West Bengal Accelerated Development of Minor Irrigation Project

Amkhoy WUA (Birbhum), on June 15th 2018

Internship Research Report

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EXECUTIVE SUMMARY

This report is the summary of the work undertaken in May, June and July 2018 by Joao, graduate student at Harvard Kennedy School, and Somveer, undergraduate student at IIT Kharagpur, on the WBADMIP. The research involved interviews, document and data analysis and multiple field visits. The first contribution of this report is to derive the theory of change of WBADMIP, using microeconomic theory. Starting from discussion over the identified problem, one conclusion is that the project, even being more broad and integrated than other irrigation projects in West Bengal, is exclusively focused on supply-side constraints; a possible demand-supply mismatch is not currently being addressed.

The qualitative analysis from the field provide insight on the project and the different performance levels between WUAs. Visited underperforming WUAs displayed at least one of the three problems: i) technical failure in the scheme early on; ii) lack of local demand for the scheme; and iii) political and social conflict among WUA members. The best performing WUAs, on the other extreme, displayed i) appropriate site selection (locally demanded scheme); ii) close and high-quality support from DPMU in the very beginning; and iii) strong, consensual local leadership.

The comparison with non-WBADMIP schemes highlighted the advantages of WBADMIP, undocumented until now. The typical non-WBADMIP scheme received zero agricultural or institutional support and was either i) poorly targeted concerning beneficiaries (not small, marginal or poor) or ii) unnecessary (installed in a place where water scarcity was not binding), or both. The observed requisites for a well-performing scheme suggests that all investigated non-WBADMIP schemes suffer from a serious policy design deficiency.

The findings mentioned above, however, need to be confirmed by a systematic quantitative analysis, that was supposed to be included in this report but was postponed due to data delivery problems. This report suggests how this could be done with data that can be easily retrieved by the existing team, exploring satellite databases going back to at least 2014.

Some findings emerged from analyzing the limited existing data. The WUA grading analysis suggests some data reliability problem: the outcomes are excessively positive for some districts, unlike the field visit conclusions (e.g. Bankura). Also, data on the time taken to hand over schemes reveals that administrative speed is reasonably homogeneous across scheme types, but significantly different between districts, suggesting a heterogeneous implementation capacity. All findings and graphs are available in editable format.

Five recommendations are made, conditioned on the findings from a quantitative analysis.

First, more data collection, analysis and documentation. The WBADMIP best potential legacy, given its reasonably small scale, is described as being a demonstration effect: exploring the best practices to deliver irrigation and improved agricultural income in West Bengal. With that goal in mind, the implementation flexibility and willingness to innovate are welcomed, but at present cannot deliver scalable results because no significant learning process or documentation is taking place. This is directly related to the lack of data and impact evaluation mindset among most project staff. It is therefore recommended that i) immediate impact evaluation is undertaken, along the lines of Section 5, and ii) adoption of methods to improve on-the-ground data reliability and speed.

Secondly, a pilot: to extend WBADMIP's institutional and agricultural supports to existing non-WBADMIP schemes. Field visits suggest that agricultural and institutional support, absent in other projects, are key to deliver positive, lasting results. This can mean that WBADMIP is closer to a good technology on public irrigation projects than comparable efforts. One key question is whether this can be scaled up. For that it is suggested that existing WBADMIP's staff, especially at the district-level, are used to provide institutional and agricultural support to existing non-WBADMIP schemes with no serious technical issue - but that yet still are not delivering expected results.

Third, another pilot: provide more autonomy for WUAs to improve agricultural production. In the most common, private schemes, ownership is higher, and costs are lower. One can leverage that if farmers are the ones taking the main decisions and installing the schemes. A step-by-step approach is suggested to experiment with transferring money to WUAs instead of procuring and installing the scheme for them. Agricultural and institutional support would still be there – the later would, in this pilot, be strengthened.

Fourth, it is recommended that **agricultural support is enhanced to include creating and improving market linkages.** This would use existing administrative capability to address this currently underexplored dimension, that can provide high and fast returns to the beneficiaries at very low cost. A case-by-case approach is recommended.

Finally, the **fifth recommendation is that institutional support in also enhanced, to include active attempts to disseminate best-performing WUAs practices** to all the others, contributing to a more homogenous and prosperous outcome across villages.

We would like to thank the Project Director, the SMPU staff, all DPMU and SO staffs, the World Bank Team for all the valuable conversations, inputs and insights that allowed this report to be written. A special thanks to all the farmers that received us in their communities, in their villages and in their lands, and devoted time to answer our questions, clarify our confusions, and share a bit of their lives with us.

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"Where irrigation was available – through dams or tube wells – farmers increased their production of both cereals and crops such as cotton, chilies and vegetables. Previously isolated villages were now integrated with the outside world. New roads allowed vehicles to take out crops and bring in commodities; they also transported villagers to the city and back, exposing them to new ideas. Within the village there was a slow spread of innovations such as the bicycle, the telephone and, above all, the school".

India After Gandhi, by Ramachandra Guha

1) Introduction, Goal and Methodology of this Report

This document summarizes the findings of the *in loco* internship research on the West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP)[1], between May 20th and July 27th, by students of the following institutions and internship programs:

Harvard Kennedy School MPA/ID Internship

The Master in Public Administration in International Development Program, at Harvard Kennedy School, includes a mandatory internship experience, after the first year of academic activities, during the academic summer break (May, June, July and August). The experience is to be in a developing or transitional economy country other than the intern's home country. The goal is to offer a practical opportunity to test the skills of the first year in the MPA/ID Program (economic development, microeconomics, macroeconomics, statistics and econometrics[2]) and broaden real-world perspective of the student on development practice.

Indian Institute of Technology Kharagpur Internship

In order to qualify for Dual Degree (B.Tech+M.Tech) in Agricultural and Food Engineering, at IIT Kharagpur, it is mandatory to have an internship experience, after the 4th year of academic activities, during the summer break in between 4th and 5th year(from

[1] [1] This report assumes a basic understanding of the project, equivalent at least to the information in the Project Appraisal Document (PAD) produced by the World Bank.
[2] The detailed core curriculum can be found at https://www.hks.harvard.edu/educational-programs/masters-programs/master-public-administration-international-development-0

May to July) of at least 40 days. The experience should be related to the Agriculture and Food Industry. The goal is to offer practical knowledge about the field's challenges.

This report summarizes the efforts to identify the main characteristics, strengths and room for improvement in the West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP), with emphasis in understanding its own internal heterogeneity and how its performance compares with other existing irrigation efforts in the state of West Bengal.

This document is therefore divided as follows. First, the methodology is presented. Then, the socioeconomic problem that the project tries to address (Section 2) and its theory of change (Section 3) are deduced and analyzed, using mainly a microeconomic framework. In Section 4 the qualitative results from the field visits are presented; Section 5 suggests how to proceed with a complementary, quantitative analysis – not undertaken here for lack of data. Finally, Section 6 provides some preliminary recommendations based on the available evidence and Section 7 concludes with areas for further investigation.

Methodology

The methodology of this report combines theory and empirical evidence as follows. First, a theoretical framework is used to make sense of the project's goal and efforts, considering the circumstances under which it exists. This borrows extensively from economic theory, and to a lesser extent on public management theory.

Empirically, while the goal of the research would ideally be the combination of a qualitative and quantitative analysis, the later was compromised due to delays in data availability (more details in Section 5). For that reason, the qualitative research is the focus of this report. Nevertheless, considering the conversations with SPMU staff and investigations on the data that will eventually be available (that can be produced internally without additional resources), informed suggestions on how to proceed once the data is available are undertaken.

The qualitative research consisted mainly of two components: semi-structured interviews and field visits. The interviews involved i) members of the WBADMIP – both at state and district levels -, ii) community workers working daily with farmers, iii) the farmers themselves, iv) the World Bank Team, and v) academicians with previous research in agriculture and irrigation in India. The interviews were combined with the field visits, to

both WBADMIP schemes and non WBADMIP schemes, as well as some DPMU offices – these are described in more detail in Section 4.

2) The problem and the Project's Theory of Change

Before exploring the design, components and implementation of the WBADMIP, it is useful to understand what the existing situation is and how the project plans to change it. First, the project's goal, according to the World Bank's Project Appraisal Document (PAD), is to "enhance agricultural production of small and marginal farmers". One can therefore assume that the problem identified, in the existing conditions, is a lower-than-desired agricultural production levels and productivity among this population.

While this might sound obvious at first, it is actually a significant decision concerning the project's design: one could, alternatively, focus on *increasing the income* of the same population, regardless of how this is to be achieved. Such an approach could lead to entirely different definitions of desirable outcomes. Rural to urban migration, for example, is one of the most distinct and intense demographic phenomena of contemporary India, in many cases leading to an increase in individual income levels[3], but nevertheless this would not be considered a desirable outcome in the way the WBADMIP goal is defined[4]. One can therefore define the problem that the project tries to address as "low income *from agriculture* among small and marginal farmers".

It is helpful to try to understand, analytically, what are the possible reasons behind this problem, so that it can be identified which causes the project is directly trying to address – which ultimately would inform the theory of change of WBADMIP.

[3] For a detailed discussion on non-farming drivers of growth and poverty reduction in India, see World Bank Group, 2011, p. xviii - more in References Section

[4] While it is an extremely relevant policy question, this report will take as given the decision to focus on this specific sector versus the wellbeing of this population more broadly.

The immediate reasons can be classified in three tentatively exhaustive groups, using a framework from microeconomic theory: constraints on the demand side, constraints on the supply side, or some kind of mismatch between supply and demand[5].

Demand-side constraints

A second layer of causes can then be derived from each first-level cause. On the i) constraints on demand, the second-level cause is straight-forward: there might be not a sufficiently large demand for the products currently being produced by the farmers, which would lead to low prices and/or low volume of sales, and therefore low revenue. The structure of the market under which the small and marginal farmers operate can be accurately described by a perfectly competitive producers market model. This is assumed to be the case unless stated otherwise, implying that farmers are price-takers. If there is nothing to be done concerning market prices of each good, the relevant question then would be *why not to shift to more demanded, higher-value products*. This takes us to ii) constraints on the supply side.

Supply-side constraints

Low volumes of production can be caused by two factors: economical (it makes no economic sense to produce more) or behavioral (production levels are below economic optimal, but potential suppliers are unwilling to expand production for behavioral reasons). Let's explore the later first.

Even as it is less commonly explored in economic theory and practice, **behavioral explanations** were mentioned in conversations with people from the top of the project's hierarchy (World Bank Team) to the street-level implementers – such as NGO's community workers. Two distinct factors seem to be at play here. One is related to social norms: in the Indian caste system, some castes consider it to be unacceptable, or at least highly undesirable, to work in agricultural land, as that would be a degrading activity – even if this activity provides higher profit than the alternative, viable sources of income. The second is related to the historical conditions of at least part of the targeted population:

many of the villages, specially but not exclusively those mainly inhabited by "tribal populations", were not significantly integrated in India's development of the past decades, lived in relative isolation from the urban centers until recently, and didn't had their livelihoods and lifestyle affected by the liberalization reforms of the 90s. These populations, even as they practice agriculture for centuries, do so with a *subsistence mindset*. In other words, they are used to cultivate the land to feed themselves and their families, but not to sell the production for profit and use the profits to buy goods in the market[6]. This has at least two consequences: one is the underproduction of goods compared to the level that would maximize profits (opting for cultivate traditional rather than highly profitable crops), and the other is the production, rather than the purchase in the market, of goods that are part of the local diet - such as rice – because spending money to buy them is considered against their traditions, even if this also leads to suboptimal production.

The constraints on the supply side can also be the more standard, **economic constraints**. One possibility is simply that there are high fixed costs associated with increased productivity: irrigation systems and tractors are expensive investments, for example. This need not be a problem if i) farmers can borrow money at reasonable interest rates to invest and ii) it makes economic sense to do investments like these, because production is expected to increase and compensate it in the future. However, perfect credit market is frequently not observed and even more so among remote, vulnerable populations; and the rural land ownership pattern of West Bengal specifically is highly decentralized, with few transactions in the land markets and high concentration of small and marginal farmers, who are the focus of WBADMIP. The result is that the average land size is smaller than what would be required to benefit from economies of scale, making the investments unjustified from an individual landowner point of view. In this scenario, two questions arise: i) why the land ownership pattern does not have fewer, larger landowners[7]; and ii)

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[6] In economic terms, this can be interpreted as a violation of the monotonic preferences assumption (they get satiated after producing what they need for self-consumption) or, less drastically, a utility function that gives higher weight to leisure (versus labor or income) than in the rest of the population.

[7] Even as public policies and history plays a large role here, as explored below, there is also a purely demographic component behind this: West Bengal is almost 3 times more densely populated than India, an already high-population-density country, according to the West Bengal Development Report, 2010 (see References Section).

why the farmers cannot coordinate among themselves to make collective investments, sharing the cost and enjoying the increased production? These are explored below.

Demand-supply mismatch

Finally, there might be some kind of mismatch between demand and supply: existing demand and supply levels could be expected to meet and produce higher revenues and profits for the farmers, but that is not currently observed. The reasons behind this can vary; field visits indicate two main hypotheses. One is the simple lack of knowledge about market prices: if there is a gap in market prices in different locations within the state, and farmers are unaware of it, they might be missing the opportunity to increase profits simply by not reaching the right market (selling their products at lower prices to better-informed middlemen). This low expected profit for otherwise highly-valued goods, caused by information asymmetry, can even act as an incentive not to produce these high-priced goods to begin with.

However, in many cases it seems like the farmers do know about the opportunities to increase profits by bypassing the middlemen. They might not be doing it for at least two reasons: for economic constraints (lack for access to credit markets, therefore depending on the high personal savings of the middlemen and paying him a premium for the intermediation) or for sociopolitical constraints: the middlemen are usually wealthier and politically stronger than the average farmer and have strong incentives not to allow the farmers to directly connect to farther, more profitable markets for their own goods. More research is needed to clarify this obstacle and propose solutions.

The above analysis on the identified problem and underlying are summarized in the diagram in the next page. There, the underlying reasons behind the low income from agriculture among small and marginal farmers are listed, and the reasons that the WBADMIP is designed to alleviate are highlighted in red color.

The next section details how, from a microeconomics perspective, the project is trying to address this market failures – and which ones are missing.

DIAGRAM 1 - IDENTIFIED PROBLEM AND UNDERLYING CAUSES

The causes explicitly addressed by the project's design are highlighted in red boxes.

