception meeting in Nepal, October 2018 and confirmed with later meetings and workshops. It was agreed that the focus should primarily lie on *increasing and stabilizing farmers' incomes* as an appropriate and relatable proxy.
2.1.2	Assemble coalitions with key state and local agencies to guide and participate in data gathering, where appropriate	A group of agencies operating at state and local levels committed to assisting in-field and building analytical capability	Y1 m3	**Completed**. Key relationships formed as part of Delphi phase 1. These were further developed by the roll-out of the BWS instrument to circa 100 experts across the region.

2.1.3	Extract institutional architecture(s) that relate to each of the following: • knowledge transfer (KT) • water rights (WR) • risk management (RM)	Detailed institutional map illustrating a variety of institutional designs for knowledge transfer across the EGP	Y 1 m6	**Partially completed**. Overarching institutional design principles were drawn from the analysis of the BWS expert data. The intention was to further explore these notions in each domain using the main farmer survey. While fully developed, the survey could not proceed as planned due to COVID19. **KT** – Some additional exploration using secondary data occurred. **WR** – A separate phone survey was developed using paired comparisons to deliver on this activity. Some additional exploration using secondary data also occurred. **RM** - Some additional exploration using secondary data occurred.
2.1.4	Develop conceptual models for testing effectiveness based on Theory of Planned Behaviour (TPB) for knowledge transfer, water rights and risk management.	A clear conceptual model suitable to the context of the research, offered for peer review in respected outlet	Y1 m4	**Completed** The final survey instrument to farmers used a number of frameworks to shape its design. TPB was one of these, although others were also used to structure the instrument.
2.1.5	Refine primary data gathering instrument for knowledge transfer, water rights and risk management as per TPB including preparation for field collection using tablets	Apps developed and survey loaded;	Y 1 m5	**Completed** The final survey instrument to farmers used a number of frameworks to shape its design. TPB was one of these, although others were also used to structure the instrument.
2.1.6	Recruit and train survey administrators including women	Field staff trained in understanding of DCE techniques generally and deployment of survey using mobile devices.	Y1 m6	**Partially complete.** Dr Alam has the Bangladesh team ready to be deployed. Dr Kishore commenced the contracting process for immediate deployment if/when the COVID19 situation eases. Enumerators were trained to administer the phone survey relating to water access and pumping technologies.

2.1.7	Collect field data on effectiveness of knowledge transfer and water rights across 4 jurisdictions (Bangladesh, India (Bihar and West Bengal) and Nepal) with a minimum of 500 surveys to support discrete choice analysis. Collect field data on effectiveness of risk management across the 4 jurisdictions with a minimum of 200 household surveys to fill gaps in extant data.	Data suitable for modelling the hypothetical relationships for different institutions involved in knowledge transfer.	Y 1 m11	**Partially complete.** Secondary data were accessed to progress the analysis relating to knowledge transfer and risk. A primary phone survey was administered in West Bengal relating to water access and the data iteratively modelled during collection to monitor its usefulness.
2.1.8	Cleanse data and develop empirical models using path analysis and structural equation modelling, as appropriate	A suit of statistical models showing the relative performance of different institutional models from the perspective of the 'average' farmer, women farmers and tenant farmers	Y1 m10	**Partially completed** Alternative modelling approaches were used given the modification to data collection required due to COVID19. Some secondary data have been analysed using Difference in Difference and other regression techniques. Simulation modelling of risk and adoption has occurred. The primary data from the water access survey was analysed using logit modelling to generate importance scores from the perspective of different farmer groups.
2.1.9	Extract and summarise empirical findings	Precis of findings that are (a) digestible to end-users (b) informative to media and other outlets	Y2 m1	**Partially completed.** Online panel discussions were prepared to assist in progressing this activity. Policy notes and conversation pieces have been assembled and continue to be developed. Key findings have been published in the popular press in Bangladesh.

PC = partner country, A = Australia – Note: all activities shared across PC and A

Objective 3: To foster collaboration with and within state, district and national authorities by developing an agreed evidence-based framework for shaping institutions that promote the '3 I's'

No.	Activity	Outputs/ Milestones	Completion date	Comments
3.1.1	Maintain contact with initial panellists involved in Delphi in objective 1	Ongoing monthly ezine or similar to continue engagement	Y1 m 3 – Y2 m12	**Ongoing** – The in-country partners are still regularly in touch with the Delphi panellists, and the expanded group who participated in the BWS of experts.
3.1.2	Circulate precis of findings with a request for additional recruitment on: • knowledge transfer institutions • water rights • knowledge transfer institutions.	Extended panel of experts for administering objective 3 Delphi	Y2 m3	**Incomplete.** The intention was to feed the findings back to the policy communities involved in Delphi and BWS experiments. COVID19 has made this problematic and the intention is to leverage from the Foresighting project in 2022.
3.1.3	Conduct new rounds of Delphi	Consensus on guidelines for knowledge transfer that is consistent with 3 Is	Y2 m7	**Incomplete.** Testing the results as part of the Foresighting project in 2022 will close this out. A capacity building activity on BWS was undertaken in June 2021 to retain interest amongst participants and their support staff.
3.2.1	Convene pre-symposium workshop in Australia for key meso-tier agencies	A draft agenda for international symposium and draft communique that captures key issues	Y2 m8	**Complete.** Due to COVID-19 a reduced virtual event was scheduled for May 2021. A symposium has also been scheduled as part of the AARES conference in February 2022.
3.2.2	Convene an international symposium to synthesise findings from across 3 domains and leverage for additional influence	Impactful social media and conventional media releases accompanied by policy related dialogues and invited presentations	Y2 m9	**Partially complete.** A more manageable online event with high profile policy makers was scheduled for May 2021. One of the participants now holds a Ministry in Bangladesh. A symposium has also been scheduled as part of the AARES conference in February 2022.

PC = partner country, A = Australia – Note: all activities shared across PC and A

7 Key results and discussion

Context to changed approach

Figure 2 shows the staged methodology that was planned to underpin the project. To reiterate, in early 2020 the deployment of the main survey to farm households was poised to commence. The instrument had been through multiple iterations and design reconfiguration following feedback from numerous stakeholders. The team had also drawn simultaneously from the work with expert policy communities as it came to hand. The main farmer instrument was designed to provide data to explicitly explore some of the institutional lessons already emerging from the work with experts and how these might specifically apply in the three nominated domains of: (1) knowledge transfer (2) water rights and access (3) risk management. The survey had also been designed to capture a broad suite of information on inclusion, especially around women's empowerment in agriculture and the impacts of policy/delivery institutions on tenant farmers. In addition, the design of the survey would allow the team to answer questions about how well integrated decision making was occurring.

The onset of COVID19 and the related uncertainty resulted in the main farmer survey instrument being paused. Initially, the in-country team provided weekly updates to establish the probability of a likely safe start date for survey deployment. This continued for several months, but ultimately a view was reached that the survey was not feasible in the current environment, regardless of the significant investment in its development. In addition, the project itself was part of a broader program supported by DFAT that had been scheduled to conclude. Thus, the prospect of an extension to the project timeline to account for the time foregone through COVID19 was not an option. Moreover, these collective events effectively reduced the time available to produce project outputs, consolidate them into digestible messages and provide the necessary reporting documentation to funding agencies.

The project team thus sort to develop an alternative methodology that would: (1) limit the COVID19 health risks to researchers (2) attempt to deliver on the objectives of the project as initially described (3) meet the truncated reporting timeline imposed by the changed circumstances facing agencies. The alternative method had three elements.

First, it was recognised that in some domains there were extant data sets that could potentially shed light on institutional gaps and issues, albeit not at the detailed level intended using the primary data. This was considered most applicable in the case of the knowledge transfer and risk management domains. There were national data sets that might be used in this context and some of the earlier CASI data was available to test some hypotheses on risk and adoption. To a lesser extent this approach was seen as partly satisfying the inclusion components of the project, with a review showing that the secondary data on inclusion was patchy across the region. Data was available on WEAI in Bangladesh but the data in India and Nepal was incomplete or missing. Of itself, this points to areas for future work for government agencies who seek to promote empowerment and inclusion.

Second, the prospect of collecting some primary data was also on offer. This particularly related to the work that had been undertaken on water access and a decision was made to progress by simplifying the intended survey instrument that specifically related to water access and deploying it by phone in West Bengal. Concurrently, it was agreed that the online expert survey would remain open longer than initially intended to add to the primary data on hand.

Third, whilst the initial ambition had been to support engagement with officials at multiple tiers through a 'demonstration site' (objective 4), this was no longer achievable. It was also initially proposed to engage with policy communities to collectively finalise a generic framework using

the information from the project – again this was likely to be only partially achievable. Similarly, some of the planned support and development opportunities that would engage via face-to-face meetings to progress this ambition were no longer on offer. In this regard a changed approach involved targeting the development of online materials, webinars and documents directed at different audiences.

The remainder of this section thus reports on a combination of results drawn from the initial approach and the COVID19-modified approach adopted later in the project. Some of the information provided is drawn verbatim, but with an emphasis on synthesis. To simplify reporting this section is divided into sections comprising (1) overall institutional analysis (2) knowledge transfer (3) risk management (4) water rights and access (5) inclusion and empowerment. As intended in the initial plan, some elements of this research overlaps and readers are encouraged to source the individual outputs to understand their contribution. Manuscripts are available to support this overarching summary in this report and these are categorised by theme in Appendices. The polish of some manuscripts reflects the circumstances described above (e.g. working papers) while others are already under review with scholarly journal outlets. A full list of outputs is also available on the project website.

Institutions

Key Findings

- Policy communities support the view that improved access to inputs – not simply subsidising their cost - is key to increasing and stabilizing farm incomes in the EGP.
- At a broad level, expert communities advocate for a greater role for the private sector to deliver improvements in access to inputs.
- These high-level institutional lessons are borne out with specific cases. For example, accessible credit and the availably of high yield seeds are shown separately to be important drivers of higher and more stable incomes.

The results and discussion about generic institutional lessons presented here draws from:

- Cooper et al. (2021) *'Institutions and policies for enhancing farm household livelihoods: Using Delphi and Best Worst Scaling to analyse the coherence of expert opinion in the East Gangetic Plain'*,
- Kumar et al. (2021a) *'Assessing the Impact of Lending through Kisan Credit Cards in Rural India: Evidence from Eastern India',* and
- Rahman and Connor (2021a) *'The effect of high yielding variety on rice yield, farm income and household nutrition: Evidence from rural Bangladesh'.*

A recorded panel discussion is also available that explores the implications of these findings. These outputs relate specifically to objective 1 of the project and to some parts of objective 2. In terms of the methodology described earlier, the results in this section pertain to the first three phases on the left-hand side of Figure 2.

Cooper et al. (2021) provide details of the Delphi study undertaken with experts across the EGP and the follow-up Best-Worst-Scaling instrument. In essence:

- Delphi Round 1 was used to identify key aspects/characteristics of policy and delivery that would lead to higher and more stable farm incomes;
- Delphi Round 2 refined these into a list of 16 items and generated an importance ranking of each using Likert scales;
- The Likert rankings indicated 10 of the 16 items were considered important/very important by 80 per cent of respondents;

The characteristics designated as significant and their relative importance using the Likert measures appears as Table 2 in Cooper et al. (2021) and is repeated here for convenience.

Table 2: Characteristics Ratings from Delphi Round 2 (means and standard errors)

Item	All Jurisdictions	Nepal	Bangladesh	India
Deals with farm inputs in isolation	4.05 (1.16)	4.11 (1.21)	4.24 (1.12)	3.90 (1.16)
Deals only with farm outputs	4.27 (0.99)	4.02 (1.15)	4.56 (0.51)	4.31 (1.04)
Involves government actively on the inputs side	3.87 (0.89)	3.77 (0.84)	4.12 (0.88)	3.81 (0.94)
Involves government actively on the outputs side	4.34 (0.96)	4.31 (1.07)	4.48 (0.77)	4.28 (0.99)
Deals with both inputs and outputs	4.33 (0.97)	4.31 (1.21)	4.04 (0.97)	4.52 (0.71)
Encourages diversification away from agriculture	3.95 (1.11)	3.43 (1.39)	4.16 (0.74)	4.26 (0.85)
Encourages diversification within agriculture	4.57 (0.86)	4.20 (1.25)	4.68 (0.47)	4.83 (0.43)
Involves more leadership by the private sector	4.07 (0.84)	4.11 (0.72)	4.16 (0.80)	4.00 (0.96)
Requires more pro-active leadership by government	4.39 (0.89)	4.37 (0.97)	4.52 (0.65)	4.33 (0.95)
Involves a partnership between government and farmers	4.35 (0.85)	4.37 (0.68)	4.36 (1.18)	4.33 (0.75)
Is created from the bottom up by farmers themselves	4.37 (0.68)	4.28 (0.62)	4.04 (0.84)	4.64 (0.53)
Involves farmers having more access to locally developed technologies	4.29 (0.83)	4.00 (1.05)	4.48 (0.51)	4.42 (0.73)

Involves farmers having access to state-of-the-art technologies even if developed elsewhere	4.26 (0.79)	4.17 (0.89)	4.28 (0.61)	4.33 (0.81)
Relates to more effective transport for farm households	4.66 (0.69)	4.71 (0.89)	4.64 (0.48)	4.64 (0.61)
Has the trust of farmers	4.37 (0.85)	4.08 (1.06)	4.48 (0.71)	4.54 (0.67)
Is consistent with customs and social expectations related to local farming	3.56 (1.27)	3.26 (1.44)	3.64 (1.11)	3.78 (1.17)

A more discriminating approach was subsequently used to explore the relative importance of these characteristics. This led to the BWS design which had the following features:

- The 16 items were unpacked into policy options (which comprised two subgroups and 8 options) and delivery mechanisms (comprising 4 alternatives)
- The BWS experiment required experts to choose the most effective and least effective policy options that were presented as sets of 4. Respondents completed 8 choice tasks.
- The survey dynamically programmed the most preferred options selected by the respondent and subsequently asked respondents to nominate the preferred delivery mechanisms.

The policy and delivery items appear as Tables 3 and 4 respectively in Cooper et al. (2021) and are repeated here for convenience.