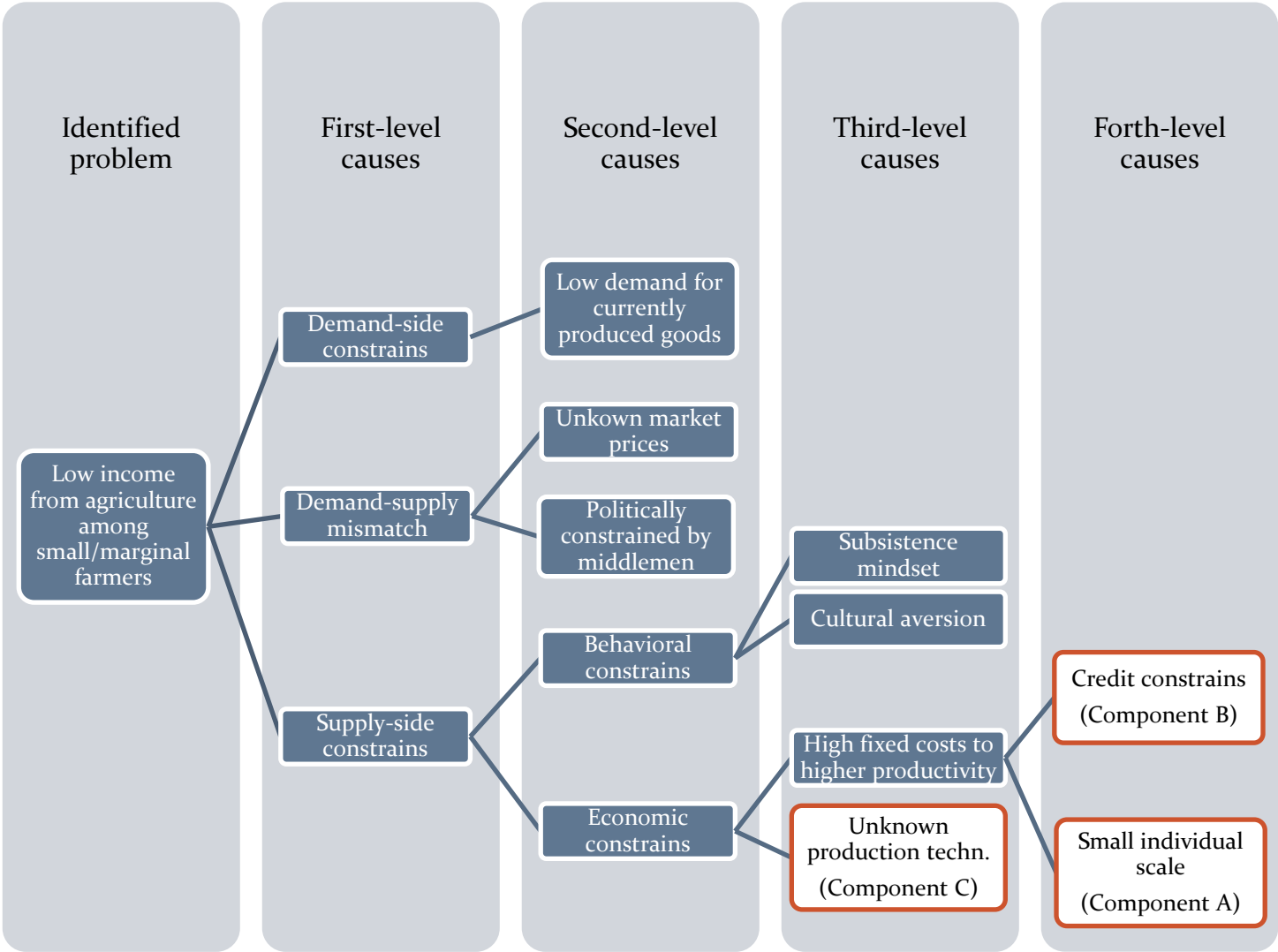

DIAGRAM 1 - IDENTIFIED PROBLEM AND UNDERLYING CAUSES
The causes explicitly addressed by the project's design are highlighted in red boxes.

3) The West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP) – an economic theory interpretation

The West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP) is a World Bank-supported initiative to "enhance agricultural production of small and marginal farmers" of West Bengal, India, according to the Project Appraisal Document (PAD). The project was approved by The World Bank Board in 2011, with planned closing date by the end of 2017 – later extended to end of 2019. The project is divided in four components, whose descriptions are detailed in the PAD.

Here, the same components are presented, but from an economic theory perspective. It is argued that the project aims to address the problem by focusing on three of the underlying causes behind it – highlighted in the Diagram 1 above. Each underlying reason maps into one of the three components of the project (the forth component is the project management by itself). The explanations on how, in theory, the project is trying to address each cause of low agricultural production is described below.

Addressing "small individual scale": Component A - Strengthening Community-based Institutions

This component aims to develop "community-based institutions, mainly Water Users Associations (WUAs), to assume responsibilities for management, operation, and maintenance of the minor irrigation schemes to be constructed under the project". Under a microeconomic framework, this effort can be seen as an attempt to fix a coordination failure that prevents the market from working efficiently. In sum, it's on all farmers' best interest to invest in physical capital – mainly irrigation structures, but also trucks to transport production to market, mechanized agricultural equipment like tractors, and others – to increase overall productivity and therefore income levels. But this doesn't seem to happen very often. Why?

Let us focus on the irrigation structures to understand the nature of the coordination problem. Considering the nature of this production system, based mainly on many small

producers[8], the smallest possible irrigation structure would nevertheless be excessive from the point of view of a single farmer, since it will provide substantially more water than the farmer needs for its own land. If selling water supply to nearby farmers (or sharing the cost of mutually used equipment like tractors) is not available, then the irrigation structure implies a positive externality from the farmer's point of view, leading to underinvestment.

The project attempts to incentivize the coordination among all farmers that would benefit from a given irrigation structure. This coordination institution, WUA, could in theory invest in the irrigation structure itself, provided that a functioning credit market is in place. However, in the project's context, it is always the case that the coordination effort is combined with a full-subsidy on the irrigation system itself, as detailed next. The main economic goal of the WUA under the project, therefore, is to coordinate operation and maintenance costs (mainly energy bills and, in some cases, security measures against theft of high-priced components of the scheme). Additionally, the WUA also i) dilutes fixed costs associated with training activities, as detailed under component C; ii) reduce the incidence of social problems and conflicts among farmers, thereby reducing the risk of misallocation of water resources and damaging of the irrigation structure. This explanation would fit Component A in a "big push" fashion, by shifting the farmers from a bad (no

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[8] The reason for the market organization around several small landowners instead of fewer, larger farms is related to historical reasons including, but not restricted to, land reforms promoted by communist governments and the demographical consequences of increased fertility rates and the Partition of Bengal (Sengupta, 1981). Some of reforms are believed to have had positive distributional and efficiency effects, like Operation Banga (Banerjee et. al (2002)). The land reforms more broadly are considered to be exceptionally successful in West Bengal: "*State-initiated land reforms are conventionally believed to have been unsuccessful in getting land to the poor in India (albeit with notable exceptions such as West Bengal)*" (Meams, 1999, p.2), and "*The agrarian system of eastern India had historically exhibited the grossest forms of feudalism. In (…) West Bengal these inequalities had been attenuated by land reforms* (Guha, 2017, loc 13,332). Finally, it should be noted that the West Bengal land distribution pattern by itself should not be considered an obstacle to higher productivity; the average land size in West Bengal was close to Japan's average – while the later experiences way higher levels of agriculture productivity (Sengupta, 1981).

one invests in irrigation, limiting productivity) to a good equilibrium (everyone collectively shares the cost of irrigation, increasing everyone's productivity). The same logic applies to other kinds of high-cost investments, not limited to irrigation structures.

In sum, if many small farmers can come together and act as one larger farmer, it starts to make economic sense to invest in some high-cost infrastructure that will improve everyone's production – like irrigation pumps, but not limited to it. This is what Component A tries to achieve, by stimulating a collective decision-making process and collective funding, by using the legal institution of the WUA and providing the required support to make it work smoothly.

Addressing (indirectly) "credit constraint": Component B - Irrigation System Development

This component aims to "improve availability of water for agriculture and fisheries by developing new minor surface and ground water irrigation schemes on areas that are currently cultivated under rainfed conditions". It can be framed as a full-subsidy on physical capital that provides one key factor to the production system.

Analytically, one could model it as the farmer being a production function of the form P = A*f(W,S,L), in which A = technology, W = water, S = seeds, and L = labor (here, human labor only). Under rainfed conditions, production's efficiency is heavily penalized in dry season (can be framed as cost of W too high in dry season).

However, to justify government's intervention one needs to add some kind of credit market imperfection, since the coordination failure would be fixed by component A. The real-life conditions of the farmers suggest that access to credit in limited. Some traditional reasons include lack of financial expertise (and therefore very high risk-aversion, making traditional loans unattractive) on the credit demand side, and inability to observe each farmer's likelihood to pay back (information asymmetry) on the credit supply side. More research is required to clarify this restriction.

Under these conditions, it would make economic sense for the government - acting as a benevolent central planner whose objective function is to maximize social welfare – to

either act directly on the credit market[9] or partly/fully subsidize the initial investment required for the irrigation systems.

Concerning the frequency of this intervention, it would ideally be a one-time subsidy. After this initial public investment, the increase in income would be partly reverted to collective savings by the WUAs – as indeed is happening in practice. – and would in turn allow for perpetuating the physical capital, by paying for its depreciation, without the need for external credit and any further government support. The lack of credit would be solved by the emerging collective savings.

Self-sustainable WUAs are indeed the goal of the project, as explicitly described in official documents, and as evident by the fact that the project has a defined end date – instead of a continuous financial support schedule. Therefore, after providing for free the initial investment, there is an expectation that the farmers will be able to self-finance any kind of future investment that might be needed to keep production at the high levels achieved by sufficient water supply.

To sum up, Component B directly subsidizes one of the required inputs for increased production (water) and therefore alleviates the consequences of credit restrictions.

Addressing lack of knowledge about production techniques: Component C - Agricultural Support Services.

This component aims to "enhance agriculture-based rural livelihoods by increasing production of agriculture, horticulture, and fisheries". Here, from an economic point of view, the component is supposed to provide training to teach more efficient agriculture– or to change the production function presented above, f(W,S,L), to g(W,S,L), such that

[9] As it indeed does, for example by providing Kisaan Credit Cards (KCCs). Because this solution is not under the WBADMIP, it will not be detailed further. It is worth nothing, however, that i) there is qualitative evidence that these credit instruments are not being optimally used, and many don't even know that it exists, and ii) theoretically speaking, better access to credit will turn the direct provision of irrigation by the government unnecessary. Farmers could themselves solve the problem by using credit and coordination (component A). All qualitative evidence suggests that, if given access to credit on the amount required to build a water pump, many farmers would use the money for other purposes, suggesting that the government occasionally invests in something that is not the biding constrain or the priority for the farmers.

g(.) > f(.). In other words, it is assumed that it is possible to produce more output with the same quantity of inputs (W, S, L), provided that one uses a better technology (g(.)) than the one currently used (f(.)). The assumption is that this is currently not done simply because the knowledge is not widespread among the targeted population (small and marginal farmers).

Let's take the example of water-saving techniques. The rationale here would be that water, both surface and underground, is a common resource (rival but non-excludable), therefore subject to the "tragedy of the commons": the individual incentive of each farmer is to use large quantities of water (assuming the price of water is below its social value). For this problem to be fixed by providing training on water-saving techniques, one would need i) failure of social norms (or voluntary agreements, on Elinor Ostrom's framework of collective action) to stop farmers from overusing water, as could be the case of a well-functioning WUA in the context; and, more importantly for the understanding of this component, ii) lack of information from the farmers-side about the water-saving techniques - because if these techniques were already known, they would be adopted to begin with, since g(.) > f(.).

Assuming that there is indeed a lack of knowledge about the more advanced (and yet affordable) techniques to improve efficiency among small and marginal farmers – which is indeed strongly suggested by field visits, this component is designed to bridge the gap and address this supply constraint.

Getting the implementation right: Component D - Project Management.

Finally, the fourth component is not directly associated with one of the underlying causes behind the identified problem. Rather, it addresses the need for "State Project Management Unit and District Project Management Units (…) to take charge of coordination and management of the implementation of all project activities". In sum, this component is simply a transaction cost, necessary to execute the 3 components above-mentioned. Component D, therefore, is the necessary means to achieve the desired activities (components A, B and C), and is designed to make sure that the goods (component B) and services (components A and C) supplied by the project will be appropriately distributed.

This component is at the core of the effort to create enough state capability[10] as to allow the project's implementation to go smoothly.

Using the above framework, the project can be understood as an attempt to simultaneously correct several market failures that, unless tackled at the same time, lead to underproduction and inefficiency in the farmland of small and marginal farmers of West Bengal.

4) Field visits: qualitative impressions

During June and July 2018, the field research described in Appendix 2 provides qualitative information about the status and implementation of the project. The schemes visited were selected aiming at getting a representative picture of the project and of micro irrigation efforts in the state more broadly[11], using the following criteria:

i) For WBADMIP schemes: the existing WUA grading system was used to target both well-performing and under-performing WUAs – the latter included, in some cases, temporarily or permanently dysfunctional schemes

ii) For non-WBADMIP schemes: there was also an attempt to visit well-performing and under-performing schemes, but because there is no systematic information equivalent to WUA-grading, these guidelines were forwarded to the Executive Engineer of each district, that in turn recommended which of all the other public micro-irrigation schemes should be visited. Considering the lower reliability of this selection method and the even smaller sample for non-WBADMIP schemes than for WBADMIP schemes, we do not attempt to differentiate between non-WBADMIP schemes in this analysis.

The findings are described below, separating the observed characteristics of each scheme, divided in 4 ideal types: i) high-graded WUA; ii) low-graded WUA; iii) considered well-

[10] For more details on the concept, see Pritchett, et. al (2013). In this piece, India is categorized as a "moderate capability" country, thus justifying The World Bank understands that a share of the project's fund should be dedicated to this end instead of relying exclusively on existing government departments and staff.

[11] This report summarizes the findings but does not detail the individual observations in each visited scheme. For the later, two-paged field report were elaborated for each visited scheme, with all data gathered on the field, and can be checked to complement this report.

performing non-WBADMIP scheme; and iv) considered underperforming non-WBADMIP scheme.

One important caveat about the existing WUA grading system

It should be immediately noted that the existing WUA grading system is not flawless and should not be blindly followed as a perfect assessment of the quality of each WUA. There are two main reasons for that caution: i) for most of the questions contained in the grading questionnaire, the answer heavily relies on observation on the field that might be inaccurate and/or subjective, and ii) because the grading system is used to award the best WUAs and the best districts[12], as well as to provide agricultural equipment free of cost to the best-performing WUAs, there are incentives in place to exaggerate the results. The answers to each question district wise were analyzed and revealed some reason to be cautions regarding the data reliability[13] – more details are in Appendix 4.

Having said that, using the grading system proved useful in practice: the high-graded WUAs indeed seemed to outperform the low-graded ones in most (if not all) observable dimensions, such that the purpose of visiting a wide range of WUAs was achieved.

High-graded WUA (WBADMIP scheme) – how do they look like?

The WBADMIP institutionalized a grading system that ranges from grade A to D; the visited WUAs under this section are all grade-A.

The first observable characteristic of well-performing WUAs are immediate to the visitors: in virtually all visits to this category of communities, the representatives of the WUA (the so called "executive committee") were **ready to meet the SPMU team as soon as it arrived** at the scheme site, usually reuniting at least 10 other farmers. This was typically

[12] Some field visits revealed an apparent excess in the supply of free equipment, with debatable effects. More caution is recommended in the design of this give-away efforts.
[13] Suggestions on how to improve the existing system are not included in this report since at the time of writing a new grading system had already being designed by the World Bank Team and was in early implementation phase.

the first evidence of a highly cohesive group, with strong leadership, and capable of coordinating its members around the collective interest.

Some concrete evidence of the former are the **water usage charges**, that each WUA member has to pay to the WUA collective bank account: in the grade-A WUAs, these fees were typically high (when compared to the average scheme), paid quite often (usually monthly), and reported payment delays were rare, if any at all. This behavior states how effective is the enforcement of the agreed-upon rules in that WUA. Even in technically problematic schemes (that would break to often and demand constant, sometimes expensive repair) the unusually organized WUAs would manage to collect money from all members and rapidly repair the scheme, acknowledging its importance for their production – all this with little interference from the State. In some cases, the purchase of production inputs was undertaken by the WUA instead of individually by each farmer, as to increase the bargaining power - achieving reported economy of 10% in costs. In other words, graded-A WUAs display high levels of ownership concerning the physical infrastructure delivered by the government and act as a highly-effective local coordination mechanism.

Remarkably, in some WUAs one could even see additional, **purely private schemes that were built (and kept), using WUA money** or even private money. In the later case, personal savings from a single WUA member were used to build private schemes outside the command area, after realizing how effective the WBADMIP schemes were for the local production. The owner would then irrigate its own land and also sell water to nearby farmers. Importantly, this is far from being something exceptional in India or in West Bengal in particular: as the 5th Micro Irrigation Census shows, of the 21.7 million minor irrigation schemes in India, over 96% are private, and most of these are owned by small and marginal farmers. The census also shows that over 80% of these are funded with farmer's own savings, as observed here – and more evidence of the deficiency of the credit market. Therefore, the WBADMIP scheme seem to have incentivized an already extremely common phenomena, but nevertheless in a desirable direction: considering how resource-constrained these specific communities are, this kind of effort is evidence of the extremely high value attributed to the schemes, both public and private.

Contrary to what one could believe, this is far from obvious: given that all the public-provided irrigation schemes in West Bengal are built free of cost to the farmers, there is evidence that many of them are actually not required, and sometimes they are not even used – more on that below. One thing that all visited grade-A WUAs had in common was

the **perception that the WBADMIP scheme was a sizable improvement in their production** and therefore income levels and life quality – so much so that they are willing to spend money in repairing existing structures and even building new ones on some occasions. The reason behind this phenomenon seems to be at least partly related to appropriate site selection: where pre-scheme scenario was a mainly agricultural community lacking water and even migrating to urban work during the dry season, the effect of the scheme seems to be the highest and so is the perception of his importance and value attributed to it. This contrasts with schemes built in areas where alternative sources of income exist and/or irrigation structures were available (even if private) before the WBADMIP scheme – more on that below.

The field visits to grade-A WUAs also revealed an interesting pattern concerning the **relationship of the district-level community workers**, hired by the State Government of West Bengal, and the farmers – especially the local leadership of executive committee. In all cases it seemed as if they met very frequently, knew each other quite well, and were comfortable with the situation of talking about the scheme and its consequences to visitors – even foreign visitors, requiring translation. This was in sharp contrast to what was observed in underperforming WUAs – more on that below – and seems to be at least partly related to the fact that grade-A WUAs are i) more frequently visited by state-level staff, researches, partner organizations, World Bank staff in mission, and even by the community members themselves. There are probably many implications behind this, but one easily observed concerns the agricultural and institutional support received by these communities. The success of the Component A (institutional support) – on its on merit or caused by context-specific conditions – is related to a greater efficacy of the Component C (agricultural support): the grade-A WUAs seem to more easily absorb and apply the best agricultural practices shared with them by community workers and agricultural specialists. This in turn reflected in higher production levels – that is one of the dimensions of the grading questionnaire, helping explain why these WUAs have high grades to begin with.

Finally, one should note that, in many cases, the role of the grade-A WUAs went **beyond pure coordination of expenses and water management among members to include other social roles**. In WUAs with unusually large savings accounts, when asked about the planned destinations for the money, some mentioned providing financial support to especially poor families facing hard times, like the need to pay the dowry when a daughter gets married, or helping with medical emergencies. Besides the financial dimension, it was

observed that the highly organized WUAs were starting to act as relevant political actors: some mentioned a stronger and closer relationship with the Gran Panchayat after the WUA was created, helping them request (and get) better roads, electricity connection and even, in one visited village, a full-time ambulance exclusively for that community.

Low-graded WUA (WBADMIP scheme) – what is missing?

Low-graded visited WUAs are almost entirely grade D (on a few occasions, grade C). In these, the scenario on the ground bears little resemblance with the grade-A WUAs. Even the physical structure of the scheme can provide valuable insight on the organizational and institutional development of that community: high-graded WUAs usually have information (water supply, list of members, water charges and production levels, among others) written on the pump-house walls; they are well-maintained and even might have some additional equipment and functionalities like security door, fan, and collective delivery pipes. All of these are usually absent in low-graded WUAs.

In the field visits engaged to produce this report there was some waiting time between the SPMU and researcher's arrival and locating the farmers. Even when members of the Executive Committee were there, there were rarely any other farmers around. The first impression is that the scheme, in these cases, is less valued for that community than they are in high-graded WUAs.

Literally all the underperforming WBADMIP schemes visited were, according to both DPMU staff and the farmers, underperforming since they were constructed and handed-over.

And the reasons for observed underperformance varied. They can be divided in 3, not mutually exclusive groups: i) technical failure in the scheme early on; ii) lack of local demand for the scheme; and iii) political or social conflict among WUA members.

I) Technical failure in the scheme early on. As noted above, well-performing WUAs seem capable and willing to maintain and repair their schemes. For underperforming WUAs, and especially for the dysfunctional (or defunct) schemes, one commonly cited reason is a serious, unfixed technical failure in the first few months after the scheme is handed-over. At this stage, since the institutional development is usually not solid enough,

there seems to be a lack of collective coordination to actively identify the problem and look for (and, especially, pay for) the solution. This can be deadly: if the scheme breaks down early on, water supply ceases and the main reason for the existence of the WUA disappears – making it hard to avoid a permanently bad outcome concerning the irrigation structure.

II) Lack of local demand for the scheme. In some cases, it seems like the lack of willingness to fix or improve a given scheme is also related to how valuable the scheme is perceived to be by the community. In places where previous irrigation alternatives exist – like private groundwater pumps of surface water supply -, the effect of the scheme is a relatively small reduction in the cost of water for the average farmer – definitely way smaller in magnitude when compared to what happens in a rainfed area once its first irrigation structured is built. In some of the field visits to dysfunctional schemes the team arrived aware of the current status and trying to identify how to make it functional again, but left with the impression that that scheme should actually not be fixed: the resources (both money and administrative effort) to make it functional again would barely change the production and socioeconomic status of the village, thanks to the existence of other sources of water or, in relatively better-off communities, alternative sources of income.

III) Political and social conflict among WUA members. Even as it happened rarely in the field visited listed in Appendix 2, it seems like the political dispute (competing political parties disputing space in the WUA Executive Committee) as well as lack of social cohesion (different castes co-existing in the same WUA, and disagreements between them) can play a role in determining how successful will a given scheme be. This requires deeper analysis, especially the determinants and relationship between these issues and the WUA performance – but should not be ignored.

Every visited underperforming scheme displayed at least one of the 3 problems listed above. It should be noted that they interact: the less required is the schemed perceived to be by the local community, the more likely it is that even small sociopolitical conflicts or technical problem result in a fully dysfunctional scheme.

Non-WBADMIP scheme – how they compare with WBADMIP schemes?

In the non-WBADMIP schemes visited[14], the performance of the scheme and its cost-benefit ratio were substantially lower than WBADMIP schemes – even as this conclusion needs to be confirmed by the broader, quantitative analysis. In short, the typical non-WBADMIP scheme seemed to be lacking at least one of the four: i) adequate targeting methodology for beneficiaries, ii) local demand for the scheme, ii) agricultural and institutional support. Each is explained below.

I) Poor targeting methodology for beneficiaries. Of the three issues, this was perhaps the more severe and apparent problem. In many occasions the visits revealed schemes whose social value were at least questionable. There were schemes where the surroundings were owned by one single farmer – such that the scheme was literally benefiting one single individual. In other cases the scheme was built near residential, rather than agricultural, land: one would have a hard time understanding how it could deliver improved agricultural conditions in such a location. "It will serve mainly for recreational purposes; you know, these are not small and marginal farmers, this is a rich-people residential neighborhood…!", informed the engineer accompanying us. This and other informal conversations on the field suggest that political influence in the determination of the scheme site is to be blamed, rather than lack of technical expertise[15].

II) Lack of local demand for the scheme. As in WBADMIP schemes, it was even more common to find non-WBADMIP schemes that were dysfunctional - either among the visited ones, listed in Appendix 2, or simply by looking for it at the road side. Conversations with nearby farmers suggested that the main reasons were other sources of irrigation in the same village and/or alternative incomes. More common, however, was to

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[14] "Non-WBADMIP" includes a vast number of different government programs. Just to mention two that exist in West Bengal and were visited to produce this report: RIDF (Rural Infrastructure Development Fund), CADA (Command Area Development Authority). In the field visits they did not seem to be substantially different concerning the results mentioned in this report – but more analysis is needed to understand that. In particular, it would be importante to understand i) why and when each project was created ii) which are the existing schemes under each of them and iii) what is the theory of change of each one.

[15] One case was especially telling. A happy landowner, the sole beneficiary of a Rs 10,000,000 new scheme, casually reported how he insisted on the scheme for years and "could only get it approved after reaching the responsible Minister", with whom he had a personal relationship. He reported tripling cultivated area and also tripling productivity per bigha after the scheme. If one is to believe in his numbers, even if he was paying for the scheme by himself, the investment payback would be in 3 months.

hear about water-deprived areas but nevertheless with dysfunctional or not fully used schemes – for reasons described in the next item.

III) Lack of agricultural and institutional support. When a scheme was installed in a truly water-deprived, agricultural area, it was expected to produce good results – and it sometimes did, but more than often it did not. In these cases, the conversations were less structured than in WBADMIP schemes, for lack of solid institutional support and existing relationship between WBADMIP staff and the farmers. These implied that the research team would just show up without notice and talk to any farmer that happened to be around. In these conversations farmers usually reported little change after the scheme was installed – in some cases they didn't even know the scheme's name or any relevant information. They constantly complained that they were not given any instructions on how to operate the scheme, what to do in case of maintenance problems, or how to properly use the new water supply to produce better agricultural results. A telling case was a scheme in which the State Government would not only provide the scheme but also a full-time operator that would operate the scheme, check any maintenance need and report problems to the government – that would also pay all electrical bills, making is completely free for all the benefited farmers. This scheme was considered a "model" scheme, a huge success by the government staff that suggested the visit – even as it was probably the less cost-effective schemes of all the functional schemes visited for this research. Clearly, the consequence of a purely engineering, irrigation infrastructure approach resulted in lack of ownership from farmers to the non-WBADMIP schemes. According to interviews and the PAD, this is the reason why WBADMIP was designed to include institutional and agricultural support since the beginning and to all WUAs: to avoid incurring in the same design mistakes observed n previous minor irrigation projects.

Categorizing observed schemes and assessing reasons for success

The above qualitative analysis is summarized in the table below. Importantly, the reader should remember that these are **preliminary findings** of a small and not-random sample of visited schemes, as require further development, especially using quantitative analysis (see next Section).

Scheme category	Institutional development	Scheme Ownership	Best agric. practices	Necessity of the scheme
High-graded WUA	High	High	High	High
Low-graded WUA	Medium	Low	Medium	Medium
Non-WBADMIP	Low	Low	Low	Medium/Low

Tolstoy opens Anna Karenina with the sentence "happy families are all alike; every unhappy family is unhappy in its own way". This suggests that a "happy family" needs to have a set of characteristics that lead to happiness; failing to achieve even a single one of those leads to misery. One could remember this principle to ask: what are the pre-requisites that make a WUA to be highly successful? Requisites that, if even one is missing, the likelihood of resulting in a bad outcome becomes very high?

Building on the above qualitative assessment, and again noting how important it is to confirm these findings with more research and more data, the following components seem key for a WUA to perform as expected or better:

I) Appropriate site selection (locally demanded scheme). Field investigation suggests that the scheme site is crucial. If a scheme is built in an area that is already reasonably supplied with irrigation or, worse, that benefits only a very small number of already-wealthy farmers, nothing will make it a well-performing WUA. The reason is simple: the WUA is only required if i) agriculture is the main source of local income, ii) water scarcity is a serious local problem and iii) there is a lack of spontaneous coordination among the nearby farmers (usually implying several small and marginal farmers instead of a few larger landowners). If the site does not meet all of these three criteria, the likelihood that a well-performing WUA will emerge is small.

II) Close and high-quality support from DPMU at the very beginning. An important insight from the field visits is that, at least from the qualitative evidence, it is rare to observe WUAs that are initially performing really well but then revert, and vice-versa. In other words, the first months after handing over a scheme appear to be a good predictor of whether that WUA will perform as expected or not – even as this needs to be confirmed by quantitative analysis. For that reason, the relationship between the WUA, WUA

members and the community workers and DPMU team before handing over the scheme and in the months right after it seem to be key for the long-run success of the WUA. The reverse of fortune is rare here, so one needs to start well to keep well.

III) Strong, consensual local leadership. One aspect that all well-performing WUAs had in common was an apparently strong, consensual leadership. There seemed to be little debate over whether the existing Executive Committee was doing their job properly or acting in the best interest of the community and other WUA members. Of course, this is an observation of relatively little help: one does not want to provide irrigation and better living standards only under these circumstances, so that the key question really is how to enable a large-scale success is how to make this social and political environment emerge even when it is initially absent. This report will not attempt to answer this challenging question. It should however be noticed that, if for any reason the project does not believe it can successfully build such a cohesive community, places where this is already the case should be preferred over places with high levels of social and political conflict, since the latter threatens the success of the project.

5) Suggestions on how to conduct the quantitative analysis

Why is hard data required to complement the qualitative analysis above?

The qualitative, field-based analysis summarized above suggests that WBADMIP presents some hypothesis about the project:

- WBADMIP and non-WBADMIP schemes deliver, on average, quite different results concerning increase in cultivated area and farmers income
- WBADMIP does have a positive impact, on average, on agricultural income
- But even for WBADMIP schemes there is a high level of heterogeneity across WUAs
- And districts are also delivering with different levels of performance, as suggested by the WUA grading system and time to hand over the schemes
- ADMI seems to be improving over time, as most of the flaws in site selection were observed in batch I schemes

However, more analysis in needed to further understand these questions and to generalize these results beyond the visited schemes.

Some important, yet-to-be answered questions are: is it really the case that WBADMIP performs better than previous or other projects in the region? Even if so, are they cost-effective, considering the size of the investment?

Moreover, if better performance is observed in a simple comparison between WBADMIP and non-WBADMIP schemes, one still needs to understand the causal mechanism. The difference might be a consequence of a better program design, but it need not be. One possible source of confounding effect is **selection bias**: the selection of which areas will receive a WBADMIP scheme is not random. On the contrary, it's a consequence of a mass petition from the farmers; that is how the process to construct a given scheme, and all the institutional and technical support, starts. Could a self-selection mechanism be operating, such that the more productive, risk-taking and entrepreneurial farmers are also the ones that receive the WBADMIP support – and they would perform better in their farmland when compared to their peers anyway?