Table 3: 'Policy' Items and Sub-Groups for BWS Experiment

Group	Item description in BWS
Features related to farm inputs and outputs	Cheaper farm inputs (e.g. subsidized fertilizer, electricity)
	Easier access to farm inputs (e.g. quality seeds; in-time irrigation water, electricity; credit; good roads)
	Higher farm output prices (e.g. more competition among buyers; easier access to markets with more buyers)
	More stable farm output prices (e.g. public procurement of rice, or other produce, at minimum prices; market linkage development for higher prices)
Features related to diversification and technology	More income from non-farm sources (e.g. support such as subsidy or training for developing off-farm income such as small agribusiness enterprises, shops etc)
	Farmers adopting different types of crops (e.g. subsidies/credit/seed etc to grow different crops such as vegetables, oil, pulses etc.)
	Farmers increasing non-crop farming (e.g. credit/subsidies to support livestock/fishing or other non-crop farm activities)
	Easier access to modern technology (e.g. low-till seeders, tractors, threshers; hybrid seed varieties)

Table 4: 'Delivery' Responsibility Items

Action by the private sector (e.g. private sector, such as fertilizer and pesticide dealers, providing advice on crop-farming, access to equipment, or know-how on markets and new products)
Action by governments (e.g. government agriculture office (extension service) providing advice)
Partnership between farmers and government (e.g. farmer organizations, such as FFS, CIG, IPM Club etc., supported by the government)
Action by farmers themselves (e.g. producers and/or marketing cooperatives built around certain commodities)

Sample choice tasks and the follow-up format that relates to delivery alternatives appear as Figures 4 and 5 respectively in Cooper et al. (2021) and are again repeated here.

Figure 4: Sample Choice Task as Part of BWS Part of Survey

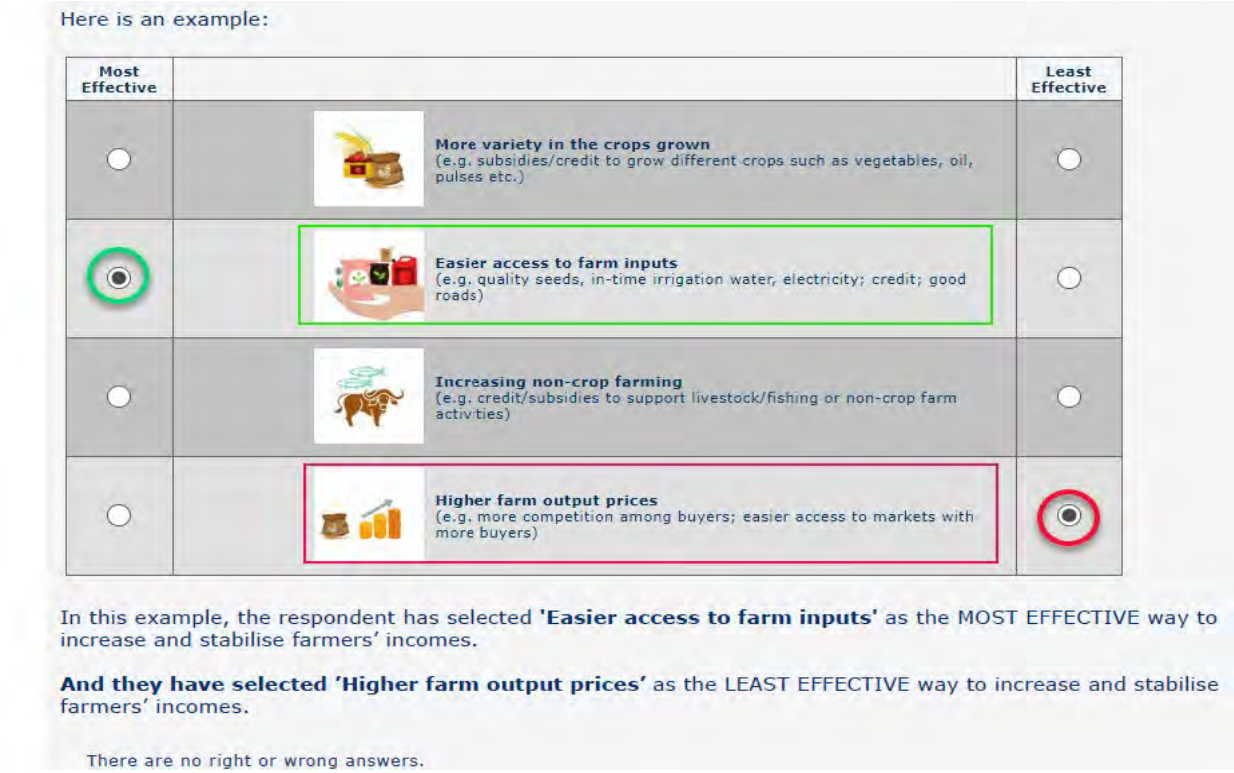
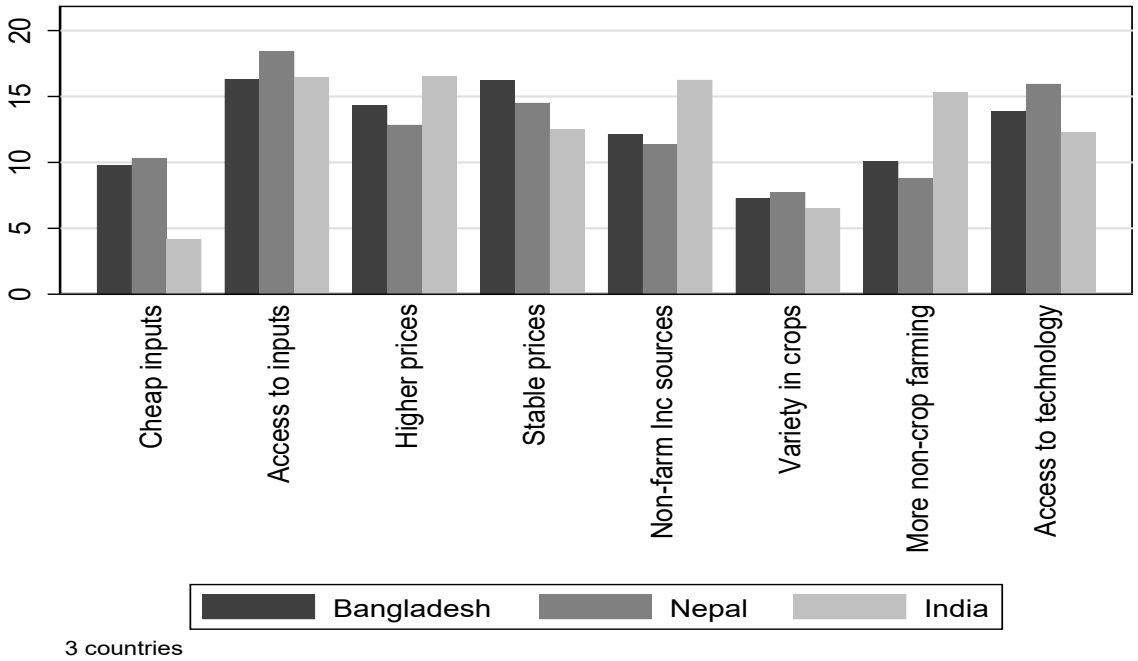


Figure 5: Example Ranking of Delivery Mechanisms against a Specific Policy Option

The experts who provided the BWS data were spread across Bangladesh (36 percent), Nepal (38 percent, and India (26 percent); 79 percent of the sample were male; there was representation from age groups ranging from 25-29 years to over 70 years, with the majority falling in the 40-59 years category (58 percent); all of the participants had a university education and there was representation from a number of disciplinary backgrounds including, agricultural sciences, biological sciences, environmental sciences, economics, commerce and management, information and computing, law and legal studies, and technology. The sample included experts from various sectors such as national government agencies, state government agencies, research organizations, and non-profit organizations, with 30 percent working for a government organization (state or national); and 91 percent of respondents had 10 years or greater experience in agricultural development.

Some significant differences appear in the expert data across countries, making it necessary to report results separately for each country. The ranking of each policy option by country are graphically depicted as Figure 6 in Cooper et al. (2021) – reproduced below.

Figure 6: Probability Scores for Eight Items, by Country



A key finding from these data was that there is strong and consistent support from across all policy communities for improved access to inputs as a means of increasing and stabilizing farm incomes. Enthusiasm also attends policies that provide access to modern technologies.

In terms of delivery mechanisms, there is again a consistent message. Namely, **the expert communities advocate a greater role for the private sector to deliver better access to inputs**. In contrast, the delivery mechanism favoured for a policy aimed at increased access to modern technology was less clear. That said, there was strong agreement that farmers were unable to achieve this on their own.

It is worth noting that distinguishing between private sector and farmer cooperatives was based on the Delphi results. Some might argue that there is a degree of overlap between these two notions. In addition, Bihar and West Bengal, the two focus states of our project, are not known for strong farmer cooperatives. There are very few strong, vibrant client-focused cooperatives in the two states—especially in the crop sector. For example, Primary Agricultural Cooperative Societies (PACS) are responsible for procurement of paddy and wheat at government fixed minimum support prices (MSP) in Bihar. Despite poor price realization by farmers in open markets, the PACS have failed to scale-up procurement of paddy above 1 million tons and start recent surveys suggest that the new generation farmer producer companies (FPCs) in Bihar are also mostly non-functional. Despite these state nuances, the results suggest some scepticism about the capacity of government and cooperatives to deliver higher and more stable incomes without recourse to the private sector.

The potential influence of gender on experts' opinions was explored, albeit within the constraints of the small sample of women. A key finding here is that male experts are more inclined to advocate modern technology as a policy solution than women.

As noted earlier, the initial research plan had sought to then contrast the findings drawn from expert communities with the views of farmers. This would have allowed for the identification of policy/delivery options that are considered most effective and simultaneously agreeable to farmers. In addition, these data would assist more detailed analysis of specific institutions, noting that many input distribution networks have somewhat unique characteristics. Finally, the farm survey data would support analysis of how integrated decisions are occurring on the ground. There is thus considerable impact on offer once it becomes possible to administer this survey instrument to farmers in 2022.

The importance of focussing on access to inputs is further confirmed by two additional studies using secondary data undertaken as part of this project.

Kumar et al. (2021a) considered the influence of the Kisan Credit Card (KCC) scheme in India. The KCC scheme was introduced in 1998 to provide a single-window system of credit to the agricultural sector and to ensure that farmers have access to timely, hassle-free credit (Diwas et al., 2012; Kumar et al., 2011). Although credit might not be considered an agricultural input, it provides an opportunity to undertake investments in other inputs while waiting to realize the benefits. Formal credit is on offer in many agricultural settings but often involves high transaction costs and this results in many smallholders relying on money-lenders for credit, but at much higher interest rates. Despite its apparent advantages Kumar et al. (2021) notes that only about 43 per cent of farmers nationally hold a card and this proportion is even less in the poorer states to the east, where credit might be even more advantageous at reducing poverty. A question thus arises about what determines access of farmers to a card and does access impact use of other inputs.

Kumar et al. (2021a) use data from a primary survey conducted during 2018-19 in five eastern states of India; namely, Bihar, Jharkhand, Odisha, eastern Uttar Pradesh, and West Bengal. They use a Coarsened Exact Matching (CEM) approach to attempt to answer the two research questions and finds that access to the KCC scheme is strongly associated with the socioeconomic and demographic characteristic of farming households. For example, farmers with larger landholding and higher education are more likely to hold a card. They also found that **access to KCC increases farmers' use of agricultural inputs and households and farm income especially for marginal and small farmers**. Finally, access to KCC reduces farmer's dependency on moneylenders for borrowing by 25 per cent.

Rahman and Connor (2021a) also highlight the benefits of access to inputs. In this case, they considered farmers' access and use of High Yield Varieties (HYV) of rice in Bangladesh. They explore the causal relationship between HYV uptake for Aman (monsoon) season rice by Bangladesh farmers and rice productivity, farm income and household nutrition. A challenge with evaluating the impact of changes such as crop varieties on yield is that farmers who self-select into groups of adopters and non-adopters often also differ systematically in other unobserved attributes that can influence yield. To overcome this problem, they employ the Difference in Difference (DID) method.

They use data from the Bangladesh Integrated Household Survey-BIHS (2012 and 2015) administered by IFPRI and found that **farms that had gained access to HYV, experienced around 35 per cent higher yield and after adopting HYV enjoyed more than 76 percent higher profit from Aman rice than non-adopting farms**. More calorie intake, more protein and especially higher fruit and vegetable intake was also associated with the switch to HYV seed. They conclude that improved seed still has a high potential return on investment for regions where smallholder farming and malnutrition is common.

Collectively, these additional pieces of research support the view that access to inputs is key to the success of agricultural development and increasing and stabilizing farmer incomes in the EGP.

Water Property Rights

Key findings

- Continued strengthening of governance at the state level can underpin private investment in irrigation and this should be given more attention.
- Delivery of irrigation as an input is of itself not a panacea to raising farmers' incomes and productivity and a range of accompanying factors need investigation.
- Careful attention needs to be paid to the linkages between energy reforms and their impacts on behaviour in groundwater markets. There are important nuances around the functioning of groundwater markets and understanding these should be a high priority, especially given the reliance of the poor on groundwater markets.

The results and discussion relating to water draws from the following project outputs:

- Lountain et al. (2021a) *'When the genie is out of the bottle: the case of dynamic groundwater markets in West Bengal, India'*
- Rahman and Connor (2021a) *'Does supplemental irrigation enhance smallholder agricultural productivity? Evidence from monsoon season rice cultivation in Bangladesh'*
- Kishore (2021) *'The Changing Energy-Irrigation Nexus in West Bengal and Bihar: Implications for Equity in Access to Groundwater'*
- Kumar et al. (2021b) *'Irrigation Governance, Private Investment, and Agricultural Productivity in India'*

Lountain et al. (2021a) provides conceptual background to the functioning of some groundwater markets in the EGP. The analysis reported in the other publications was derived from secondary data sources, in response to the COVID-19 disruptions. In line with the other components of the project, a short recorded panel conversation is also available. The purpose of this section is to provide an overview of the results from this body of work, along with a synthesis of key messages and their relationship to the aim of the project.

At the outset it is important to understand that the notion of 'property rights' has a specific meaning in disciplines like economics that can vary from the common view that equates the term to ownership, often of land. To make the analysis of water property rights manageable, the team agreed to focus primarily on property rights as relating to the right to access a stream of benefits from a resource (i.e. water). The finding from the wider institutional analysis that access to inputs was seen of primary concern for experts, also supported this approach. In addition, initial enquiries showed that access to the benefits from water cannot be easily separated from access to energy, especially as groundwater plays such a large part throughout the EGP and requires energy to extract. Nonetheless, it needs to be acknowledged that there are other important aspects of property rights (e.g. divisibility, transferability, quality of title) that have not been addressed in this project and may warrant additional research.

The EGP is a region characterised by relatively abundant water supplies, although perversely there are also periods of intense shortage. Public channel irrigation schemes operate across the region, but their importance as a source of irrigation has progressively declined in a relative sense with the rapid and substantial growth of groundwater pumping that accompanied improvements in pumping technology since the 1970s. Prima facie surface water systems that use gravity should enjoy an advantage over pumping technologies that require additional energy cost. And yet surface water (channel) systems have either stagnated or progressively declined across most of south Asia, and this has often been attributed to failed governance in collective and/or government managed irrigation programs.

This is emphasised in the work of Kumar et al. (2021b) that forms part of this project. Using secondary data their study examined Indian state-level trends in the interlinkages between private investment in agriculture, irrigation governance, and agriculture productivity between 2001/2002 and 2015/2016. It is worth noting that this analysis focusses on public governance, not public expenditure per se. The latter can both stimulate and substitute private investment.

Data were sourced from the unit-level All-India Debt and Investment Survey of the 59th and 70th Rounds of the National Sample Survey; data on public expenditure on irrigation and other variables were also sourced from the Finance Accounts (India, Ministry of Statistics and Program Implementation, National Accounts Statistics) and from the Indian government's Agriculture Statistics at a Glance (India, Ministry of Agriculture and Farmers Welfare 2015).

A governance index was constructed by taking a set of public irrigation water and infrastructure variables that also capture key dimensions of governance; these included institutions and regulatory mechanisms, participation and accountability, and service delivery. The analysis of governance by Kumar et al. (2021b) is viewed primarily through an economic lens and alternative frameworks might yield different observations. Nonetheless, the results obtained from the structural equation model and from the instrumental variable method indicated **a positive impact of water governance on private investment in agriculture; an increase in private investment can, in turn, augment agriculture productivity and net returns earned by farmers**.

The findings validate the existing literature on the importance of governance in the agricultural sector and the need for improvements in irrigation governance. With the exception of Punjab and Haryana, the estimated governance index is very low and has been on a declining trend since 2001/2002. Among 20 selected states, high governance and high investment in irrigation by farm households are found only in Haryana, Gujarat, Andhra Pradesh, Maharashtra, Rajasthan, and Tamil Nadu. Low governance and low investment in irrigation, as are found in Assam, Odisha, West Bengal, Kerala, Bihar and Jharkhand, Uttar Pradesh and Uttarakhand, suggest the need for improvements in governance in these states. Notably, two of the foci of this project are West Bengal and Bihar in the EGP.

Kumar et al. (2021b) conclude that **to create incentives for farmers to undertake higher asset formation, states should make concerted efforts to improve the governance of irrigation projects**. Importantly in the context of this project, their work again highlights the need for increased attention to institutions that deliver below the level of policy.

Bangladesh has also witnessed a surge in interest in irrigation to supplement crop demands and improve agricultural production. This has extended to irrigation even in the wet season, where field trails have shown some benefits from reduced crop stress. Rahman and Connor (2021b) sought to further test this relationship as part of the project's goal to undertake closer analysis of the links between policy and delivery in the context of water.

In the absence of the opportunity to use primary data, Rahman and Connor (2021b) extracted data from the Bangladesh Integrated Household Survey for 2012 and 2015. Their interest was to test the extent to which supplementary irrigation might universally raise monsoon season rice production – the dominant crop in Bangladesh. Their work uses a specific econometric technique referred to as Difference in Difference. The Difference in Difference technique uses panel data to replicate the conditions of a natural experiment – i.e. comparing a treatment versus control group. Importantly, the researchers sought to gain unbiased estimates by matching the control group and the treatment group based on observable characteristics from an estimated propensity score. This has the advantage of isolating only the variable of interest (use of supplementary irrigation) from other variables that irrigation adopters might share versus those in common across non-adopters.

The results of Rahman and Connor's (2021a) analysis is a timely reminder that the detail matter and universal panacea, like encouraging supplementary irrigation on its own, are rare. More specifically, **they find no statistically significant gain in terms of yield among the farmers who converted from rainfed irrigation to supplementary irrigation**. This raises important questions about government investment in further expansion of supplementary irrigation, at least in monsoon rice cultivation. The data available to this research were not able to distinguish if access had occurred through private sector of other mechanisms.

Access to water for many farmers in the Indian states of Bihar and West Bengal rests heavily on the private sector, even though the influence of government can be significant. The interaction between public sector policy settings and water access are key topics that sit behind the work of Lountain et al. (2021a) and Kishore (2021a) that were part of the secondary data analysis in this domain.

Lountain et al. (2021a) trace the development of groundwater markets in West Bengal and explores the scope for reining such markets into more formal arrangements. They find that groundwater markets have emerged organically and play an important function in providing access to water, especially for poorer and tenant farmers. This arises because pumping assets are relatively expensive and unaffordable for many, even with a subsidy. The upshot is that richer farmers generally purchase pump sets and, in many cases, become water sellers in groundwater markets to less-well-off groups, driven by the desire to defray the up-front cost of the pump set. In many districts there are also active pump rental markets used by those unable to meet the initial fixed costs.

The review by Lountain et al. (2021a) also confirms the important link between the functioning of groundwater markets (that ultimately influence water access for the poor) and the costs related to energy use. More specifically, they draw on the history of mandated changes to energy prices to explore the water-energy nexus. They conclude that attempts to bring organically formed water markets into some formal marketing framework would likely yield little, especially if the water-energy nexus was not given full consideration. More specifically, **the drivers of buyers and sellers in groundwater markets that come from changing energy prices are much more important than any feasible regulations imposed around how water is used**.

The nexus between energy pricing and water access is given further attention by Kishore (2021a), in this instance he undertakes a comparative analysis of water-energy scenarios in Bihar and West Bengal. In the absence of primary data, he uses data from representative samples of paddy and wheat growers of Bihar and West Bengal from 2000-01 to 2016-17 to see how the water markets and water application rates to two crops have changed with the increase in diesel prices in Bihar and rapid electrification of irrigation in West Bengal. He finds that a one rupee increase in diesel price is associated with a smaller increase in the average hourly pump rent in Bihar, which suggests low monopoly power of pump owners in the state. The situation is different in West Bengal where rapid electrification of pumps after 2011 led to a sharp reduction in the hourly cost of irrigation for pump owners, but not the water buyers, suggesting an increase in the monopoly power of pump owners with electrification. The increase in the monopoly power of pump owners despite deregulation and capital subsidies for new connections is surprising. Kishore (2021a) argues that **understanding how changes in the source of energy for groundwater irrigation and the power tariff structure affect water markets is crucial further work**. This is important not only for the agricultural development of West Bengal but also the neighbouring regions of Bihar and Bangladesh where rapid electrification of pump-sets is also underway.

In sum, the body of work undertaken to consider the institutions that relate to water access adds significantly to the policy debate. First, **continued strengthening of governance at the state level should be a priority if private investment is to be stimulated**. Second, **delivery of irrigation as an input is of itself not a panacea and a range of accompanying factors need strengthening**. Third, **careful attention needs to be paid to the linkages between energy reforms and their impacts on groundwater markets as these can have perverse impacts for the poor**.

Knowledge Transfer

Key Findings

- Extension services are positively linked to improved productivity and profitability of rice farming in Bangladesh.
- There is a positive and significant relationship between exposure to extension and expansion of the technology portfolio used by farmers.
- Whilst adoption of a broader portfolio may be warranted and positive, there are also potential risks.
- There are potentially less obvious spill-over and feedback effects through access to extension, like correlations to improvements in women's empowerment.
- The expansion of mobile phone technologies offers considerable promise for extension and targeting uptake by women is worth considering.
- The causal links from extension services to other variables and the detail around how extension can be nuanced to give greatest impact needs to be scrutinized with primary data.

Under the initial (pre-COVID19) research plan the more detailed analysis of knowledge transfer institutions was intended to take place in Bangladesh. The revised research plan retained a

focus on knowledge transfer in Bangladesh, primarily because of access to a more comprehensive data set in this country. This section summarizes and synthesizes several papers developed using the Bangladesh Integrated Household Survey. The section draws from:

- Alam et al. (2021) *'Impact of Agricultural Extension Services on Farm Productivity and Profitability in Bangladesh'*
- Sarma et al. (2021a) *'Agricultural Technology Adoption, Extension Service and Production Risk Nexus: Evidence from Bangladesh'*
- Begum et al. (2021) *'Nexus among Extension Services, Women Empowerment in Agriculture and Farm Income: A Stochastic Modeling Approach'*
- Kandulu et al. (2021) *'Improving rural agricultural production and income in developing countries using mobile phones'*

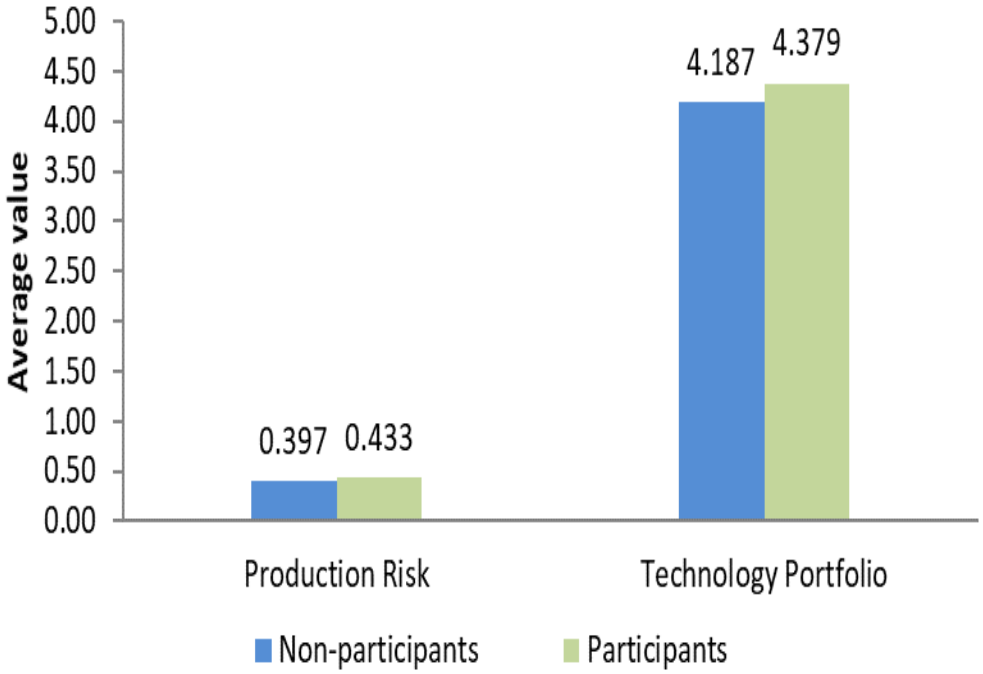
The analyses use relatively sophisticated econometrics in an effort to control for a range of interrelated factors. Given the current status of these papers and the need for better primary data, the report remains silent on causal relationships and positions key findings accordingly. In addition, the primary data that will ultimately be collected in 2022 will include additional details that are not available in the secondary data reported here. More specifically, the secondary data do not provide details on the character of communication channels or the information communicated. A simplified description of findings is available via the recorded panel discussion that overlaps with some other work from the project.

The role of agricultural extension as a means of improving farmer productivity is generally accepted, although empirical evidence at a granular level is often missing. This is complicated by the fact that knowledge transfer to farmers can take a variety of forms. Alam et al. (2021) summarises the range of extension services on offer in Bangladesh, spanning from farmer field schools, farmer-to-farmer extension and the establishment of common interest groups. The main farmer survey initially planned for this project had taken account of these differences but the aggregate secondary data on hand does not. Accordingly, Alam et al. (2021) use a dummy variable to capture any extension engagement in the last 12 months.

Using the DID approach to account for other variables in common with those accessing extension and those who did not, Alam et al. (2021) find that rice farm productivity and profitability is significantly different for those exposed to extension services. More specifically, **productivity is 18 per cent higher and profitability is 23 per cent higher for those exposed to extension** versus those not exposed to extension. Alam et al. (2021) also find that extension is related to a range of other positive outcomes.

Sama et al. (2021a) further investigate the relationships between extension services and some of these other outcomes. Using the same data set they manipulate a number of variables to produce scores on technological adoption and production risk. This is done by exploring only rice farmers in the Farmer to Farmer zones, including the EGP, using data within the broader national survey. Their analysis of the relationship between participation in extension and production risks and technology portfolio is summarised in Figure11 below.