Even if the causal mechanisms are well-understood and the project's impact is detected and positive, it should be noted that WBADMIP also selects the areas that will receive a scheme after the mass petition; some are geographically not suitable for the project's intervention. This selection might affect the **external validity** of the results – just to mention a few challenges that can arise during a rigorous impact evaluation and while (if) scaling WBADMIP up.

How to proceed with an impact evaluation in a fast, cost-effective way

For the reasons stated above, a deeper analysis is needed to test the research hypothesis, which should include a full impact evaluation. That should not be undertaken with solely academic purposes in mind but, rather, should provide useful and readily available information for decision-makers in the West Bengal government to constantly improve the irrigation efforts in the state, following an experimental, adaptive project design approach. This section suggests how to approach this task, using existing staff and data, for one of the most important indicators that WBADMIP is trying to affect: the **total cultivated area during the dry season** –a proxy of agricultural income of the targeted population.

First, it should be noted that the total cultivated area has the sizeable advantage of being detectable using **satellite images**. Concerning the observed limitations of data collection on the ground – different districts and blocks don't always follow the same data collection methodology or frequency; there is no strong incentive to collect high-quality production data; and data recording is many times done manually -, to rely on standardized, frequent, state-wise and independently provided satellite data is strongly preferable.

To investigate the cultivated area, freely-available satellite image providers, such as Landsat and Sentinel, have images for all India at 30x30 meters resolution (see Recommendations section for paid, higher resolution images considerations), in high frequency (bimonthly) at least since 2014. This kind of data, already partly produced by the GIS existing team, can be used to produce a **panel data for all the WBADMIP schemes and even for non-WBADMIP and privately-provided irrigation structures** (see Appendix 5 for the detailed data structure, with fictional examples, as well as existing analysis for one selected scheme).

In the absence of an experimental setting (or Randomized Control Trial) that could accurately identify the causal effect of the project by comparing the treated areas with a control group, a long, high-frequency panel data for all the schemes delivered yet is as good as it gets. One could easily use econometrics techniques, controlling for season, district, scheme type and other variables – with over 1,100 handed over schemes and data at least every month since 2014, there is sufficient data to proceed with several sub-population analysis. Most if not all of the hypothesis listed above could be investigated with satisfactory results using a panel data of this kind.

Some **challenges** remain, however. First, the command area of each scheme has to be manually drawn on GIS software before the analysis of the cultivated area can be undertaken, which is dependent on inputs from the field, susceptible to human error and highly time-consuming, with low scalability. Secondly, the data production doesn't seem to be high in the priorities of the department: even as the exact same data structure as in Appendix 5 was requested on June12th and the team itself agreed to provide it in week, until the end of July the data for 90% of the schemes was missing – which is the reason why the impact assessment analysis is not included as part of this report. The reason behind that can be easily understood: there is a pressure for delivering schemes more than for assessing the quality of the already handed-over schemes. While this is understandable in a time-defined project with expenditure way below projections even after a deadline

extension, it also implies that important quality considerations might be sacrificed over quantity. For that scenario to change, the incentives to the team will need to be shifted, requiring different requests from the project's managers. Finally, for non-WBADMIP schemes – both public and private – there is an even higher data collection challenge. Although evidence suggests that most of the required data exists – namely latitude, longitude and construction year of each scheme, which seems to be the data used to build the 5th Micro Irrigation Census[16] -, it needs to be collected separately and merged with WBADMIP data. For these schemes, the challenge of digitally drawing the command area of each scheme is harder and would probably require a standardized methodology that minimizes the differences with the results obtained for the WBADMIP schemes.

Since the econometric techniques of the recommended impact assessments are not available internally in the existing WBADMIP scheme, and since some degree of autonomy and independence is recommended, **it is advisable that WBADMIP partners with a renowned institution to conduct this analysis**. At the moment of writing, the conditions of a partnership with Precision Agriculture for Development (PAD) were under discussion, including an impact assessment component.

6) Recommendations

Based on the analysis above, this Section provides 5 recommendations concerning the WBADMIP, to be implemented rapidly enough as to produce results before December 2019: one key administrative improvement, two pilot initiatives, and two enhancements on existing components. Each is listed and explained below.

A) The WBADMIP legacy: more data collection, analysis and documentation

Considering that this project is a minor irrigation initiative, the standard *modus operandi* is to replicate hundreds of times the same implementation strategy and efforts. This provides an excellent opportunity to learn with initial mistakes, gradually improve the project and

[16] The report of this census can be downloaded in the link in the References Section, but scheme-level microdata needs to be required directly with the department and until this report was written this data has not been provided.

build state capability. Considering the diversity of minor irrigation projects currently existent in West Bengal and in all India, learnings of this nature provide an irreplaceable opportunity to improve the quality of expenditure and the outcomes of a huge share of public sector investments in rural development. In such a scenario, the quantity of systematic data collected and, especially, the effort dedicated to data analysis and impact evaluation is surprisingly low.

The WBADMIP is exceptional when compared to other, similar projects in the same state thanks to its institutional framework and funding mechanism: the World Bank guidelines provide a flexibility that allow for greater levels of fast experimentation (some are suggested below). This provides the ideal circumstance to try different approaches, check how well they are performing, experiment again, document effective and proven practices, and provide a benchmark for other irrigation projects in West Bengal and in the rest of the country. One could even say that this would be the most impactful and meaningful legacy of WBADMIP: given its reasonably small scale (for Indian standards) of around 100,000 beneficiaries in a 90-million-people agricultural state, it can only scale its impact by carefully documenting how to master minor irrigation technology and promote its learnings to other departments and states.

However, this is not what seems to be happening. During this research period no team or person in WBADMIP was identified as responsible for analyzing the data in a systematic way, comparing different districts, scheme types, agroclimatic zones, implementation partners or any other dimension that could provide insight on how the project's efforts should be concentrated. This research effort was also praised for being the first attempt to compare WBADMIP to other, nearly identical irrigation projects happening in the same state, by the same level of government. Clearly there is a lack of understanding and record of what is working and what is not.

To address this issue, two sub-recommendations are made.

A.1) Immediate impact evaluation with satellite images. This was supposed to be part of this report but, due to a sequence of delays in the data delivery, could not be included. This is the fastest and easiest way to get data at the scheme-level and get a better understanding about the circumstances under which WBADMIP is delivering its best results. Section 5 provided details on how to proceed.

A.2) Improved data collection on the ground using technology. To complement satellite data, that is limited in the outcomes that can be obtained (at present, only total cultivated area in the command area), better, faster and more reliable field data collection needs to be adopted. Here, one could tentatively suggest mobile solutions; more research, including market research, needs to be done to assess what is the best solution. At present, any on-the-ground information requires each DPMU to request its local implementation partner to collect the data manually, in each WUA – which is time consuming, expensive, slow and unreliable. The ideal solution would address these problems.

B) Pilot 1: WBADMIP's institutional and agricultural supports in existing non-WBADMIP schemes

WBADMIP's exceptional flexibility to procure goods and services and try new approaches can be further leveraged with innovative pilot programs. First, and following the qualitative analysis done above - Section 4, to be complemented with the quantitative findings that would follow from implementing Section 5 -, it seems like the effect of the institutional and agricultural support (components A and C, respectively) of WBADMIP are a key reason behind its apparent better performance when compared to schemes that lack these two components. To better understand this hypothesis and, especially, to get more information on how this finding can be scaled-up (if confirmed by data), it would be ideal to use the existing WBADMIP's staff, especially at the district-level, to provide institutional and agricultural support to existing non-WBADMIP schemes, that present no serious technical issue but still are not delivering the expected results[17]. It could be done in a small

[17] One possible starting point, visited by this research team in June 15th, would be Amlakuri Check Dam scheme, in Birbhum District, constructed by Command Area Development Authority (CADA). The scheme was physically in very good condition, but the farmers were not leveraging the water supply as much as they could. This became evident as we discussed the water practices and irrigation strategies currently adopted, and DPMU staff highlighted that there was room for improvement when compared to nearby schemes, in the same region, if only they received some agricultural training. Given this diagnosis, the farmers themselves showed great interest in learning more about the agricultural training and in visiting a nearby WUA.

scale, with minimum need to expand the existing staff, and in different districts as to increase the external validity of the pilot.

C) Pilot 2: More autonomy for WUAs to improve agricultural production

There is a widespread impression that the cost of the average scheme when procured and provided by the government is substantially more expensive than a comparable private scheme. Beyond structural reasons (e.g. higher perceived risk of delayed payment, legal disputes or anything that be behind this gap, including less technical explanations), one suggested explanation is that the publicly-provided schemes often are bigger (and therefore more expensive) that would be needed.

Additionally, one useful test to assess the efficacy and usefulness of any public policy is to compare the beneficiaries' satisfaction with the delivered goods or services with their expected satisfaction if they were to receive the cost of this good or service in cash, no strings attached, to spend as they wished. This hypothetical test, when mentioned to the WBADMIP staff, resulted in laughs: no one seriously considered that this was a fair comparison. The overall impression is that farmers would strongly prefer to be given the money in cash. This indicates that i) the project's cost-benefit might not be optimal from the farmers point of view, which is a serious concern, and ii) they would probably allocate the money differently if given the chance.

There was also a high level of skepticism and mistrust concerning cash-transfer programs when these conversations happened. Also, the WBADMIP is an irrigation and agricultural development program, not a cash-transfer one.

To stick to the existing goals of this project and take advantage of the available staff and institutional infrastructure, it is recommended that some of the new WUAs are given the opportunity to allocate resources, within certain boundaries, to improve their agricultural outcomes, instead of passively receiving a publicly-provide scheme. The following steps are suggested, as a tentative list to be further discussed with the WBADMIP staff:

1) Among identified scheme sites where no procurement process has yet taken place, randomly select around 50 WUAs to receive this flexible version of WBADMIP

2) Engage in a customized institutional support with these 50 WUAs, explaining the expected benefits or irrigation, the alternative technical solutions, and any other requested information to take an informed investment decision
3) Let the farmers come up with ideas and perceived best options, and finally agree on the scheme's type, number of pumps, dimensions and other basic technical specifications that seem appropriate (simpler than a full procurement guideline). Other uses of the money besides irrigation but still related to agriculture practice could be considered (e.g. automated solutions for agriculture, like tractors).
4) Estimate the cost and transfer the money to the WUA account and recommend its use following the agreement on item 3
5) Provide technical advice and other needed support while the WUA members buy the pump(s) and installation services on the market
6) Engage with the usual institutional and agricultural support once installation is done; do not provide free maintenance services or similar support concerning the physical structure itself

If the WUA decides to use the money to something else even after the agreement on step 3, they should be disengaged from WBADMIP.

This pilot is designed to provide the farmers with a greater autonomy on the money allocation, as to take its use closer to what would be the ideal allocation from their point of view – therefore implying a higher level of ownership with the irrigation structure. All the international evidence on cash transfer programs is unanimous: the usual, feared unintended consequences, including misspending the money in temptation goods, do not happen (Evans et. al, 2014). This should be enough reason to justify experimenting with a design that gives the farmer the larger share of decision making.

D) Enhancing Component C: creating and improving market linkages

The third recommendation is to include, in the existing efforts of agricultural support (Component C), guidance and advice to farmers on how to get the best possible price for their products. In particular, as mentioned above, there seems to be i) some information asymmetry about market prices, ii) excessive bargaining power in the middleman, and iii) missing link between potential buyers and sellers, as highlighted in the discussion of

Diagram 1. For all the three issues there is a case for government intervention to raise the agricultural income of the beneficiaries with the existent goods.

The specific needs and possibilities concerning market linkages vary between districts and WUA; an effort to understand the circumstances of each locality – that would benefit from the data collection strategies of Recommendation A – should be undertaken to understand how WBADMIP can better address this concern.

E) Enhancing Component A: Experiment with ways to spread good practices between WUAs (how to reverse the fortune)

Finally, and as detailed in Section 4, the large heterogeneity on WUA performance can be leveraged. The institutional support (Component A) does not seem to be spreading the best practices observed in the well-performing WUAs, especially across districts – where the information flow is less frequent. Visits of members of underperforming WUAs to best-performing ones is the most straight-forward suggestion, to be complemented with other efforts. Further studies on the reasons behind the heterogeneity are recommended, possibly by partnering with experienced on-the-ground organizations, followed by attempts to spread them in a more systematic way to all WUAs.

7) Further research

This report aimed at summarizing the research hypothesis and findings of the period between May 20th and July 27th. Naturally, the field visits and interviews revealed way more possibilities, questions and interesting, puzzling situations than it was possible to summarize here or even to investigate further.

To provide information and suggestion for further studies and efforts by the State Government of West Bengal and public or private organizations partnering with WBADMIP in the future, the following list tries to mention the topics that seem especially promising and crucial to get a better understanding of the WBADMIP and how to improve its design and implementation.

- **Effect of ADMI schemes on private pumps market**. One can notice that in many cases the construction of a public scheme crowds out the private investment

in pumps. This can be desirable or not, depending on distributional and efficiency considerations: the private pump owners likely lose, since they cannot rent their pumps to pumpless farmers anymore[18]; the pumpless farmers probably are better-off, since on average the water charges of public pumps seem to be lower than private pumps. However, microeconomic theory suggests that some efficiency might be compromised, if the private farmers are better informed as to install the pumps if the areas in which the return will be the highest, and/or if the private cost is lower than the public cost for the same pump (as mentioned above). More research is needed to clarify this point, understand the market dynamics and the efficiency and distributional impacts.

- **Program's resource allocation: how would farmers spend money if the scheme cost was handed to them?** As mentioned above, there seems to be an intuitive collective consensus that the farmers would not use the money, if given the opportunity, to build an irrigation scheme – or at least not one identical to the project one. Why is that? How would the farmers decide to spend such money? What does that suggest about the cost-benefit analysis of the project – if every rupee invested is delivering maximum welfare increase? Evidence of cash-transfer programs can be helpful here. It is likely that the important question of whether one should focus on agricultural productivity and production versus farmer's general income and wellbeing will be key here.
- **Credit market constraints: what are they, what is the implication and how to solve it?** There seem to be a high level of inefficiency and misallocation in the credit market, as apparent by the fact that the large majority of private schemes are

[18] • Do private pumps usually display characteristics of a monopoly, as to justify government intervention even where previous irrigation exists? This is an interesting possible research. Intuitively, it seems like it has some characteristics of natural monopoly, since it makes little sense to have two pumps accessing the same water source in the same exact place. However, apart for credit constraints, there are no significant barriers to entry in this market – any farmer can install a private pump, if money is available -, so it does not seem to be a monopoly in most cases. In addition, even if (or when) it was, it would be debatable that providing a cheaper, public irrigation structure would be the first best approach: following the "one goal one instrument" principle, one should address the reason behind the monopoly (e.g. credit constraint, or political intimidation) rather than try to use public resources to provide the same service for a lower price.

financed with personal savings, among others. How serious and big is the problem? What is the best way to address it, and what would be the consequences?