Figure 11: Relationship between Extension Participation, Production Risk and Technology Portfolio

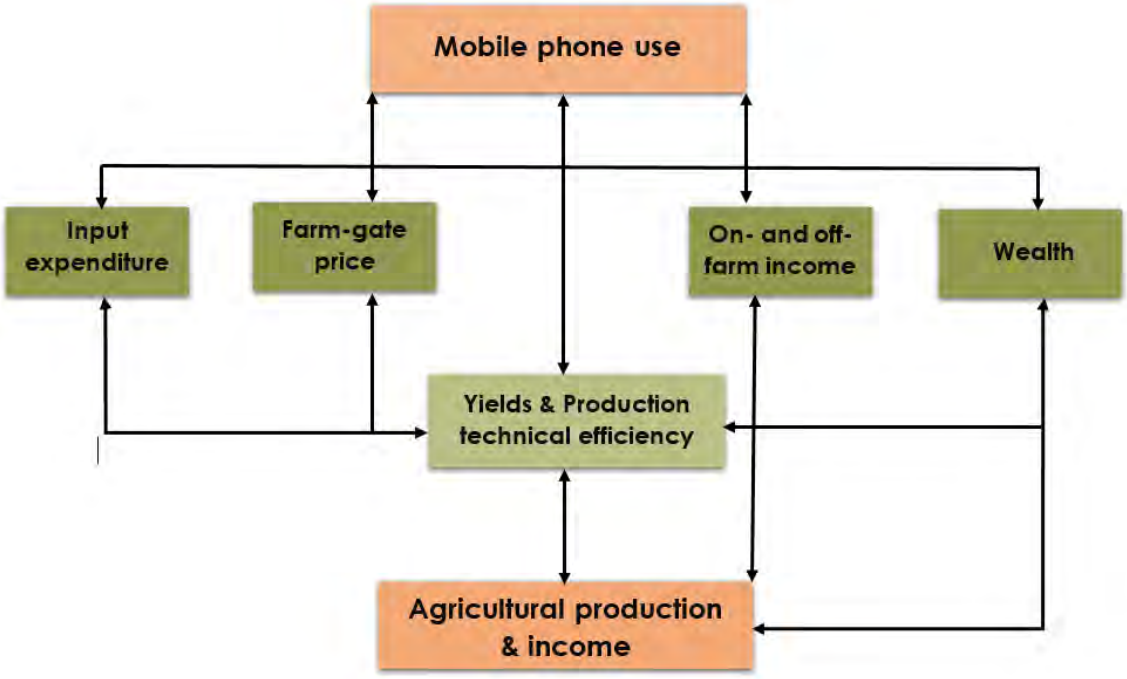


Technological adoption is consistently higher for participants in extension services, but production risk is also higher. This suggests some relationship between extension and the use of new inputs but also highlights the need to consider potential risk that attend adoption, a point explored in more detail by Connor et al. (2022) below.

Begum et al. (2021) take the analysis of Alam et al. (2021) and Sarma et al (2021a) a step further by contemplating the interrelationships between rice productivity/profitability, extension services and women's empowerment. Comparisons between 2015 and 2018 show that households that participated in extension also witnessed a 16 per cent increase in women's empowerment over the three-year timeframe. Using a simultaneous econometric system, they find that agricultural extension service has significant positive relationship ($p<0.05$) with total rice farm income and the women's empowerment index in Bangladesh. This is taken further in Sarma et al. (2021b) and reported in the inclusion section of this report.

Kandulu et al. (2021) used the Bangladesh panel data employed by Alam and others. Recall, that Begum et al. (2021) initially found a significant and positive relationship between extension service access and women's empowerment in agriculture, at least in the case of Bangladesh. Kandulu et al. (2021) also had an interest in knowledge transfer and were particularly motivated by the role of mobile telephones. The conceptual model used to buttress their empirical work appears as Figure 13.

Figure 13: Heuristic of Possible Impact Pathways through which Mobile Phone Use Can Influence Various Agricultural Production Indicators



In addition to the panel dataset on households in Bangladesh, they combine a spatial climate dataset from Bangladesh. Household fixed effects and control function modelling approaches are used to evaluate the causal influence of mobile phone use on rural households' agricultural production and income. Kandulu et al. (2021) results show that mobile phone technology can significantly improve yields, production technical efficiency, and agricultural net revenues.

Importantly, they find that **policies targeted at addressing gender disparities in mobile phone use can yield the highest benefit**. Thus, employing mobile phone technology in agricultural extension services and prioritizing regions with poor access to off-farm employment can yield the highest benefits.

Collectively, this body of work contains important policy implications that can be further explored with the deployment of the farmer survey in 2022. First, **extension services are positively and significantly related to productivity and profitability of rice farming in Bangladesh**. Second, **exposure to extension is positively related to the technology portfolio of farmers.** Third, **whilst adoption of a broader portfolio may be warranted and positive, there are also potential risks.** Third **there are less obvious potential spillover and feedback effects through access to extension, borne out by the correlated increase in women's empowerment.** Finally, **the expansion of mobile phone technologies offers considerable promise for extension and targeting uptake by women is worth considering.**

Risk Management

Key findings

- Subsidies for inputs, like fertilizer, have limited impacts on production and incomes. They are also distortionary and unless well targeted will likely benefit larger, richer farmers disproportionately. There is also evidence that such subsidies result in the over-application of fertilizers.
- Shifting to income transfers as a policy approach has some clear merits but the detail of delivery again matter. Unless comprehensive transfers systems are in place that cover all the community there is risk that more transfers will simply accrue to landholders. International funders of agricultural development research might consider broadening their focus to go beyond the farm to achieve better poverty-reducing outcomes.
- The adoption of new techniques might on average lead to higher farm incomes. Greater attention to the stability of those incomes and the risks of new production techniques is required. In the case of zero tillage, there are benefits from governments seeking to address the downside risks associate with realising the expected yield.

As with the analysis of knowledge transfer in the EGP, the project's contribution to understanding risks has been constrained by our inability to administer the farmer survey and the subsequent reliance on secondary data sources. Under the initial project plan, the intention was to use primary data from farmers to better understand the links between policy and delivery, particularly those that had been purportedly aimed at risk reduction, like national insurance schemes. The nature of the secondary data that was available required a broader interpretation of the notion of risks. More specifically, we extended this analysis to interrogate programs that seek to promote agricultural production, like input subsidies.

The outputs especially relevant to this section are:

- Connor et al. (2021a) *'Fertilizer subsidy removal and agricultural production risk: A natural experiment from India'*
- Connor et al. (2022) *'Simulation modelling for insights into variable adoption of conservation agricultural practices in the East Gangetic Plain'*

This section also draws from a media release by Kishore and Crase (2021) and we encourage readers to access the recorded panel conversation on this topic.

Connor et al. (2021a) used secondary data from India's paddy production in the period 2000-2016. Their aim was to understand the impact of removing fertilizer subsidies on rural farming households. Fertilizer subsidies have been cited in some cases as generating a positive effect for farmers, particularly in the Sub-Saharan African region where they have been attributed to increased food security for small farm households, particularly during lean periods when food is less accessible (Wiredu et al., 2019). The study by Connor et al. (2021a) empirically estimates the input and output demand functions with respect to phosphate and potash prices. The aim was to examine the effect of subsidies on farm yield, profit, fertiliser demand, and factor substitution in paddy production. In addition, price elasticities and marginal values were calculated to scrutinise the effect of price subsidy removal in 2011.

Connor et al. (2021a) note that the impacts are not universally similar. In the context of demand and fertilizer application, the marginal impact from subsidy removal from 2011 to 2012 is twice as great for the lowest capitalised quartile of farms compared to the more capitalised quartile. Put differently, smaller farmers reduced their use of fertilizer substantially more than capitalised farms (where there are likely complementary assets that would be underutilized with less fertilizer).

Regardless of these differences in input demand, Connor et al. (2021a) also found that changes to the value of subsidies had a very small impact on operating profit and yield. For instance, a 100 per cent increase in phosphate prices decreases yield by less than 3 per cent and profits by less than 4 per cent in the full sample. Farms with less capital suffer disproportionately – yields decline by over 4 per cent for this group whereas larger more capitalised farms realise no change in yield at all. Collectively, the findings of Connor et al. (2021a) suggest that **the removal of the fertilizer subsidies in 2011 did not significantly impact farmers in general, particularly the large farmers**. Connor et al. (2021a) conclude that **where fertiliser subsidies are implemented, they should be targeted towards poorer and smaller farmers. The results also support the view that subsidies induce over-application of fertilizers.**

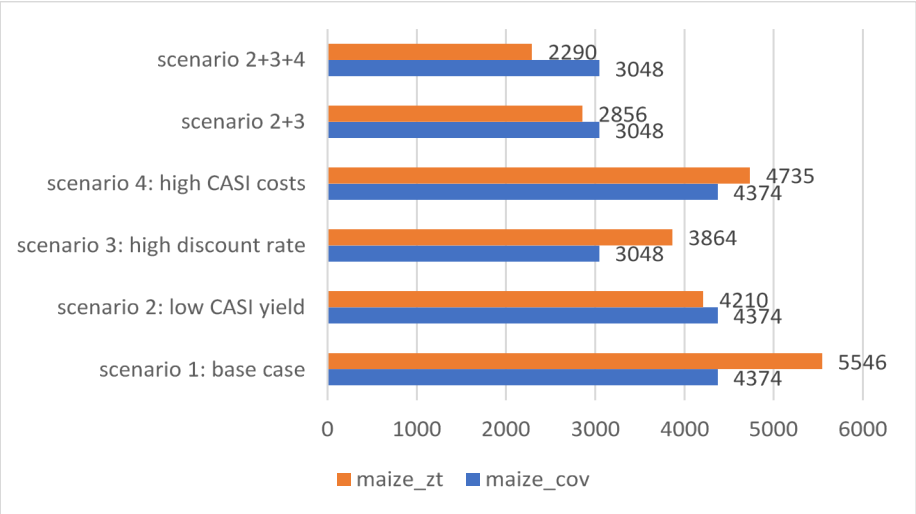
The removal of fertilizer subsidies was also examined in Kishore and Crase (2021). In an op-ed piece provided to the *Conversation* they note that like other governments in the region, the Indian Government has been progressively moving towards direct cash transfer of fertilizer subsidies, rather than manipulating prices. On the face of it, most economists would see this as a sensible approach because the current price distortions caused by the subsidy leads to imbalanced applications of fertilizers and diversion of subsidized fertilizers into non-agricultural uses. However, a big challenge in switching to non-distortionary cash transfers is: How to measure and track payments to farmers who do not own land?

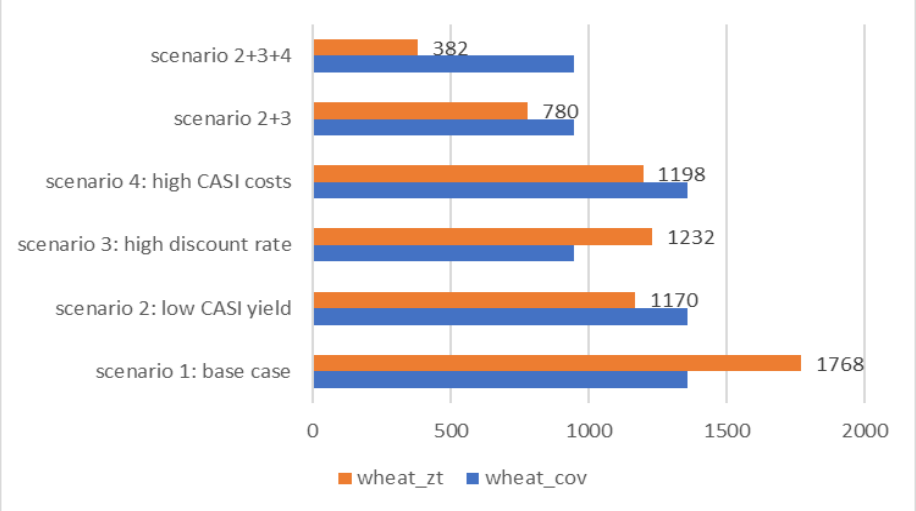
The challenges of policy delivery were also highlighted in their observation about the Indian crop insurance scheme. The Indian crop insurance scheme is worth over USD 2 billion and offers subsidies equal to at least 95% of the premium, but this completely excludes tenant farmers who bear most of the production risks. Kishore and Crase (2021) **advocate for agricultural research to consider going beyond the traditional spheres of crop and animal production/marketing and help guide the development of other civil infrastructure to support the delivery of better policies**.

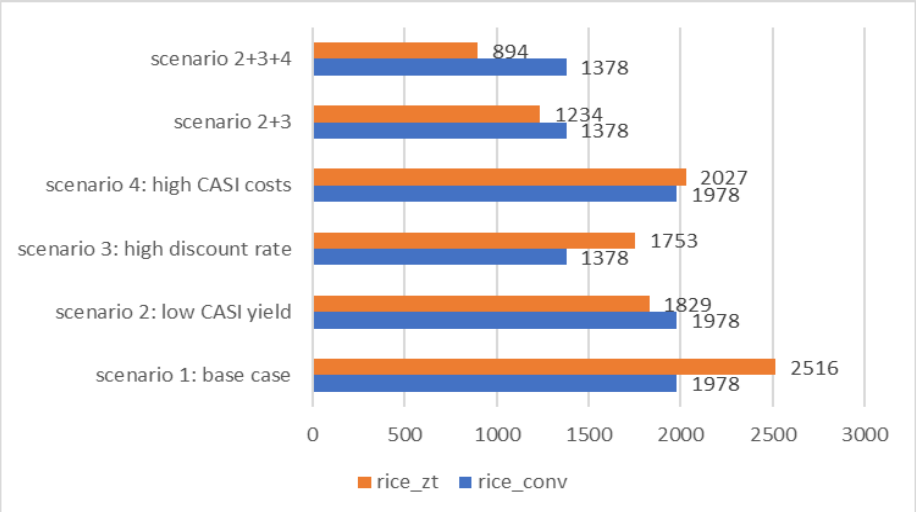
Notwithstanding that a shift in donor sentiment may occur over time, the Australian government has invested significant monies to promote intensification of agriculture in the EGP by focussing on improved technologies and different farming systems. A large body of published work has been generated by these efforts and new work continues to focus on the scaling out of conservation agriculture practices. Gathala et al. (2021) produce a large amount of data relating to the impacts of conservation agriculture in the EGP and show substantial increases in profits, along with reduced input uses and improved efficiency thanks to conservation agricultural adoption. Whilst these field trials continue to show promise others report only modest uptake.

Against that background, Connor et al. (2002) used simulation modelling to further investigate how risks might inhibit adoption. Put simply, evidence from adoption literature shows that farmers expect learning costs resulting in less yield and higher input costs when they first adopt a new technology. This means less return initially than occurs in demonstration trial and more risk on the downside. Connor et al. (2022) develop their simulation models directly from the data available in Gathala et al. (2021) and explore scenarios where alternative assumptions are applied around the likely yield, input costs and cost of capital (i.e. discount rate), labour, the cost of other inputs and less yield. The results of combining all those scenarios across three different crops appear in Figure 12.

Figure 12: Mean Profits for Maize, Wheat and Rice under Zero Till and Conventional Cropping with Simulated Scenarios and Base Case (i.e. existing field trial data)







In the top panel the scenarios from the maize production simulations are presented followed by wheat (middle panel) and rice (bottom panel). Scenario 1 is the base case and is grounded on the distribution of data reported in Gathala et al. (2021). The presentation of results in Figure 12 disguises the distribution of actual results for individual farmers – that is, these are average outcomes and some farms will perform above and others below the mean. The base scenario for all three crops shows the clear financial advantage of zero tillage (in orange) compared to conventional tillage (in blue). For example, rice production shows an average profit of USD 2516 per Ha under zero till versus USD 1978 per Ha for conventional tillage.

Scenarios 2, 3 and 4 are used to explore policy options for encouraging adoption. Scenario 2, where the farmer expects yields to be lower than those witnessed in the trial sites for the first 3 years, results in the profitability of conventional tillage outweighing the profitability of zero till. This result holds for all three cropping systems. In contrast, scenario 3, where discount rates are increased to reflect the cost of informal borrowing, do not impact the relative profitability of zero tillage against conventional tillage. Scenario 4, which is based on input costs being higher than those experienced in the field trials, gives rise to mixed impacts on the relative profitability of zero tillage. More specifically, zero tillage remains relatively more profitable than conventional tillage for rice and maize production but not for wheat.

An important contribution of Connor et al. (2022) is that their work sheds light on the magnitude of different barriers to adopting conservation agriculture. In this case, **policy options that ensure that actual yields come close to those in field experiments will be more influential in encouraging adoption than either subsidising inputs or making credit more affordable**. Put differently, policy that helps cover the downside risks associated with lower-than-expected yields will likely be more effective if adoption is sought.

Collectively, the research on risk and policy/delivery institutions shows the following: **Subsidies for inputs, like fertilizer, have limited impacts on production and incomes. They are also distortionary and unless well targeted will likely benefit larger richer farmers disproportionately. There is also evidence that such subsidies result in the over-application of fertilizers.**

Shifting to income transfers as a policy approach has some clear merits but the detail of delivery again matter. Unless comprehensive transfers systems are in place that cover all the community, there is risk that more transfers will simply accrue to landholders. International funders of agricultural development research might consider broadening their focus to go beyond 'the farm' to achieve better poverty-reducing outcomes.

The adoption of new techniques might on average lead to higher farm incomes. Greater attention to the stability of those incomes and the risks of new production techniques is required to support delivery of conservation agriculture. In the case of zero tillage, there are benefits from governments seeking to address the downside risks associate with expected yield.

Inclusion

Key findings

- Technology can increase incomes and make them more stable. Focussing on how technologies can specifically address the needs of less advantaged groups can lead to greater welfare gains than simply looking to increase universal access to technology.
- Policy communities have made substantial progress in recognising the benefits of greater empowerment of women, but this needs to be matched by efforts to measure and monitor change in the status of women over time. There is also scope to refine the measurement of empowerment.
- Care also needs to be taken when reviewing data on empowerment – there may be some instances where aggregate improvements in empowerment disguise the welfare impacts on some women.
- There is empirical evidence that an integrated approach to raising women's empowerment is generally more effective.

Figure 3 in the Methodology section of this report details the initial methodology that sat behind the main farmer survey. Inclusion, particularly in the form of women's empowerment and the status of tenant farmers, was a topic that spanned all domains and locations. Moreover, the modified method post COVID19 retained a focus on inclusion, wherever feasible. For example, the analysis of water rights was specifically targeted to capture data on women and tenant farmers in West Bengal and the link between knowledge transfer via extension services and women's empowerment was also examined. Within the broader institutional analysis of experts provided by Cooper et al. (2021) the opinions of women were also considered against those of men.

In that regard some of the earlier outputs add to the understanding of inclusion. Nonetheless, this section specifically synthesises five outputs to derive key findings. Accordingly, this section draws upon:

- Lountain et al. (2021b) *'Technology, gender and sustainable livelihoods: Insights into preferences for irrigation pumps in West Bengal'*
- Lountain et al. (2021c) *'Complex policies for complex issues: Policy convergence for women's empowerment in agriculture in West Bengal'*
- Sarma et al. (2021b) *'Measuring determinants of women's empowerment: An Application of Structural Equation Modelling and Path Analysis'*
- Cooper and Crase (2021) *'Women's Empowerment and the Feminisation of Agriculture: Insights from a Systematic Review'*
- Cooper et al. (2021b) *'Measuring women's empowerment in India should be given a higher priority: An issues brief'*

As with other themes, a short panel recording is also available.

Cooper et al. (2021b) observe in their policy note that data on women and empowerment is sadly lacking in many cases, or patchy at best. The Bangladesh data used by Kandulu et al. (2021) described earlier represents an outlier. Cooper et al. (2021b) argue that **more attention**

needs to be paid to systematically measuring the plight of women, if policy ambitions are to live up to expectations.

Using the Bangladesh data, Sarma et al. (2021b) attempted to unpack the relationships between extension services and women's empowerment. They use structural equation modelling, which allows for multiple path dependencies which can be critical in complex environments, like those related to increased empowerment.

The study reveals that five latent factors, namely decision making, freedom of mobility, membership, birth control, and extension services were positively associated with the women's empowerment in agriculture index. Women's membership (M=0.425), decision making (D=1.822), freedom of mobility (F=0.055), decisions on birth control (B=-0.252) and extension services (E=0.976) all appear to have a significant effect on WEAI (P<0.01). **Nonetheless, the complexity of these types of relationships warrants more analysis and the primary survey scheduled for 2022 will assist**.

The need for more comprehensive data on empowerment of women in agriculture and their specific circumstances is tackled, in part, by Lountain et al. (2021b) in their analysis of pumping technologies in West Bengal using targeted phone surveys. The purpose of the survey was to shed light on the links between pumping technologies and likely use by specific farm households. Lountain et al. (2021b) position their analysis in the context of the sustainable livelihoods framework and seek to explore how the uptake of new technology is influenced by a number of factors, including gender and land tenure. The work had initially been structured as part of the main farmer survey and was designed to rely on the BWS technique.

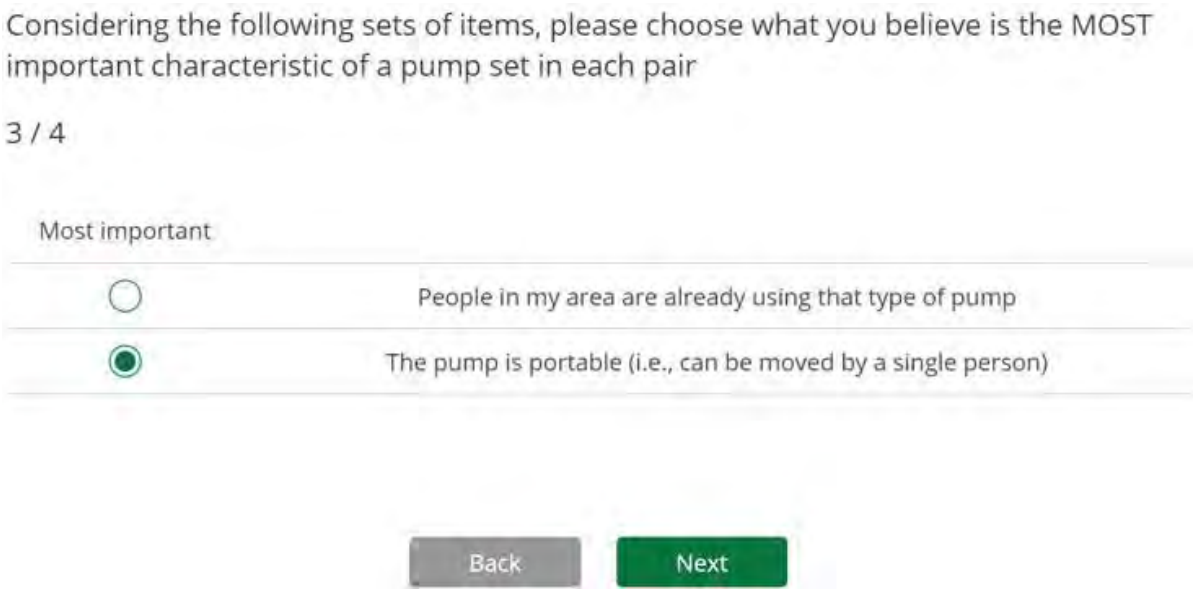
Given COVID-19, the data collection instrument for this research was ultimately shifted to a phone survey with a paired comparison experiment. In paired comparison experiments, data is collected by presenting respondents with two choice options at a time and asking them to select only one (Burton, 2003) – in this case, the option considered most important by the respondent. Paired comparison is a valuable technique because of the simplicity of the required judgements and the focus that this gives the experiment (Burton, 2003).

The development of the items for the experiment is described in full in Lountain et al. (2021b) as is the statistical design that sat behind the paired comparisons. The attributes and an example comparison set appear as Table 5 and Figure 7 in Lountain et al. (2021b) and are repeated here for convenience.

Table 5: Pump Paired Comparison Attributes

Attribute	Attribute details
1	The pump has affordable ongoing costs (i.e., I can pay the cost of running the pump)
2	The pump can access deep water sources
3	The pump can be connected to the electricity grid
4	People in my area are already using that type of pump
5	The pump is portable (i.e., can be moved by a single person)
6	The pump can be used at any time of the day or night
7	I can make money from the pump when I'm not using it
8	The pump has affordable upfront costs (i.e., I can pay the cost to purchase the pump)
9	The pump does not produce (too much) fumes and smoke
10	The pump can be maintained and repaired by myself or someone local

Figure 7: Example Paired Comparison Choice Set



In addition to presenting the statistical models, Lountain et al. (2021b) offer graphical illustrations of the results in Figures 8 -10 (repeated below).

Figure 8: Comparing Preferences by Gender

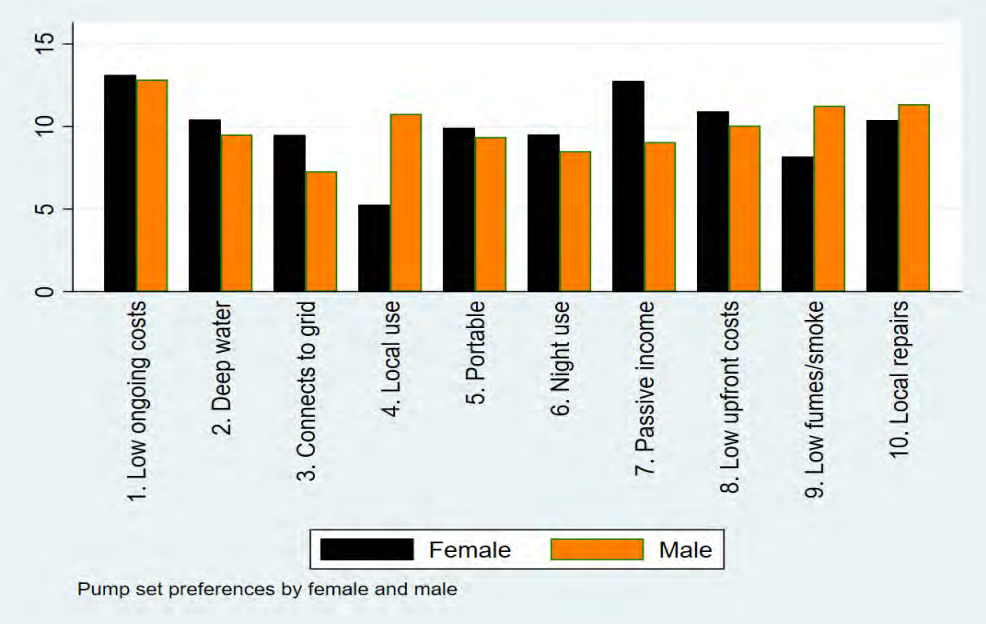
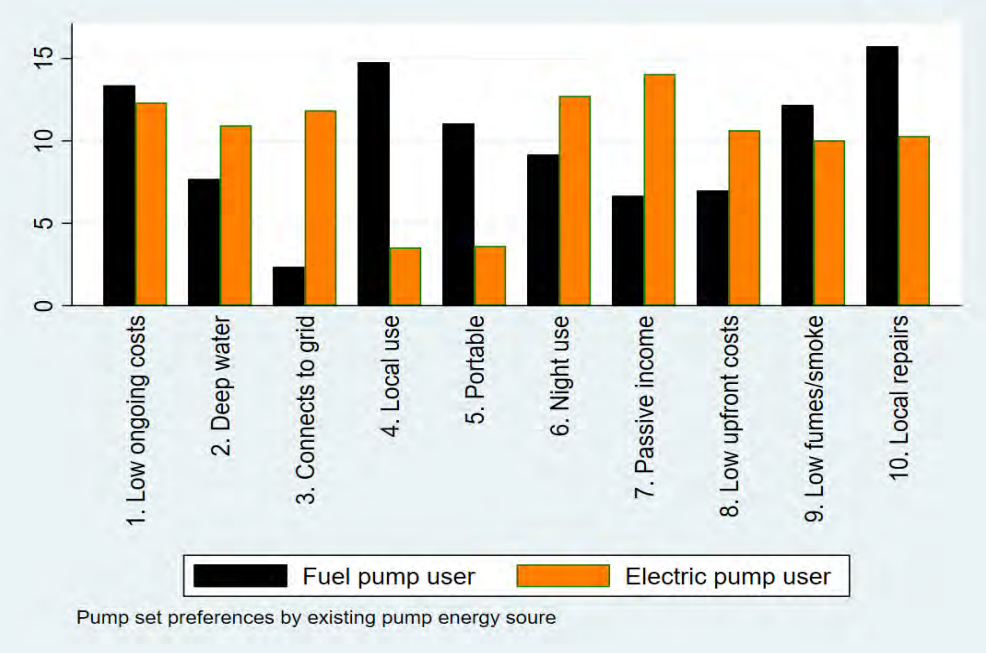


Figure 9: Comparing Preferences by Land Ownership

Figure 10: Comparing Preferences by Existing Pump Energy Source



It is important to note that these data are all scaled so that they are directly comparable (i.e. an importance score of 10 indicates that the attribute is twice as important/preferred to an attribute with a score of 5). Whilst lower cost is commonly preferred across all groups, there are other key differences that matter, especially taken with the work by Kishore (2021) and others. Specifically, it is noted that **the preference for earning indirect income from the pump device is significantly stronger amongst women** and to a lesser extent tenant farmers. This raises important questions about the flow on effect to the groundwater market if government incentives to own a pump set were skewed in favour of male farmers and those who own land (also usually men). Given Kishore's (2021) concern about the scope for monopoly power to emerge in groundwater markets in West Bengal, the results also highlight the importance of understanding how access to inputs (like water) and its relationship to preferences for adopting specific technologies needs further consideration. An important caveat on Lountain et al. (2021b) is that it takes place in a setting where groundwater resources are sufficient and recharge adequate to support further development. This is not universally the case in the region.