- **Digging deeper into permanently dysfunctional (defunct) schemes.** No systematic study exists concerning the so-called defunct schemes. They are even excluded from some of the databases and lists of existing schemes. These schemes represent the extreme case of wasted public resource, as they deliver zero return for a sizable financial investment and administrative effort. For each defunct scheme, rather than switching off the lights, extra attention should be given: what happened there? Was there a real demand for the scheme? Technical problems? What can be learned as to avoid ultimately dysfunctional schemes in the future?
- **Effect of different DPMUs and SOs in implementation quality**. There is a intuitive understanding that the technical quality and delivery capabilities vary between districts. To understand the causes behind this heterogeneity is key to improve the capability of the underperforming districts. In addition, the Support Organizations are a key stakeholder in the project, and one SO is responsible, usually, for multiple districts. Does the specific SO matters for the project's outcome? If so, by how much? There are questions rarely mentioned but are key to improve the implementation outcomes of the project.
- **Effect of project in variables beyond cultivated area and income**:
    - **School attendance**. Qualitative evidence from the field suggests increase in school attendance thanks to better socioeconomical conditions. Is this really happening? If so, how is this affecting public and private schools? What this implies for the long-term demographic and socioeconomic dynamics of the village?
    - **Price of land**. The field visits sometimes indicated up to 10x increase in land prices after the scheme is installed. If increases of this magnitude are happening on a frequent basis, the implications for the farmers wealth are not negligible. A better understanding of this dynamics and its long-term effects is key to get a complete picture on the project's impact.
    - **Housing infrastructure**. Field visits also indicated substantial improvements in the housing facilities of well-performing WUAs. It remains to be systematically registered how relevant is this improvement and if it is truly caused by the project instead of other, competing explanations like better road access, electricity, etc.

- **Others?**

- **WUA turning into important political body for other matters?** The most successful WUAs appear to be extending their activities to topics beyond agriculture practice and water management. In some cases, they are already acting as local, slightly informal financing institutions. What is expected to happen concerning the local politics environment once WUAs become more solid and long-lasting? How is and will be the relationship with the Gran Panchayat? What are the expected consequences for the WUA members?
- **How to make Component B's procurement and contracts better?** The scheme procurement guidelines and the signed contracts do include warranty clauses, security deposits and other legal mechanism considered to be best practices in government procurements. However, in practice there is a overall feeling that these mechanisms do not work, and contractors hold a disproportionate bargaining power with the government. Defective schemes, even when the cause should be under the responsibility of the private company, as frequently just fixed in some other way. This requires further investigation to understand what exactly is preventing the contract from materializing in practive.
- **The (missing) crop insurance market**. Even as floods are frequent and other natural events can damage the crops, there seems to be no developed crop insurance market. It could greatly improve farmer's wellbeing and production level by incentivizing practices compatible with a more risk-taking behavior (by eliminating or reducing the risk). This potential indicates room for further understanding and perhaps pilots with crop insurances provided by ADMI – the on-the-ground information should be leveraged to reduce the usual problems of information asymmetry.

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RAW DATA AND EDITABLE FORMAT FOR ALL APPENDIX FILES

The data that originated all the Appendix Section can be checked, audited, edited and copied by accessing the link https://tinyurl.com/reportwbadmip2018.

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APPENDIX 1 – DISTRICTS VISITED

Date	Location	Objective of the visit and focus of observations
May 29th	North 24 Parganas	First visit to schemes
June 7th	South 24 Parganas	ADMIP vs. RIDF surface water schemes
June 10th-11th	Kalimpong	Accompany PD in new scheme sites + meetings
June 12th	Bankura	Differences between ADMIP vs. non-ADMIP schemes and well/under-performing WUAs
June 13th-14th	Birbhum	
June 29th	Hooghly	Accompany Precision Agriculture for Development
July 2nd	New Delhi	Interview with World Bank project's Team Leader: expectations and Bank's understanding of status
July 4th-5th	Coochbehar	ADMIP vs. non-ADMIP schemes (North Bengal)
July 6th-7th	Jaipaiguri	

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APPENDIX 2 – WBADMIP SCHEMES VISITED PER DISTRICT

Scheme Name	Scheme Type	Construction/ HO Date	Investment Cost	Previous irrigation?	WUA Grade	Field qualitative assessment	Obs
Uludanga-II	LDTW	2014	4,450,102	There were private tube wells	B	After the scheme, agriculture production increased, and farmers income also increased	-
Paruldaha WDS	WDS	26.03.2015	9,794,324	No irrigation in Rabi and Pre-kharif season	A	After the scheme, farmers are doing cultivation in more than designed command area in Rabi season	In pre-kharif season cultivated area is less than 1/3rd of CCA, because farmers are cultivating Boro paddy in Rabi season. Therefore, they don't have enough time for pre-kharif cultivation (Boro paddy takes 4.5 months)
Jhunjka Baro Bundh SFMIS WUA	SFMIS	10.01.2017	19,754,264	There was a small pond before the scheme, but farmers were not using it for agricultural purposes.	A	Now farmers are using water from SFMIS. Farmers are managing a register of cost of cultivation, income from agriculture and income from fishery.	This SFMIS is a renovated scheme - after Batch I, the Project focused only on new schemes, following Word Bank guidelines

Scheme Name	Scheme Type	Construction/ HO Date	Investment Cost	Previous irrigation?	WUA Grade	Field qualitative assessment	Obs
Ranigram check dam	Check dam	2016	8,192,855	No irrigation in Rabi and Pre-kharif season	A	Before the scheme, there was not enough water in Rabi and Pre-kharif Season but now they are cultivating in all 3 seasons	Qualitative evidence of increased income: before scheme farmers didn't have enough money for their own expenditure. Now they are doing charity work (donating money for temple and mosque).
Amkhoy (MD)TW WUA	MDTW	12.05.2015	3,251,464	N/A	A	After the scheme, there is more than enough water in every season. Farmers are growing different types of vegetables.	Farmers who are outside the command area are learning from the WUA members about the agriculture. Two farmers installed their own, private pumps after the scheme implementation
Chandrapur Check Dam WUA	Check Dam	18.03.2016	8,093,883	No irrigation in Rabi and Pre-kharif season	D	Even after the scheme implementation farmers cultivating only in Kharif season	Check Dam Gate/water barriers were open on our visit, so dam was empty, resulting in WUA with close to no activity at all.
Kanmara solar PDW	PDW	13.10.2014	5,505,690	N/A	C	Scheme implication resulted in increasing income from agricultural	Centrifugal pump used in PWD needs to be replaced with submersible pump as water level declined in area. There were some unused solar panel with no connection to main wiring, (DPMU members unaware).

Scheme Name	Scheme Type	Construction/ HO Date	Investment Cost	Previous irrigation?	WUA Grade	Field qualitative assessment	Obs
Ichhapur MDTW WUA	MDTW	7/6/1905	2,430,668	No irrigation in Rabi and Pre-kharif season	A	Now 267% cropping intensity, different types of new crop introduced and production per bigha per season increased	In this WUA farmers are growing vegetables in 67% of command area in kharif season. Before the scheme there was not enough water for irrigation in Rabi and Pre-kharif season but now thay have enough water even they are selling water to the nearby farmers
Bhandijelash STW WUA	STW	03.01.2014	3,084,768	Some of the farmers were using diesel pump previously	D	Scheme implementation had no effect on farmers livelihood	Pump failed after two months and there was no replacement made after reporting. It seems like water is not the constraint (some of the farmers have diesel pump and other farmers are paying rent to use those). They are missing agricultural support.
Chamta STW WUA	STW	2014	2,302,392	Some of the farmers were using diesel pump previously	A	After the scheme, farmers are doing cultivation in more than designed command area and their agricultural income increased. New machinery was bought by them	Here were the best scheme outcomes out of all visited places. WUA members installed nine more pumps with their own money beside scheme criterion and that resulted in increased command area

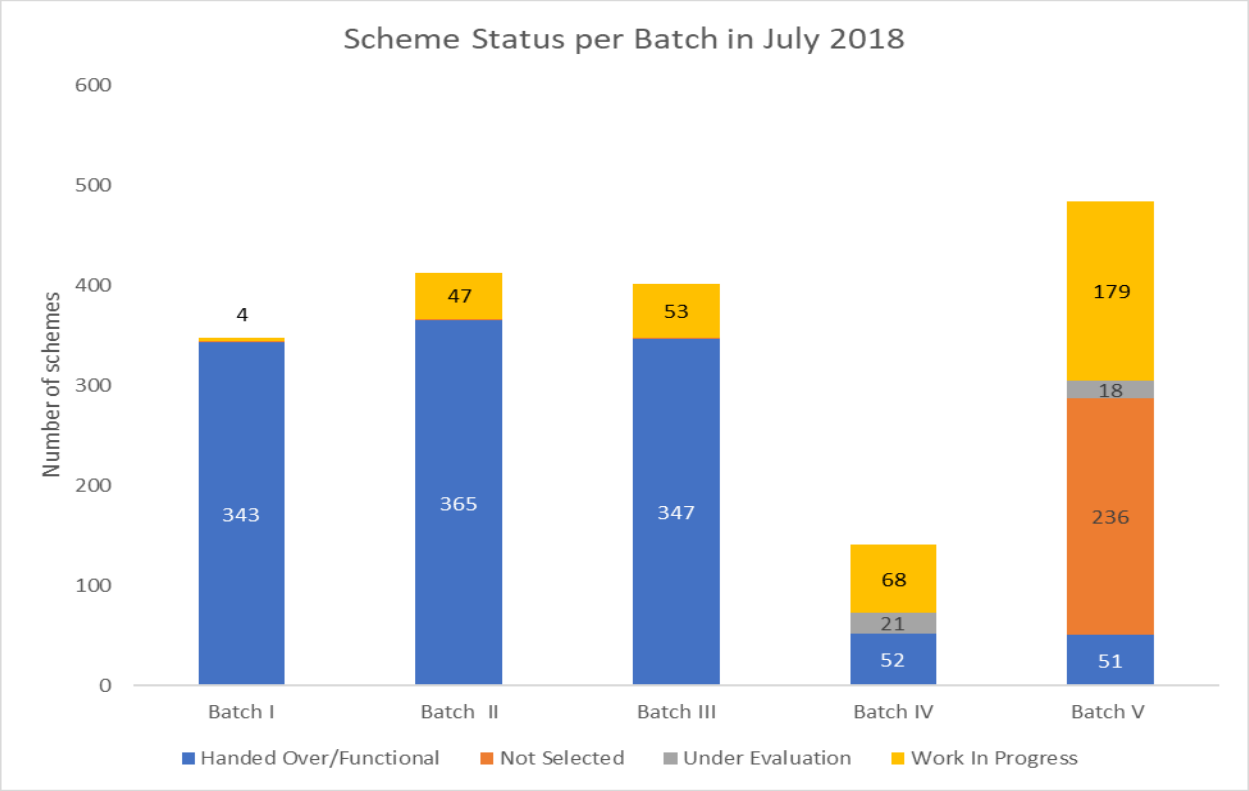
Scheme Name	Scheme Type	Construction/ HO Date	Investment Cost	Previous irrigation?	WUA Grade	Field qualitative assessment	Obs
Kataamer Gor WUA	STW (cluster)	Nov.2017	N/A	Farmers are using some diesel pumps to irrigate in Rabi and Pre-kharif season(some of them are providede by govt. and some of are private)	N/A (new)	New scheme, too early to report effects on the ground	All governing body of WUA are women
Patakamari RLI WUA	RLI	2014	1,849,153	farmers were using their private pump to lift the water from the river	A	Different types of crop introduced, per capita income increased.	Pump failed after one year and scheme was not functional for 2 year; after that farmers managed to save some money and replace the pump. Floods are common in the area and no crop insurance exists.
School Para	RLI	2014	N/A	farmers were using their private pump to lift the water from the river	D	Scheme worked only for one year	Scheme worked for only one year: river shifted away from pump and landless farmers occupied sides of the river during dry season, using the water - so even less water reached the pump. However, farmers have their individual private diesel pump, so they are nevertheless able to cultivate in Rabi season.

Scheme Name	Scheme Type	Construction/ HO Date	Investment Cost	Previous irrigation?	WUA Grade	Field qualitative assessment	Obs
Thanspur Uttarpada WUA	MDTW	2015	2,545,724	N/A	A	Cropping intensity increased	They have a not-well-maintained greenhouse (provided by ADMI project). Being grade A implies that farmers are getting lot of support from project (2 paddy harvesters, 1 seed cum fertilizer and 1 paddy trans planter).
Dakshin Sakoajhora	Mini RLI(E)	2014	1,957,064	100 to 150 bigha were irrigated by using private diesel pumps, 5 HP, costing INR 200/hour to rent. Everyone was farming since it's close to a river.	D	Scheme was disfunction due to political problems (WUA leaders had party-related disagreements between each other), and remained so for several years	Farmers are doing cultivation in Rabi and Pre-kharif season but they are not taking water from the scheme (dysfunctional until recently)
Salbari III Solar WUA - Gobrabasty Upardhura Kisan Unnya	Solar PDW	2015	2,266,893	There is canal near by the Scheme so farmers were used to take water from the canal	B	Cultivated area and production per Bigha increased	In cloudy atmosphere solar panel doesn't work properly, so farmers are demanding electrical scheme.: 5 years ago only 10% of kids from WUA members went to private schools, now it is 50%.

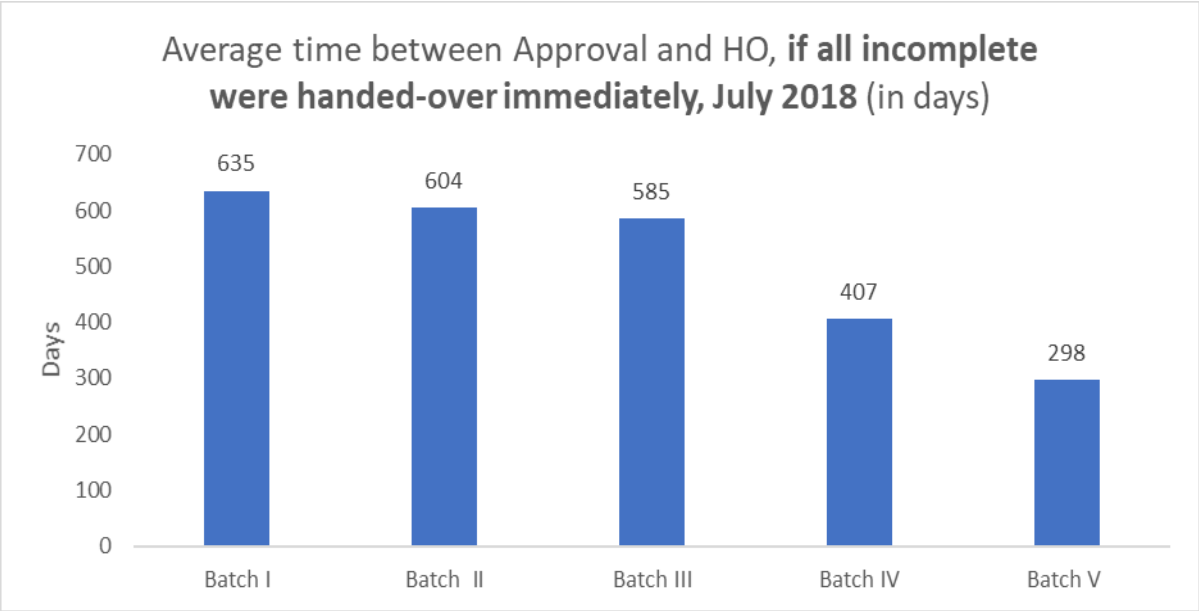
Scheme Name	Scheme Type	Construction/ HO Date	Investment Cost	Previous irrigation?	WUA Grade	Field qualitative assessment	Obs
Uttardanga Mini RLI	Mini RLI(E)	Feb-14	1,879,068	Some of the farmers were using diesel pump previously	A	Crop diversity increased, triple cropping is now reality	No benefits before, no government person would even come but now their income increased, no vacant land, increased production even in Kharif (from 2 to 6 quintile per bigha), more kids at school, improved housing. No one thinks anymore about converting their lands to tea garden. Now almost no one leaves the area to find work elsewhere. Problem**:** There was hale rain in last winter and it damaged 20.5 bigha of maize crop. No crop insurance there.