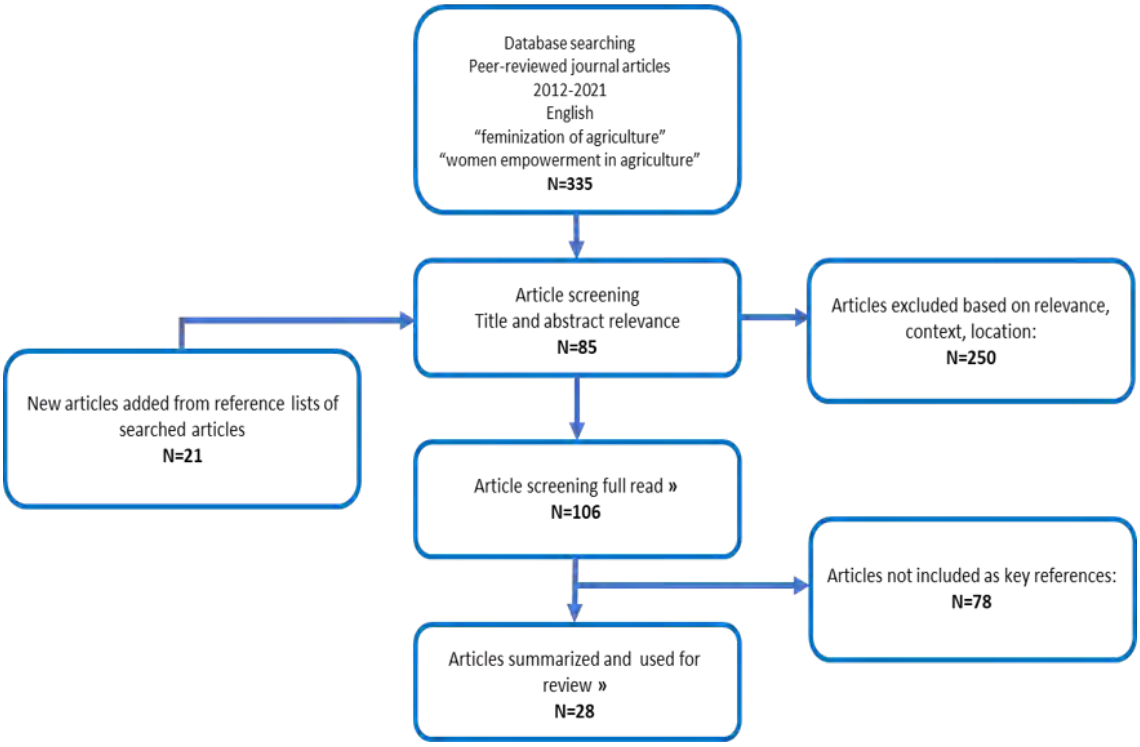
Lountain et al. (2021c) use the related survey data drawn from West Bengal to further explore how multiple actions can culminate in shaping the preferences and ultimately behaviours of women. This work specifically addresses the integration theme that underpins the 3i's project. Importantly, it also highlights the pivotal nature of using primary data to better develop this theme and the advantages of deploying the household survey in 2022.

Lountain et al. (2021c) empirically investigate the linkages between the uptake of technology by women and the other facets of their lives; specifically, institutional and social support. The interest was around establishing the validity of a 'convergence' approach that has been advocated in parts of the EGP. The idea of 'convergence' partly hinges on the limited capacity to assist communities and the benefits of having agencies work in synch to achieve specific goals, like empowerment. Lountain et al. (2021c) find that **while policies supporting female**

farmers to access agricultural resources can provide benefits, institutional and social support are necessary to facilitate real empowerment and, thus, overall development. By generating empirical evidence of these linkages their work helps to support further dialogue about the need for a holistic approach to raising women's empowerment.

Building from this foundation, Cooper and Crase (2021) developed a proposal that (a) provided a precise of the policy frameworks for women in India, Nepal and Bangladesh (b) reviewed the scholarly literature on women's empowerment (c) contemplated instances where empowerment can and cannot increase life satisfaction for women. The approach to the literature review is summarised in Figure 11.

Figure 11: Approach to literature review of empowerment



The findings from the literature review were subsequently used to underpin discussion around the use of the property rights literature to enhance and simplify the measurement of empowerment. More specifically, by considering the multiple dimensions to the property rights to a woman's labour it may be feasible to create and index that encapsulates shifts in the dimensions of empowerment over time. This work was summarised in a successful grant application at UniSA where **they argued that more attention to the measurement of empowerment and drawing on existing literatures around property rights was a useful line of inquiry**. This is expected to establish an ongoing program of work that helps guide policy and research around WEAI.

Combined with the other studies that have embedded inclusiveness, this body of work offers several key messages. First, **technology can increase incomes and make them more stable. Focussing on how technologies can specifically address the needs of less advantaged groups, like women, can lead to greater welfare gains than simply looking to**

increase universal access. Second, **policy communities have made substantial progress in recognising the benefits of greater empowerment of women, but this needs to be matched by efforts to measure and monitor change in the status of women. There is scope to refine the measurement of empowerment.** Third, **care needs to be taken when reviewing data on empowerment – there may be some instances where aggregate improvements in empowerment disguise the welfare impacts on some women.** Fourth, **an integrated approach to raising women's empowerment is generally more effective.**

8 Impacts

This project set out to primarily impact officials in government who were well placed to advocate for improved institutional alignment between policy and delivery approaches. Objective 4 in the initial research plan specifically involved the creation of a demonstration that would add further weight to the calls for greater attention to this issue.

COVID19 resulted in excising objective 4 from this project and much of the face-to-face engagement that was planned to accelerate impact. Nonetheless, there are non-trivial impacts to report to date and more can be expected in coming years.

8.1 Scientific impacts – now and in 5 years

A substantive body of scientific knowledge has been generated from this project. The primary data collected from expert communities and the novel application of the Delphi and BWS techniques to generate the institutional mapping are particularly valuable. This represents a substantive contribution to the New Institutional Economics literature and development analysis. This part of the research involved extensive collaboration from each country and the manuscript detailing the method and outcomes is currently under review in a Q1 ranked journal. The data from this component has also been assigned a Digital Object Identifier to enhance future impact and to support the publication of a data paper in due course.

The primary data collected as part of the water rights analysis by Lountain et al. (2021b) is similarly valuable and has been assigned a DOI. This part of the project is also under review in Q1 ranked outlets. Similarly, the works by Rahman and Connor are currently under review as is the work by Connor et al. on subsidies.

To the knowledge of the project team, the simulation method used to better articulate potential risks of adopting conservation agriculture has never previously been employed. This manuscript is undergoing further refinement for submission to a Q1mjournal. Similarly, the manuscript developed by Kandulu et al. focused on mobile phones and empowerment is currently under review with a reputable outlet.

At the time of preparing this report at least 15 papers were either submitted or in the process of refinement for submission to peer reviewed outlets, all of high academic standing.

The survey instrument prepared for administration to farmers is poised to make an additional important scientific and policy impact in 2022. The data that can be yielded from this survey will provide a further lens on policy/delivery institutions and shed light on the most effective and acceptable combinations for improving livelihoods in the EGP.

8.2 Capacity impacts – now and in 5 years

The project was aimed squarely at enhancing the skills of institutional actors/leaders and the policy making communities, via the evidence generated on institutional mapping. The analytical techniques used to produce this evidence and the processes by which empirics can inform a wider discourse was also an important part of this development. The enthusiasm of members of the policy communities to better understand some of the analytical techniques resulted in CI Burton developing and recording a series of instruction sessions on the use and interpretation of BWS experiments.

Considerable capacity was also developed within the research team. Delphi and Discrete Choice (i.e. the BWS approach) are rapidly changing research approaches and training

sessions were arranged for the research team. This included sessions presented by Professor Darryl Maybery (Monash University) and Professor Dan Rigby (Manchester University) on Delphi and DCE, respectively. CI Cooper also worked closely with colleagues at BAU, honing their skills in Delphi and publication, ultimately co-authoring a paper with a BAU PhD candidate submitted to the *Journal of Business Process Management*.

Three Higher Degree Research students were also directly supported as a result of this project; 2 submitting theses at the time of reporting. A HDR scholarship was provided by UniSA to support Sophie Lountain. Some of her earlier work has already been published and she won support from the Crawford Fund to expand her work in south Asia. An additional fully-funded PhD scholarship at UniSA has been secured by the project team to commence in 2022. The candidate will continue to work on refining the measurement of women's empowerment, in line with the opportunities identified inthis project.

Mahbubur Rahman was also supported by this project through his scholarship at UniSA. As a result of his continued work on Bangladesh agriculture he secured a promotion to a new post in the Bangladesh government. John Kandulu's work also helped him leverage a role in the private sector where he now provides advice to multiple government agencies.

A team of researchers at BAU were appointed through this project and given opportunities to develop expertise in discrete choice methods, mobile data collection and related analysis and problems solving. Exposure opportunities in *Qualtrics* and *Sawtooth* software also attended the project. Supporting appointments at IFRPI were also made and given scope to develop new projects and finalise existing work.

8.3 Community impacts – now and in 5 years

The project focused on expert communities with the aim of bringing changes that would impact across the EGP. The opportunity to engage directly via the farmer survey and the establishment of demonstration sites was halted due to COVID 19.

8.3.1 Economic impacts

In addition to engaging directly with policy communities as part of the institutional mapping, the formal and grey published material from this project provides clear guidance on how to better structure and align policies and delivery apparatus. The national budget allocation to agriculture across the EGP is substantive and small improvements in allocation can yield substantial flow-on effects to the wider economy. The fertilizer subsidy in India is alone valued at $US 11 billion per year and research undertaken by this project clearly shows that this has little useful impact. Moreover, policies and delivery institutions that focus on access to inputs rather than the price of inputs stands to significantly improve agricultural incomes. The World Bank (2016) also notes that much of the commendable growth in Bangladesh agriculture since 2000 is directly attributed to enhanced policy settings accompanied by strong institutions.

In the case of conservation agriculture specifically, Gathala et al. (2018) estimated that CASI had the potential to positively impact 1.5 million farmers in the EGP by 2020/21 and this included at least 35% women farmers. The research undertaken as part of this project provides clear guidance on how some of the policy and delivery options might be adjusted to realise those changes. Specifically, this project has provided evidence that the most effective way to promote CASI is through supporting farmers to realise the promised improvements in yields.

In the context of current events, it is not feasible to accurately estimate the economic impacts in the EGP, however leveraging from the existing resources created by this project can be expected to produce substantial positive economic achievements within 5 years.

Image 1: Farmer discussion around crop diversification and productivity changes through irrigation access due to electrification, West Bengal

8.3.2 Social impacts

The project purposefully sought to shed light on the plight of women and tenant farmers and how policy/delivery options might be adjusted to better meet their needs. This was achieved across all domains considered by the project. The examination of water rights revealed opportunities to better engage women in groundwater markets and also provided guidance on shaping energy policies that do not produce detrimental impacts on groundwater buyers (usually poorer and tenant farmers). Specific opportunities were also identified for women through expanded extension service and increased access to mobile phones.

Advice on expanded data collection to better monitor changes in the status of women also stands to have significant social impacts however calibrating those changes in the current context is problematic. Again, we would expect these to materialise in 5 years, particularly if an opportunity arises to deploy the main farmer survey as this will add more weight to the case for change.

Image 2: Qualitative field sessions to discuss roles and relationships with tenant farmers and women farmers, West Bengal

8.3.3 Environmental impacts

Judicious use of natural resources is a key feature that underpinned several aspects of this project. For example, the analysis of knowledge transfer covered a range of issues that relate to better management of soils, capital and water. The empirical insights into the energy-water nexus in groundwater markets also has significant environmental consequences through less carbon-polluting pumping technologies.

Climate change is predicted to have a major impact in the EGP and several elements of this project help deal with those challenges. The analysis of risk management, for instance, can significantly inform better ways to deal with the environmental consequences of a changing climate and the policies to encourage adoption by farmers.

8.4 Communication and dissemination activities

Given the objectives of the project, the communication and dissemination activities have focussed on the key audience – policy making communities that impact the EGP. Two face-to-face workshops were undertaken in Nepal prior to the disruption caused by COVID19. These included a range of interactive sessions designed to both inform the institutional mapping exercise and gain buy-in from key informants. In round 1 of the Delphi, 70 experts in the region engaged with the open-ended format to share their views on institutions that matter. Round 2 had participation of over 100 experts who refined concepts and provide a preliminary ranking that later helped shape the BWS.

Image 3: Delegates at the project inception meeting, October 2018, Nepal

Image 4: Meeting with senior officials (Planning Commission, Ministry of Planning and Ministry of Water Resources, Bangladesh) during the Project Inception meeting

Image 5: Delphi workshop delegates, Bangladesh

Image 6: In-person Delphi interviews

The BWS received voluntary engagement from 96 experts and an additional 30 participated in the completion of a pilot phase. The training sessions arranged on BWS were in response to demands for participants keen to learn more of the approach. Prof Burton continues to engage and support government personnel who are experimenting with different survey approaches for gathering data from farming communities.

Although farming communities could not be engaged as planned, qualitative phases of some of the survey work and pre-testing provided opportunities to communicate with farmers and farmer organisations. The pilot of the main survey instrument using tablet-based technologies was scheduled in Bangladesh. Farmers were also engaged in West Bengal through a phone survey. This reached 534 farm households across multiple districts.

Image 7: Portable pumps used in West Bengal, 2021

Image 8: Hand pump and electrical shallow pump in West Bengal, 2021

Preliminary findings from some of the quantitative analysis were presented at international conferences. This included sessions at the Australian Agricultural and Resource Economics Society in 2019, 2020 and 2021. For example, Dr Cooper chaired a mini-symposium titled *Social inclusion in a development context: Cases from ACIAR projects*, at the virtual AARES conference in 2021. The Bangladesh team also presented their work virtually at the Agricultural & Applied Economics Association (AAEA) meeting held at Kansas City, MO, USA in 2020. An additional symposium to promote the wider findings has been programmed for the Australian Agricultural and Resource Economics Society in February 2022.

Image 9: Professor Alam presents preliminary findings and Ms Sophie Lountain presents at AARES Conference 2020

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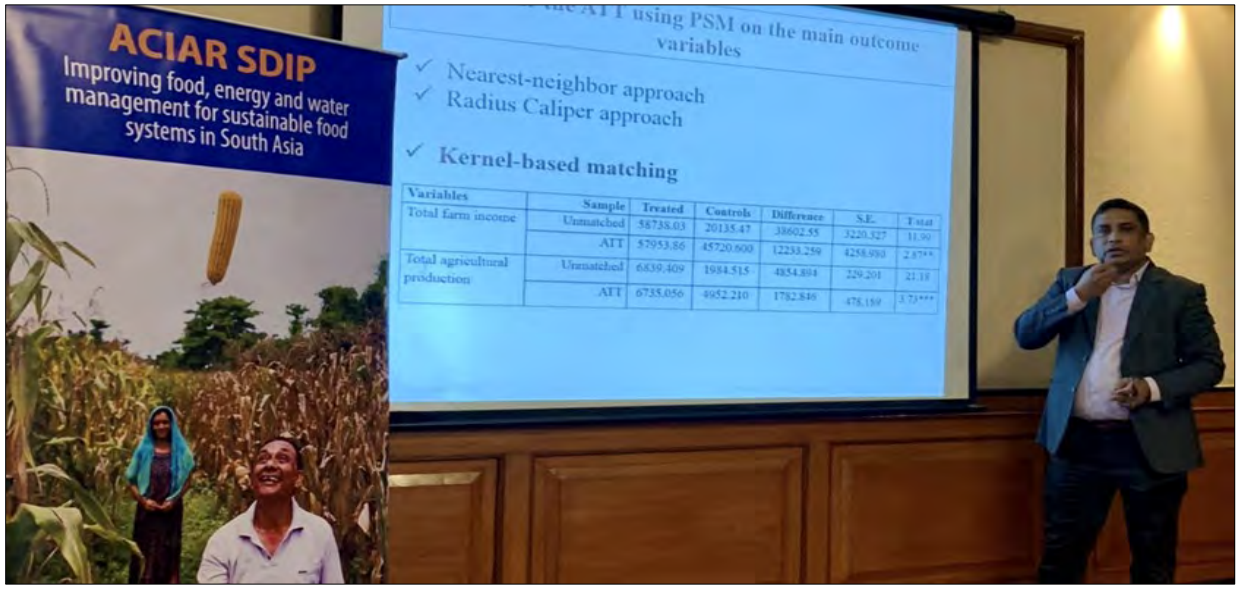
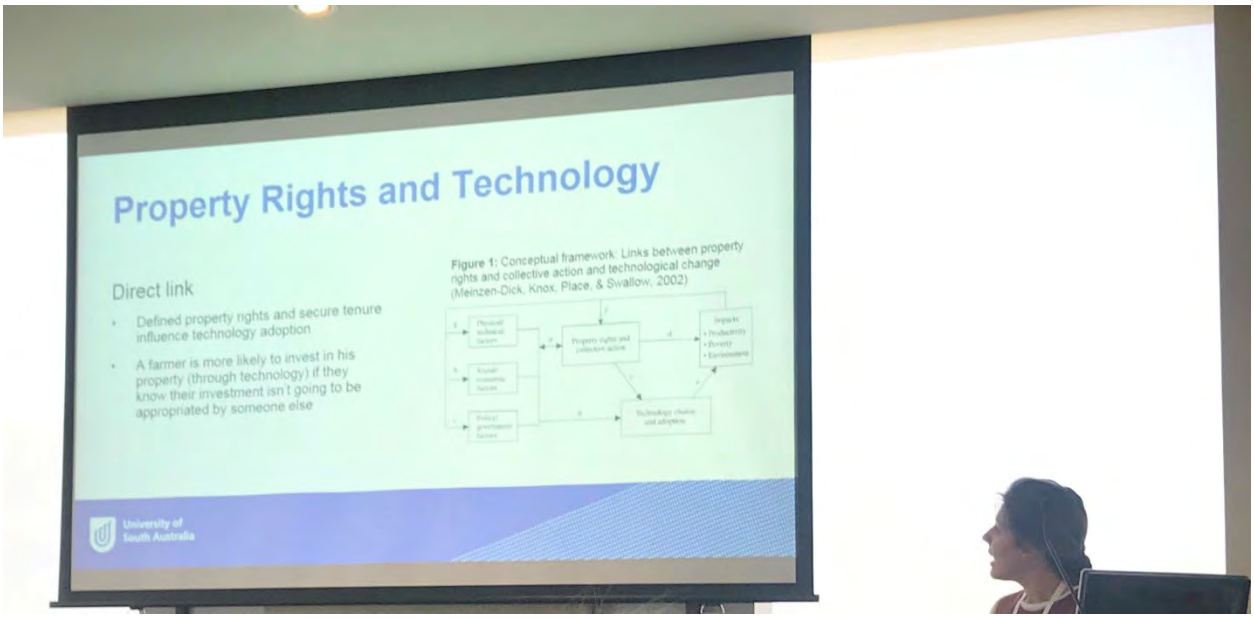




In addition to the extensive publishable material for scholarly outlets, op-ed pieces were produced for media outlets. For instance, ‘Banking on successful agriculture for progress’ was published in the *Financial Express*, one of the top-rated newspaper outlets published in English in Bangladesh. Similarly, ‘South Asia needs a change of approach for agricultural progress’ appeared in *The Daily Star* – a highly rated newspaper in the region.

Image 10: Samples of dissemination in local media

FE The Financial Express

Saturday, 27 November 2021 | Today's FE | e-Paper

/ Views

Banking on successful agriculture for progress

Mohammad Jahangir Alam and Lin Crase | Published: October 09, 2021 00:16:25

The Daily Star

South Asia needs a change of approach for agricultural progress

Mohammad Jahangir Alam and Lin Crase

REGARDLESS of the remarkable progress that some industries across South Asia have achieved, agriculture still remains the primary source of employment and income for a large segment of people in the region. In Bangladesh, for instance, 38 percent of the working population was employed in agriculture in 2019, and more than 40 percent of Indians are still employed in the sector. Efforts to improve the welfare of the poor across the region also rely on achieving higher and more stable incomes for farm households. Simultaneously, improved management of the agricultural sector is required to deliver on food security and political stability. This is especially the case in the Eastern Gangetic Plain—one of the most populated parts of

policymakers from Bangladesh, India and Nepal. The project commenced by gathering information from nearly 100 policy experts who are closely involved with agricultural development. These experts were recruited because of their experiences in this field. After nominating the different policies and programmes of interest, experts were then asked to rank the ones that they thought were most effective at raising and stabilising farm incomes.

On the one hand, it was not surprising to see that the experts, coming from different countries, had slightly different ratings of the policy approaches. But there was a consistent theme across the board.

Overwhelmingly, all the experts indicated that the difficulty of accessing quality inputs was the main barrier to improving the incomes of farm

In terms of the empowerment of women, the project found that giving women access to technology can have markedly different and potentially better impacts, compared to the same technology in the hands of men.

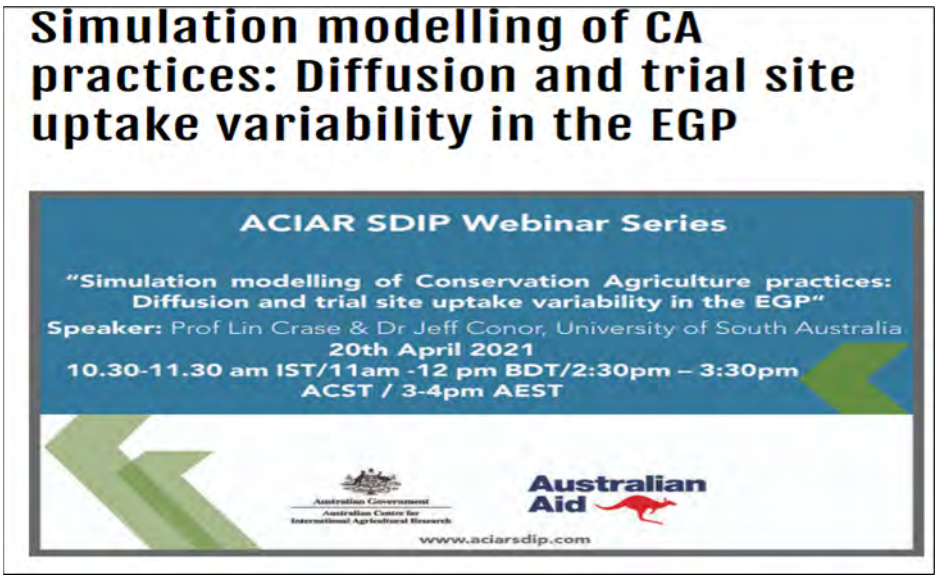
This again brings into question policies that are concerned primarily with the cos of inputs and not their distribution, as w highlighted by the data gathered from th experts.

Access was also a key component of the work on extension and information to farmers. It was found that farmers accessing information was positively related to higher incomes and productivi In a related analysis of mobile phone use by farmers in Bangladesh, better yields, improved production efficiency, and high agricultural net revenues were all positive related to mobile phone access and use.

In terms of the empowerment of women, the project found that giving women access to technology can have markedly different and potentially better impacts, compared to the same technolo in the hands of men. For example, one

As results became available towards the end of the project the team also disseminated finding through webinars and seminars.

Image 11: SDIP Webinar series, 20th April 2021



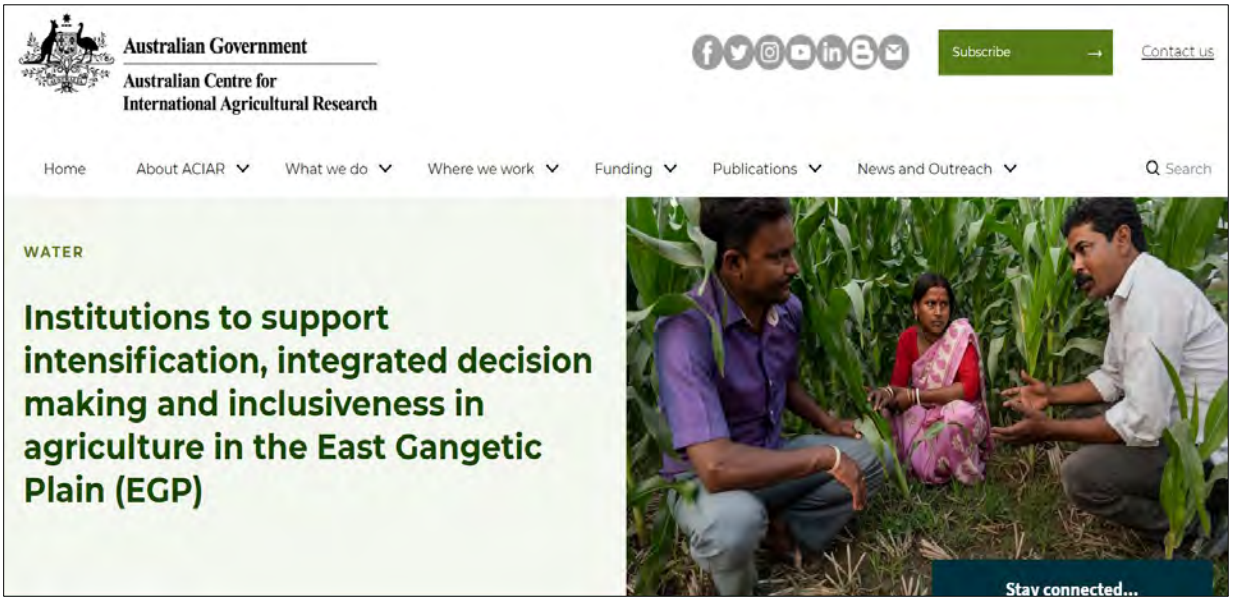
Findings and progress were regularly shared across the other research teams engaged with SDIP projects including program meetings in Nepal.

Image 12: Project meeting and SDIP field trip, November 2019, Nepal

Online Zoom panel discussions were arranged around the key themes that structured the results. A summary of each panel appears Appendix A

An International Webinar was undertaken in May 2021 to further engage with the policy communities and stimulate discussion. The webinar was led by the Hon. Christopher Pyne and included contributions from members of government advisory bodies in south Asia, like the Planning Commission in Bangladesh. The webinar title is *Aligning low level institutions with high level policies for effective outcomes*. Notably, the webinar included a contribution from Prof Dr Shamsul Alam who subsequently assumed the role as State Minister, Ministry of Planning of the government of Bangladesh.

Additional dissemination is planned into 2022. Notably, the Foresighting work that formed part of the wider program of activity in the EGP is scheduled to host additional activities in 2022. The findings from this project will be presented as part of those workshops. In addition, the project team has secured a UniSA PhD scholarship to continue work on the refinement of measuring women's empowerment in 2022. This scholarship includes working collaboratively with IFPRI and other ACIAR partners and thus provide a vehicle for continuing to engage around the project findings.



9 Conclusions and recommendations

9.1 Conclusions

Collectively, the project has managed to assemble several important conclusions about the current alignment of policies and delivery mechanisms in the region along with specific conclusions relating to water, knowledge transfer, risk and inclusion.

In the context of *general institutional design* it was concluded that:

- Policy communities support the view that improved access to inputs – not simply subsidising their cost - is key to increasing and stabilizing farm incomes in the EGP.
- At a broad level, expert communities advocate for a greater role for the private sector to deliver improvements in access to inputs.
- These high-level institutional lessons are borne out with specific cases. For example, accessible credit and the availably of high yield seeds are shown separately to be important drivers of higher and more stable incomes.