APPENDIX 3 – SUMMARY STATISTICS OF TIME TO COMPLETE SCHEMES

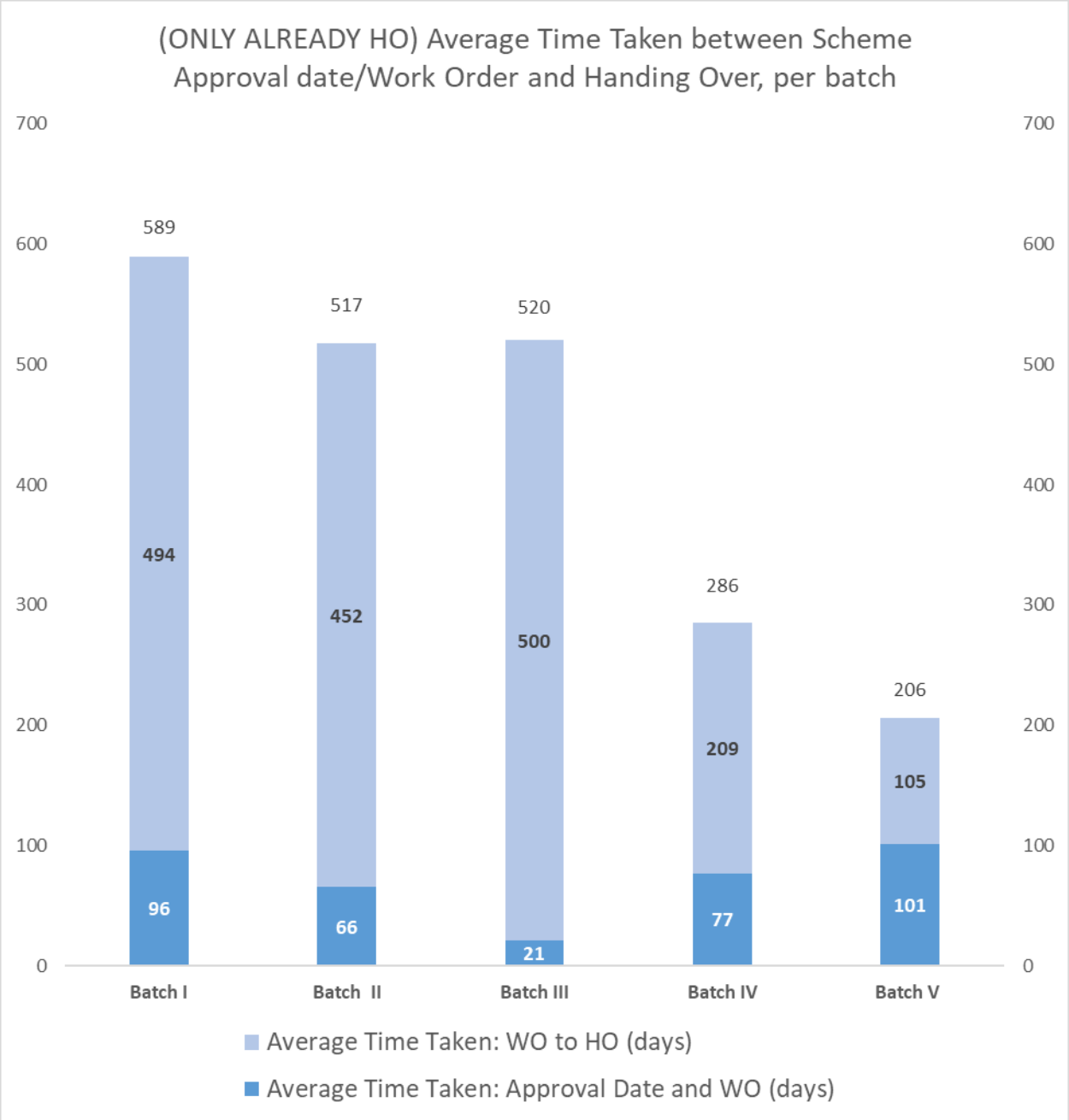
Questions of Graph 1.1: What is the status of each schemes, per batch?



Question of Graph 1.2: Has the time taken between approving the scheme and handing over changed between batches?

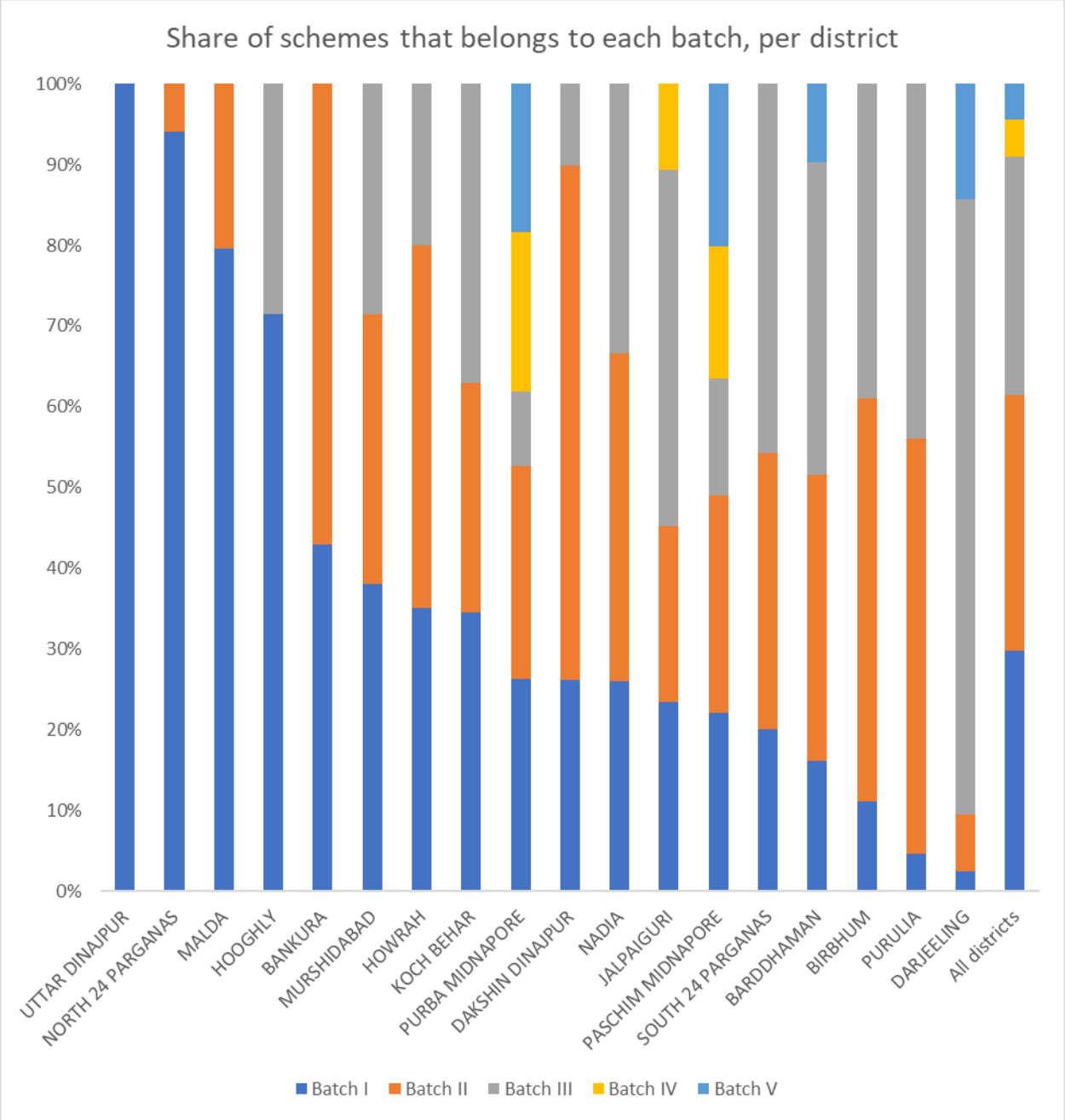


Question of Graph 2: How the total time between approving a scheme and handing it over is divided between approval time and construction time, per batch?



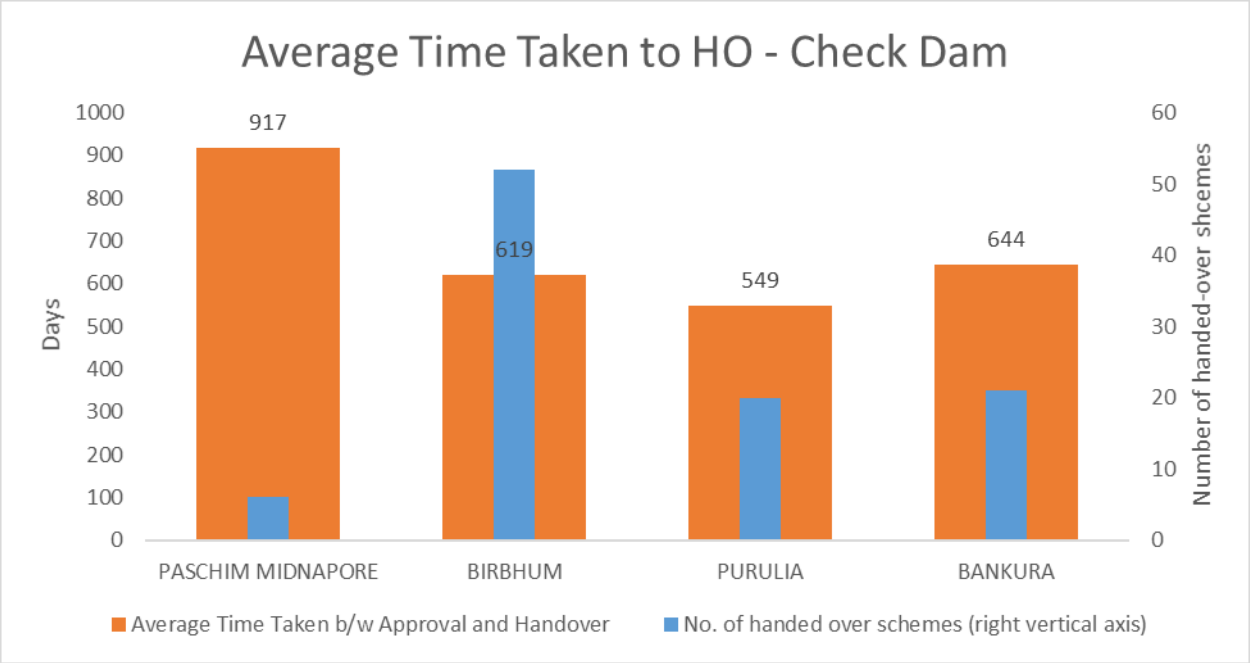
Obs.: the total days taken between approval date and handing-over date differ between Graphs 1.2 and 2 (e.g. 298 vs. 206 for Batch V), because graph 1.2 is assuming the (hypothetical) scenario under which all ongoing schemes are handed-over immediately. Graph 2 is computing the average only for the schemes that were already handed over as of July 2018.

Question of Graph 3: For each district, what share of schemes was built under each batch?

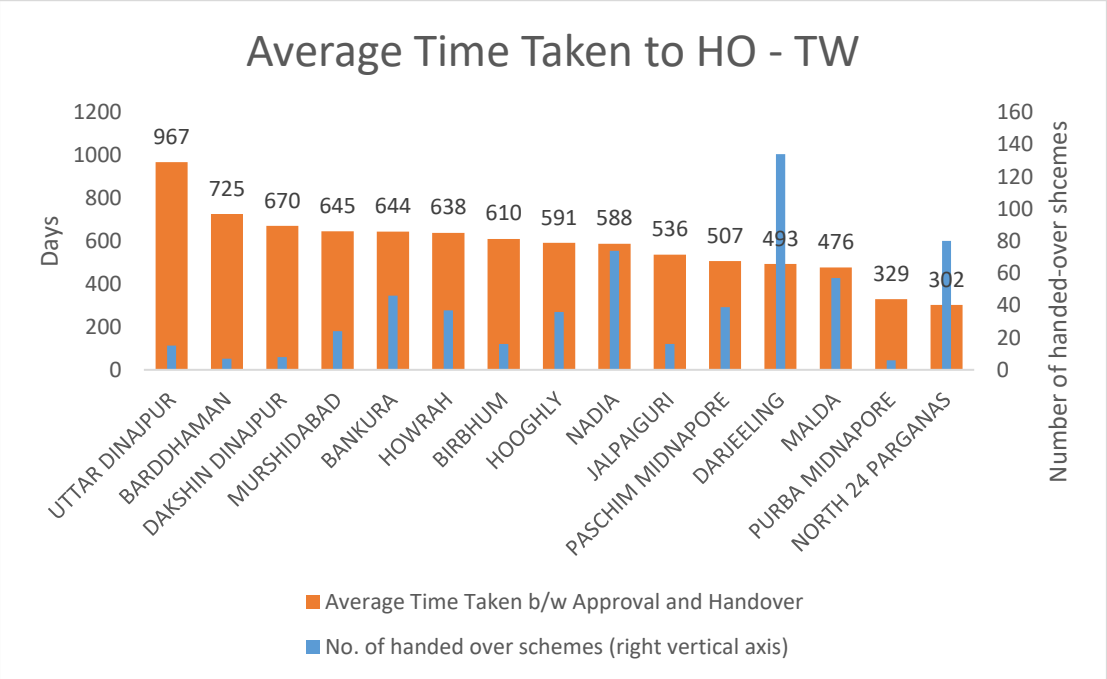


Question of Graphs 4 to 9: Different scheme types take different times to be constructed. But for a given scheme type, does the time between approving the scheme and having it handed over varies between districts?

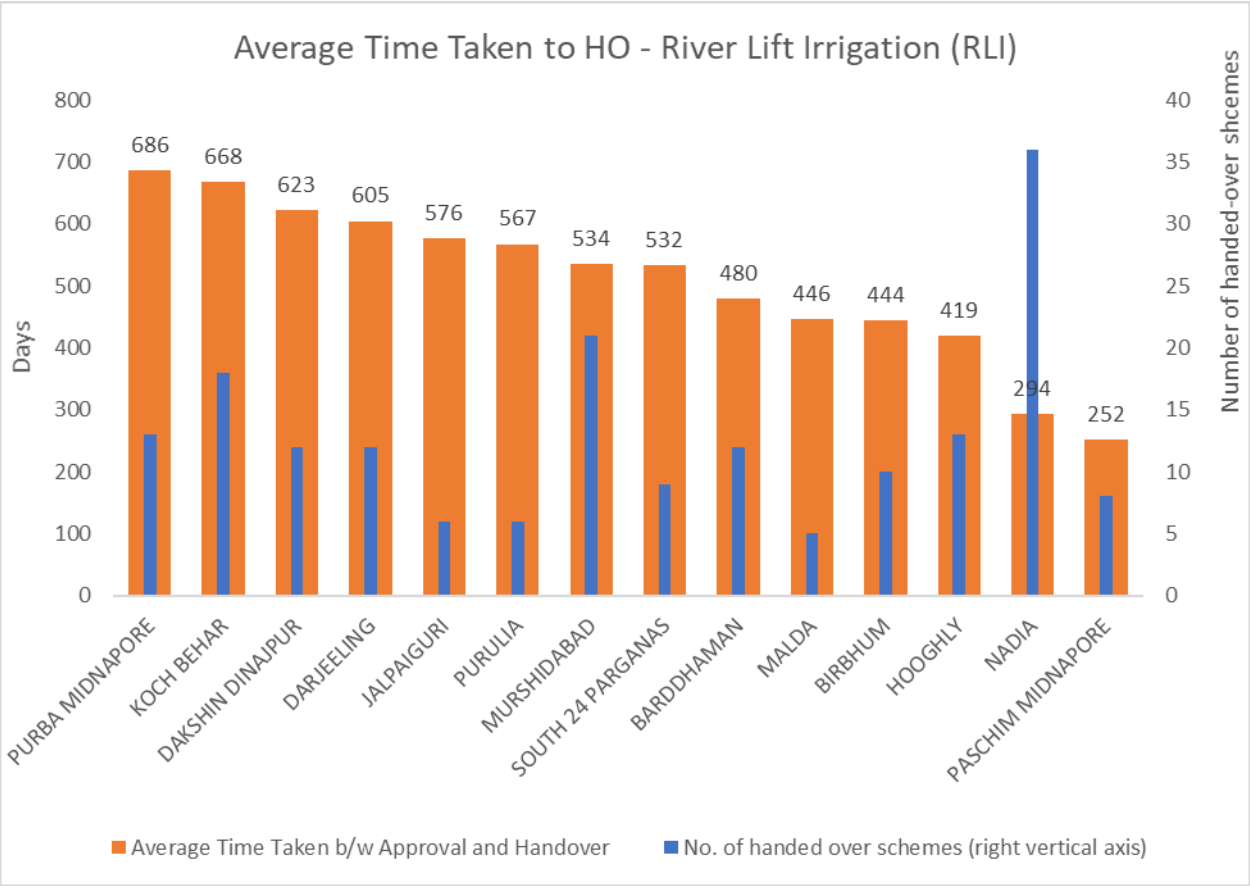
Graph 4 – Check Dams: for districts that have check dams, how many do they have and what's the average time between approving the scheme and having it handed over?



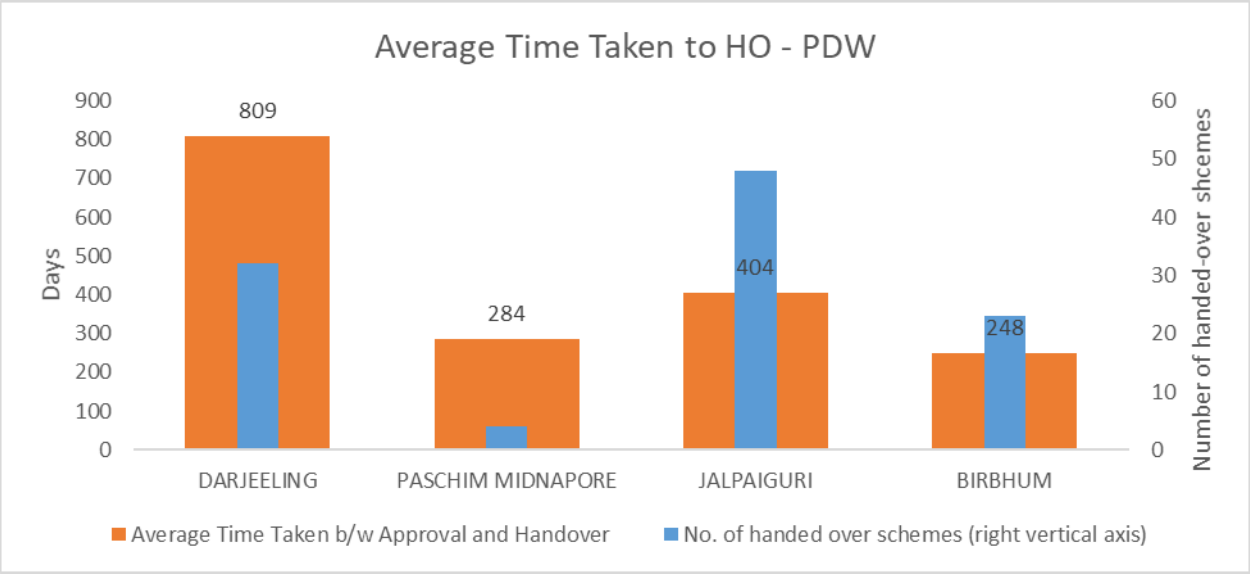
Graph 5 – TW: for districts that have TW, how many do they have and what's the average time between approving the scheme and having it handed over?



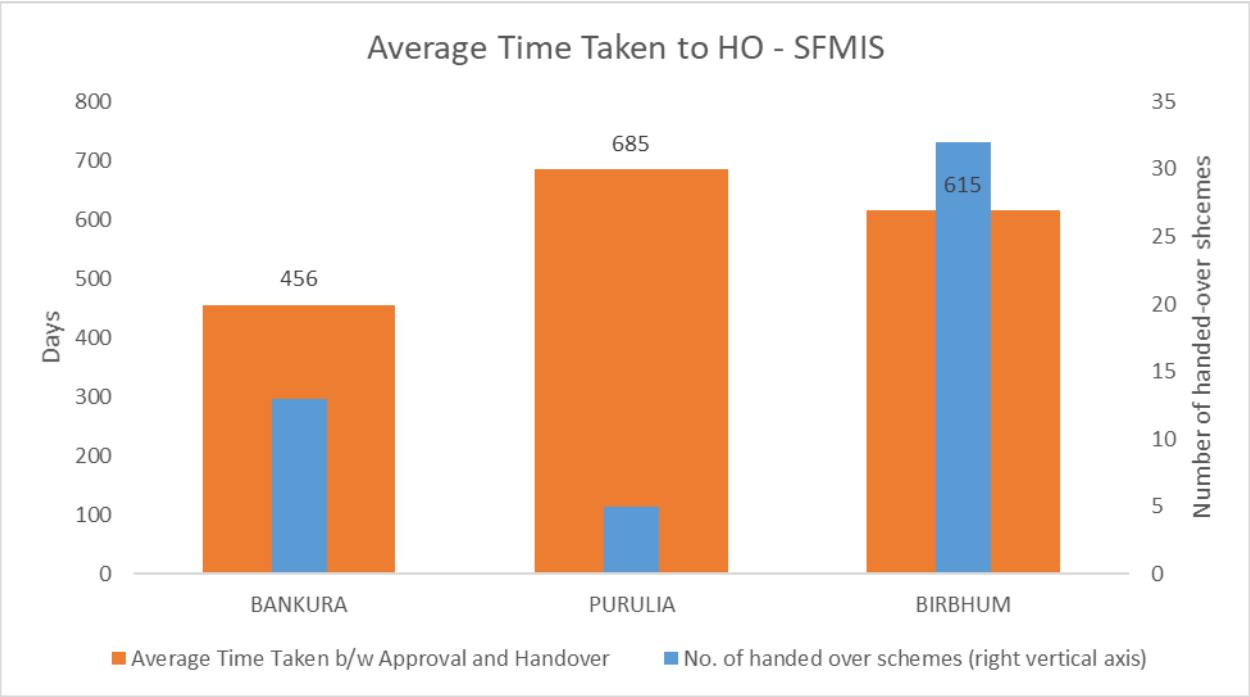
Graph 6 – Lift Irrigation: for districts that have LI, how many do they have and what's the average time between approving the scheme and having it handed over?



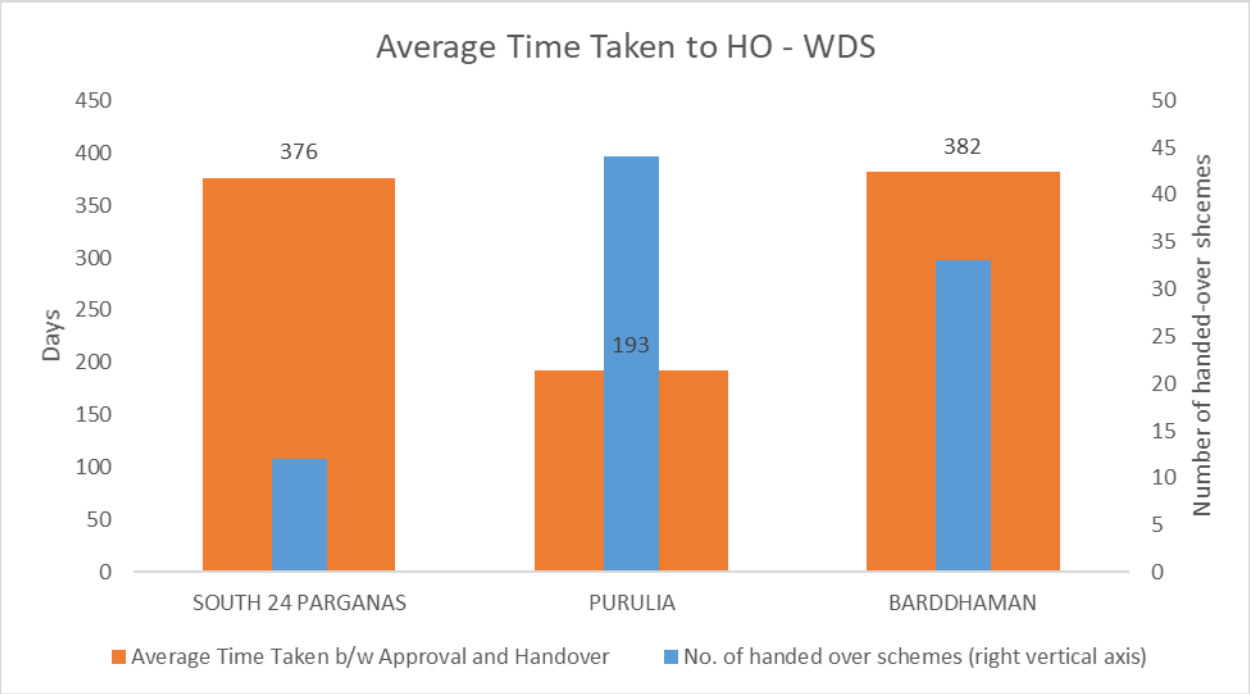
Graph 7 – PDW: for districts that have PDW, how many do they have and what's the average time between approving the scheme and having it handed over?



Graph 8 – SFMIS: for districts that have SFMIS, how many do they have and what's the average time between approving the scheme and having it handed over?



Graph 9 – WDS: for districts that have WDS, how many do they have and what's the average time between approving the scheme and having it handed over?

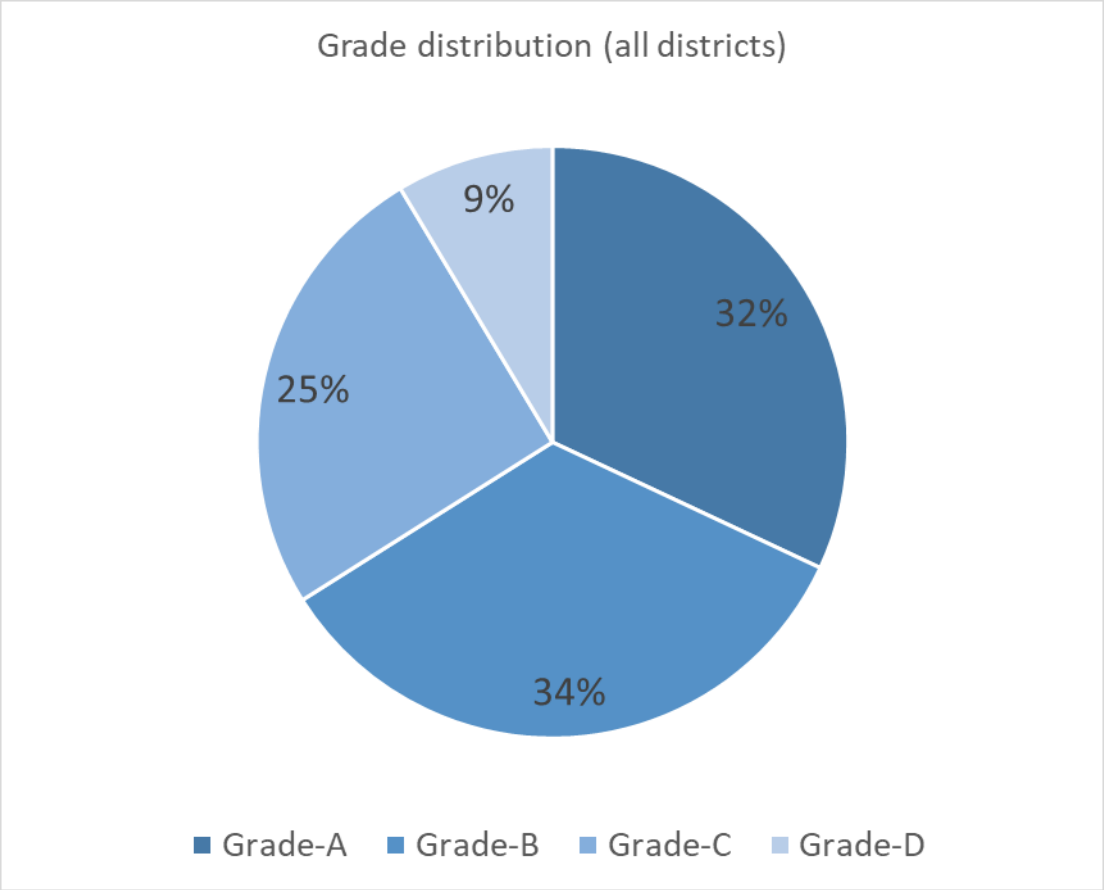


APPENDIX 4 – SUMMARY STATISTICS OF WUA GRADING RESULTS

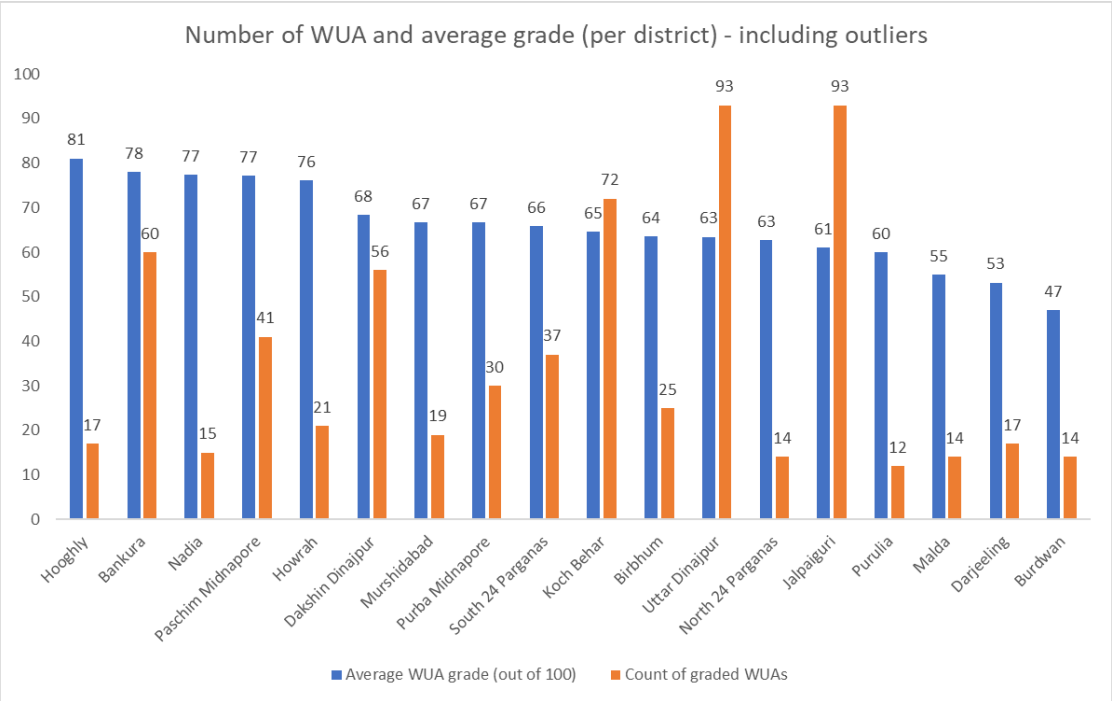
All the following graphs were built using the data from the WUA grading system applied until 2017, comprising 650 WUAs. At the moment of writing a new grading system was in implementation stage.