In the context of *water* it was concluded that:

- Continued strengthening of governance at the state level can underpin private investment in irrigation and this should be given more attention.
- Delivery of irrigation as an input is of itself not a panacea to raising farmers' incomes and productivity and a range of accompanying factors need investigation.
- Careful attention needs to be paid to the linkages between energy reforms and their impacts on behaviour in groundwater markets. There are important nuances around the functioning of groundwater markets and understanding these should be a high priority, especially given the reliance of the poor on groundwater markets.

In the context of *knowledge transfer* it was concluded that:

- Extension services are positively linked to improved productivity and profitability of rice farming in Bangladesh.
- There is a positive and significant relationship between exposure to extension and expansion of the technology portfolio used by farmers.
- Whilst adoption of a broader portfolio may be warranted and positive, there are also potential risks.
- There are potentially less obvious spill-over and feedback effects through access to extension, like correlations to improvements in women's empowerment.
- The expansion of mobile phone technologies offers considerable promise for extension and targeting uptake by women is worth considering.
- The causal links from extension services to other variables and the detail around how extension can be nuanced to give greatest impact needs to be scrutinized with primary data.

In the context of *risk management* it was concluded that:

- Subsidies for inputs, like fertilizer, have limited impacts on production and incomes. They are also distortionary and unless well targeted will likely benefit larger, richer farmers disproportionately. There is also evidence that such subsidies result in the over-application of fertilizers.
- Shifting to income transfers as a policy approach has some clear merits but the detail of delivery again matter. Unless comprehensive transfers systems are in place that cover all the community there is risk that more transfers will simply accrue to landholders. International funders of agricultural development research might consider broadening their focus to go beyond the farm to achieve better poverty-reducing outcomes.
- The adoption of new techniques might on average lead to higher farm incomes. Greater attention to the stability of those incomes and the risks of new production techniques is required. In the case of zero tillage, there are benefits from governments seeking to address the downside risks associate with realising the expected yield.

In the context of *inclusion* it was concluded that:

- Technology can increase incomes and make them more stable. Focussing on how technologies can specifically address the needs of less advantaged groups can lead to greater welfare gains than simply looking to increase universal access to technology.
- Policy communities have made substantial progress in recognising the benefits of greater empowerment of women, but this needs to be matched by efforts to measure and monitor change in the status of women over time. There is also scope to refine the measurement of empowerment.
- Care also needs to be taken when reviewing data on empowerment – there may be some instances where aggregate improvements in empowerment disguise the welfare impacts on some women.
- There is empirical evidence that an integrated approach to raising women's empowerment is generally more effective.

9.2 Recommendations

It is recommended that ACIAR:

- Continue to support the dissemination of the findings from this project as it is poised to make a significant impact post-Covid19.
- Give serious consideration to supporting the deployment of the main farmer survey once ground conditions improve in the EGP. The instrument is fully developed and this is a significant resource. The assembled data will provide a platform for going beyond the views of the expert communities and identify solutions that are both effective and acceptable to farming communities.
- Consider partnering across government more broadly to leverage Australian expertise in the region. This includes providing support and advice on efficient income transfer mechanisms to remote communities.

The project uncovered other areas of research that require attention and have potential to positive influence agriculture for development:

- The nexus between water food and energy is particularly relevant in West Bengal. The research team is of the view that the institutions that are embroiled in this nexus require closer scrutiny. For example, the conditions under which localised groundwater markets transition towards monopoly has significant outcomes for poorer farmers who rely on groundwater markets to access water. Research on this topic could identify ways of limiting monopoly power and thus support more inclusive development. Similarly, better understanding the demand side of these markets could have important implications for policy making.
- Greater understanding of how non-agricultural activities related to outmigration and how this ultimately influences household wellbeing would assist. In line with the final recommendation above, there is a risk that only focussing on activities within the agricultural domain overlooks important feedback effects between the income effects from outmigration and farm-related activities. Understanding the nature of these feedback effects would help tailor policies that treat household well-being mor holistically.
- The analysis of empowerment of women revealed multiple gaps and areas for development. The research team has made small steps towards developing the property rights of women's labour as a way of formulating a clearer and more consistent understanding of empowerment. Given ACIAR's broader commitment to this topic, there are benefits to supporting this work and integrating it into other ACIAR projects.
- Risk modelling to better understand adoption barriers has multiple potential applications beyond this project. Other areas where ACIAR is concerned with the uptake of new technologies from field trials could benefit from incorporating this type of behavioural analysis as a matter of course.
- The secondary analysis of input subsidies again highlights their potential deleterious consequences. Regardless, subsidies remain a persistent part of the policy landscape and there is value in better understanding the political economy that sustains their use. Similarly, using cases where nations have successfully transitioned to alternative payment systems might highlight the opportunities for alternative approaches.
- Throughout the project the nomenclature around governance, policy, institutions and their interrelationships has been used differently by different stakeholders. Developing a shared view of the definition of these topics within ACIAR would make a useful contribution.

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11 Appendixes

Appendix A: Manuscripts and other outputs by domain, authors, title, topic and publication status.

Domain	Author	Title	Research Topic	Status
Institutional mapping	Bethany Cooper, Lin Crase, Michael Burton, Dan Rigby, Mohammad Jahangir Alam and Avinash Kishore (2021)	Institutions and policies for enhancing farm household livelihoods: Using Delphi and Best Worst Scaling to analyse the coherence of expert opinion in the East Gangetic Plain	Reports the ranking of policies and delivery mechanisms adjudged most effective by experts at raising and stabilizing farmers' incomes	Under review
	Mohammad Rahman, Jeffery Connor (2021)	The effect of high yielding variety on rice yield, farm income and household nutrition: Evidence from rural Bangladesh	Using panel data from Bangladesh the paper finds that access to high yield varieties still offer significant potential to raise productivity and incomes	Under review
	Anjani Kumar (2021)	Assessing the Impact of Lending through Kisan Credit Cards in Rural India: Evidence from Eastern India	This paper attempts to identify the determinants of access to the KCC program and empirically evaluate its impact on farmers' use of agricultural inputs and farm household incomes in Eastern India	IFPRI Working Paper series
Knowledge transfer	John Kandulu, Sarah Ann Wheeler, Alec Zuo, Jeffery Connor (2021)	Improving rural agricultural production and income in developing countries using mobile phones	Uses panel data from Bangladesh to investigate the impacts of mobile phone access on rural households' agricultural production and income	Under review

	Paresh Kumar Sarma, Mohammad Jahangir Alam, Jeff Connor, Sheikh Mohammad Sayem & Ismat Ara Begum (2021)	Agricultural Technology Adoption, extension service and Production Risk Nexus: Evidence from Bangladesh	Engagement with agricultural extension was linked with a 5 per cent increase in the adoption of new technologies and a reduction in production risks	BAU working paper series/submission for review January 2022
	Mohammad Jahangir Alam, Paresh Kumar Sarma, Lin Crase, Riffat Ara Zannat Tama, Md. Abdul Kader & Ismat Ara Begum (2021)	Impact of Agricultural Extension Services on Farm Productivity and Profitability in Bangladesh	Uses an unbalance panel data from the Bangladesh Integrated Household Survey of 2015 and 2018 to examine the impact of agricultural extension services on profitability and productivity of farmers	BAU working paper series/submission for review January 2022
	Ismat Ara Begum, Paresh Kumar Sarma, Bethany Cooper, Lin Crase, Sheikh Mohammad Sayem & Mohammad Jahangir Alam (2021)	Nexus among Extension Services, Women Empowerment in Agriculture and Farm Income: A Stochastic Modeling Approach	Uses data from the Bangladesh Integrated Household Survey to determine the Household Wealth Index (HWI), Women's Empowerment in Agriculture Index (WEAI), and Livelihood Vulnerability Index (LVI) and compare these against interactions with extension services	BAU working paper series/submission for review January 2022
Risk management	Avinash Kishore, Lin Crase (2021)	Solutions to agricultural development and poverty require governments to look beyond land	Argues for broader support from international governments to back initiatives that go beyond agriculture in seeking to address rural poverty	*Conversation* pitch 2021

	Jeff Connor, Rajabrata Banerjee, Kartick Gupta and Avinash Kishore (2021)	Fertilizer subsidy removal and agricultural production risk: A natural experiment from India	Using Indian data on paddy production from 2000-2016 the paper considers the removal of the fertilizer price subsidy and find it had limited impacts on production but had the most deleterious outcome for smaller and less capital intensive farmers	Under review
	Jeffrey Connor, Lin Crase, Mahesh Gathala, Brendon Brown (2022)	Simulation modelling for insights into variable adoption of conservation agricultural practices in the East Gangetic Plain	Uses simulation models to understand why adoption of conservation agriculture practices may be lower than expected relative to analysis that considers only average returns	Submission for review January 2022
Water rights	Mohammad Rahman, Jeffery Connor (2021)	Does supplemental irrigation enhance smallholder agricultural productivity? Evidence from monsoon season rice cultivation in Bangladesh	Using panel data and Difference in Difference to investigates impacts of supplementary irrigation on rice Production and finds no significant gains	Under review
	Sophie Lountain, Lin Crase and Bethany Cooper (2021)	When the genie is out of the bottle: the case of dynamic groundwater markets in West Bengal, India	Traces the evolution of groundwater markets and the complex interactions with other policies related to energy	Published in Wheeler, S. (ed) 2021 *Water markets: A global assessment*, Elgar, Cheltenham
	Avinash Kishore (2021)	The Changing Energy-Irrigation Nexus in West Bengal and Bihar: Implications for Equity in Access to Groundwater	Uses data from representative samples of paddy and wheat growers of Bihar and West Bengal from 2000-01 to 2016-17	IFPRI working paper series

			to analyze how the water markets and water application rates changed with the increase in diesel prices in Bihar and rapid electrification of irrigation in West Bengal	
	Anjani Kumar, Seema Bathla, K. Elumalai, Sunil Saroj (2021)	Irrigation Governance, Private Investment, and Agricultural Productivity in India	Using a constructed governance index for surface water irrigation in 20 Indian states the paper finds that farmers' dependence on electric tube wells, and hence groundwater, has increased extensively due to inadequate access to public (canal) irrigation.	IFPRI working paper series
Inclusion	Bethany Cooper, Lin Crase, Avinash Kishore (2021)	Measuring women's empowerment in India should be given a higher priority: An issues brief	Critiques gaps in women's empowerment data that need to be filled to better understand the changing status of women	Policy note published online
	Paresh Kumar Sarma, Ismat Ara Begum, Bethany Cooper, Dilshad Zahan Ethen, Farzana Yeasmin & Mohammad Jahangir Alam (2021)	Measuring determinants of women's empowerment: An Application of Structural Equation Modelling and Path Analysis	This study used structural equation modeling (SEM) to investigate causal relationships among women's empowerment indicators across a range of dimensions	BAU working paper series/submission for review January 2022
	S. Lountain, B. Cooper, L. Crase and M. Burton (2021)	Technology, gender and sustainable livelihoods: Insights into preferences for irrigation pumps in West Bengal	Using phone survey data, the paper reports that preferences for pumping technologies vary significantly for women who are more inclined to	Under review

			sell water into a groundwater market	
	Sophie Lountain, Bethany Cooper, Lin Crase, Michael Burton (2022)	Complex policies for complex issues: Policy convergence for women's empowerment in agriculture in West Bengal	Uses phone survey data collected in West Bengal to empirically validate the interrelationships between multiple policy and institutional settings that produce integrated benefits for women	Under review
	Bethany Cooper, Lin Crase (2022)	Women's Empowerment and the Feminisation of Agriculture in Bangladesh: Insights from a Systematic Review	A PhD research proposal to gain support for a 3 year PhD scholarship focused on simplifying the measurement of women's empowerment	Proposal endorsed and funded 2022-2025

Appendix B: Panel discussions, webinars and video training session links

Panel sessions

A series of panel discussions designed to summarise and the research that was completed were recorded with relevant research team members. The panel discussions covered: Institutions, Inclusiveness and each of the three domains (Water Property Rights, Knowledge Transfer and Risk Management).

We provide a brief explanation about each panel discussion and a link to the associated recording below.

Institutions

This panel discussion walks you through the paper 'Institutions and policies for enhancing farm household livelihoods: An analysis of the coherence of expert opinion in the East Gangetic Plain' with the authors elaborating on aspects related to their contributions.

Panel members: Professor Crase (Chair), Professor Alam, Associate Professor Burton and Dr Cooper.

Inclusiveness

Discussing access to resources, a case study about pump preferences in West Bengal and the inclusiveness aspect of agricultural extension services, agricultural productivity and the Women's Empowerment in Agriculture Index nexus.

Panel members: Dr Cooper (Chair), Professor Alam, Professor Crase, Dr Kishore, Miss Lountain

Water property rights

Drawing on observations made in the Conversation 'Solutions in agriculture require governments to look beyond land' and other research findings, Professor Crase leads the discussion about water property rights in the study areas (Bangladesh, India and Nepal).

Panel members: Professor Crase (Chair), Dr Cooper, Dr Kishore, Miss Lountain

Knowledge transfer

The panel discuss research from three papers:

1. Impacts of Agricultural Extension on Farm Productivity and Profitability in Bangladesh
2. Nexus among Agricultural Extension Services, Women Empowerment in Agriculture and Farm Income: A Stochastic Modelling Approach
3. Improving rural agricultural production and income in developing countries using mobile phones

Panel members: Dr Kishore (Chair), Professor Alam, Professor Connor, Dr Cooper, Professor Crase, Mr Kandulu

Risk management

Along with discussing elements of obtaining insurance in the Indian context the panel discuss research from three papers:

1. Does supplemental irrigation enhance smallholder agricultural productivity? Evidence from monsoon season rice cultivation in Bangladesh

2. Agricultural Technology Adoption, Agricultural Extension Services and Production Risk Nexus: Evidence from Bangladesh

3. Simulating risk to better understand low adoption of conservation agriculture in the east Gangetic Plain.

Panel members: Professor Crase (chair), Professor Alam, Professor Connor

International Webinar

24th May 2021, titled: Aligning low level institutions with high level policies for effective outcomes.

Panel members: Led by Hon. Christopher Pyne and followed by contributions from members of government advisory bodies in south Asia, like the Planning Commission in Bangladesh.

Online Training Session on Best-Worst Scaling Technique

18th May 2021

Instructors/Convenors: University of Western Australia and University of South Australia

Participants: Experts in agricultural development across India, Bangladesh and Nepal