All the answers to the WUA grading questionnaire were tabulated and analyzed, totaling **34 graphs**. They can be checked in the link mentioned in the References Section, in editable format (one file presents the summary statistics considering only the final grade, while the other has information at question-level. Here we reproduce a selection of these.

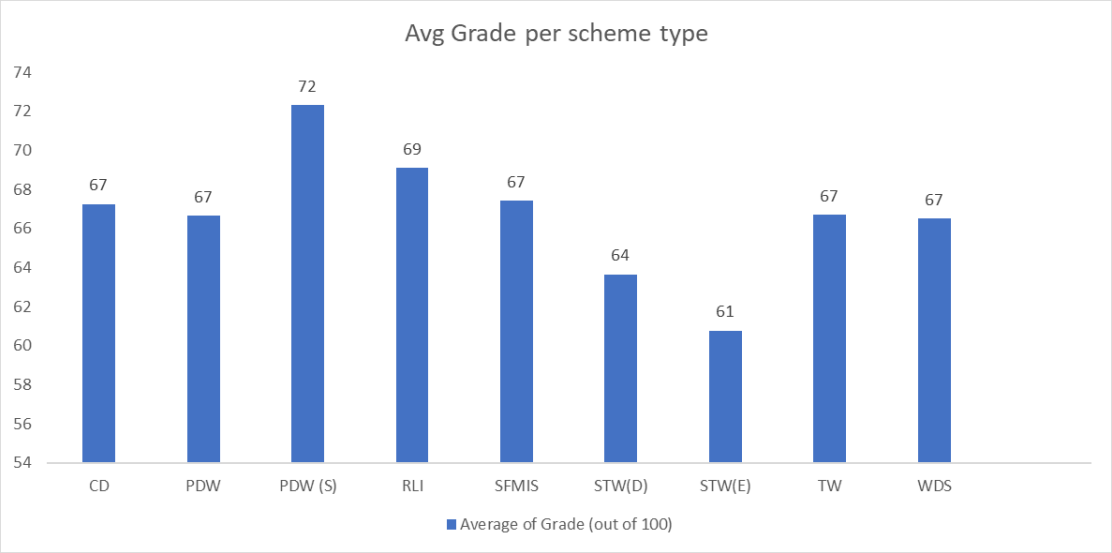
Graph 1: - Grade Distribution: Which share of the schemes are classified in each of the four grades?



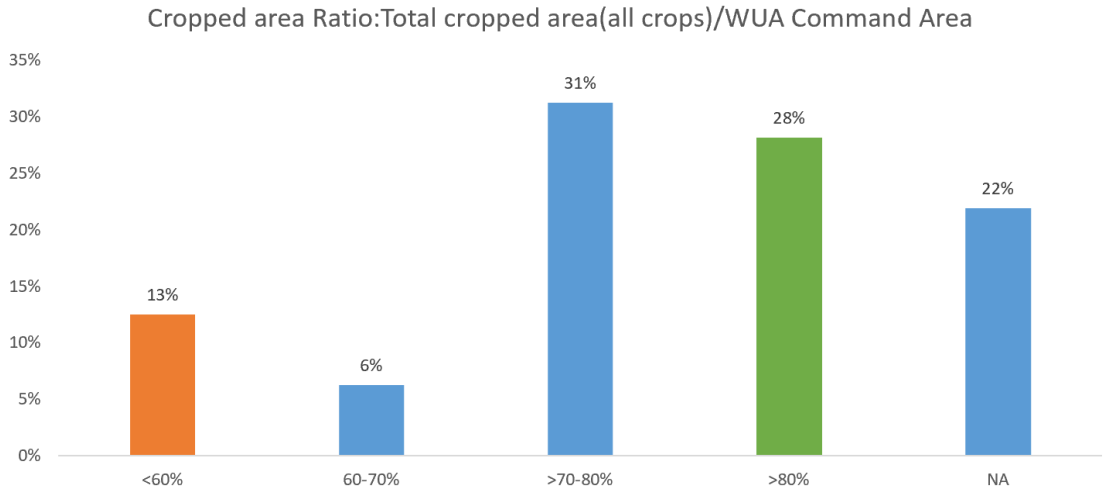
Graph 2: - Average WUA grading per district: For each district, how many graded WUAs are there and what is the average grade (out of 100)



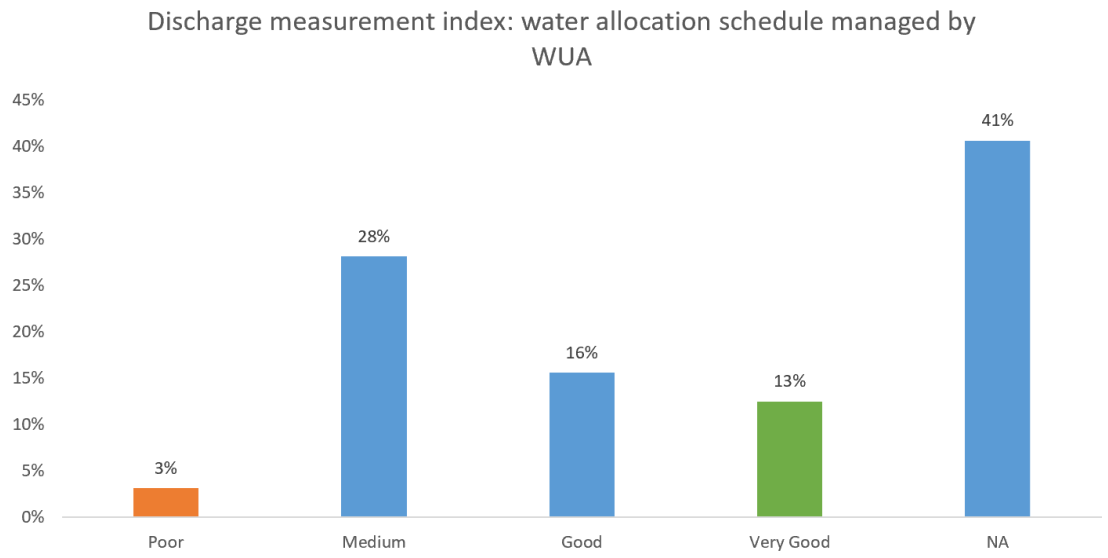
Graph 3: - Average grade per scheme type: For each scheme type, what is the average grade of the graded WUAs (out of 100)



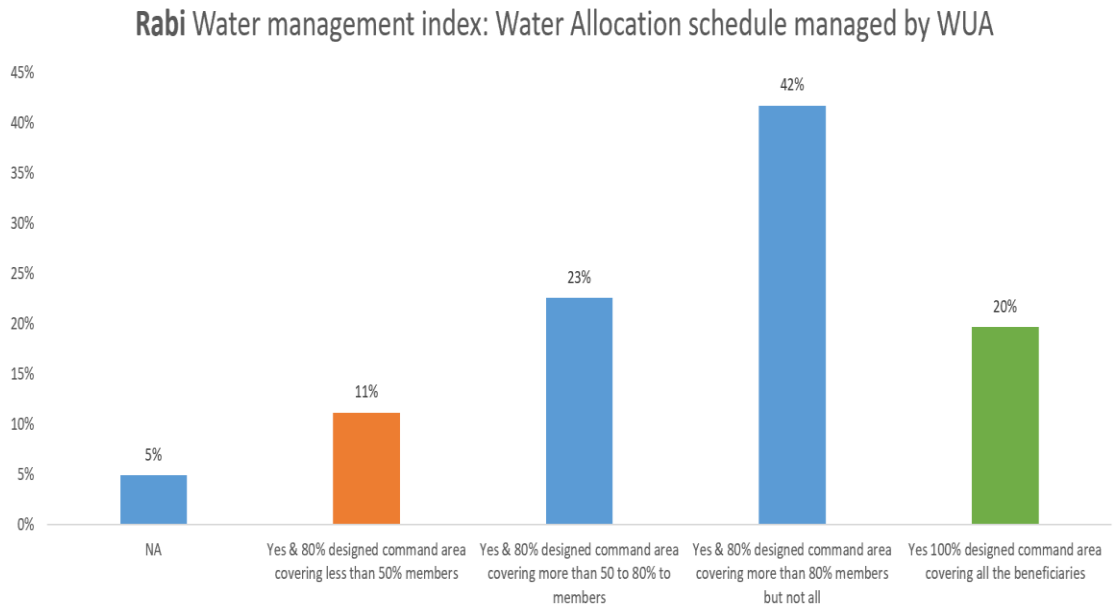
Graph 4: - % Cropped Area: Of all graded schemes, how they replied to the question about cropped area ration (share of the command area that is currently cropped)



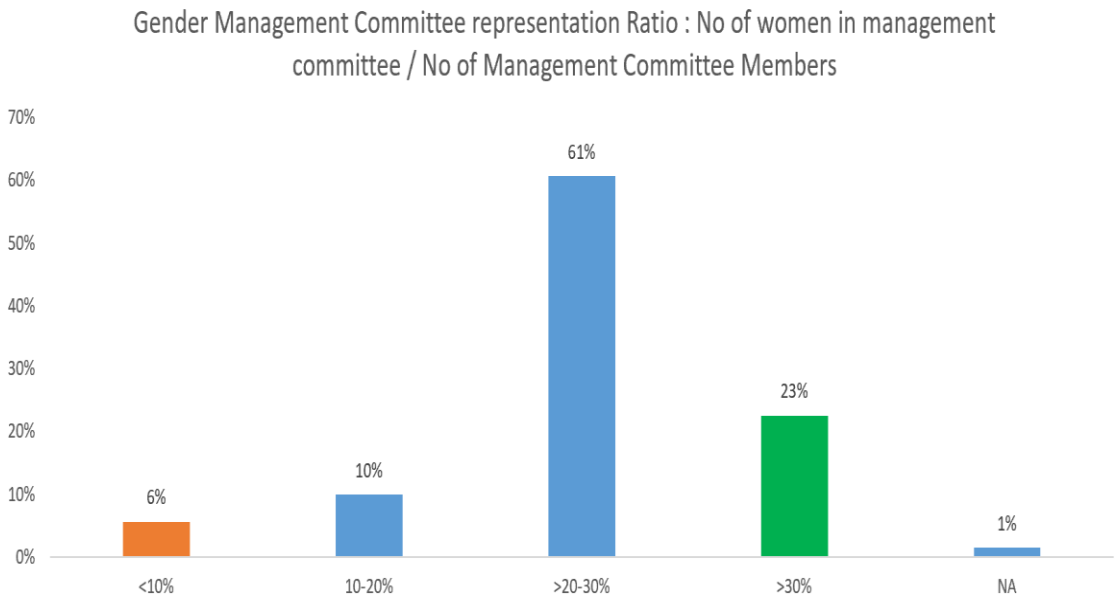
Graph 5: - Discharge measurement index: Of all graded schemes, how the field team assessed the quality of discharge measurement



Graph 6: - Rabi Water management Index: Of all graded schemes, how the field team assessed the water allocation practice, considering the available categories

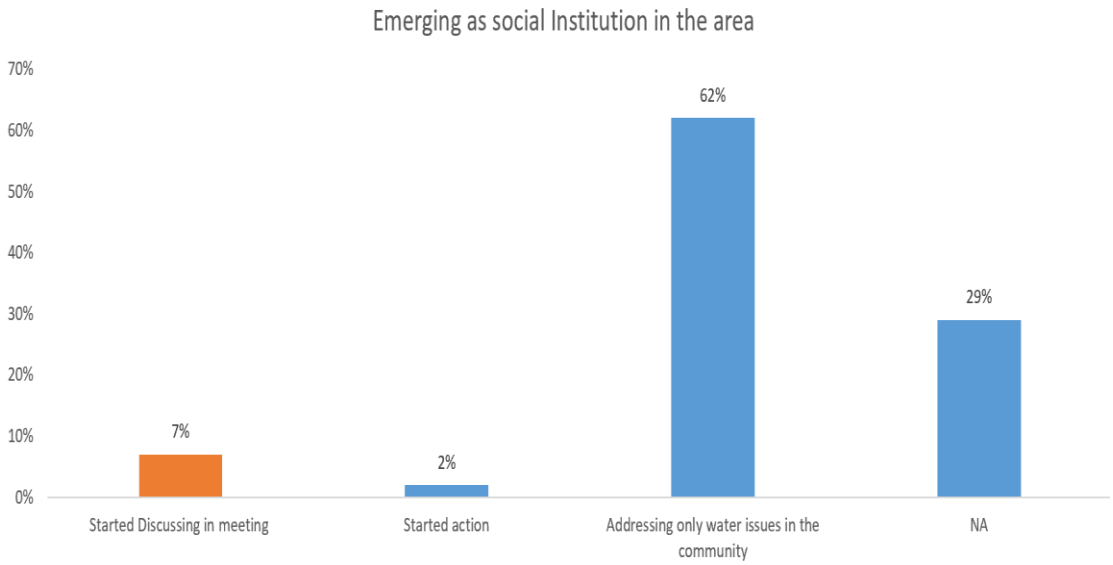


Graph 7: - % Women in Executive Committee: Of all graded schemes, what is the share of women in the WUA Executive Committee

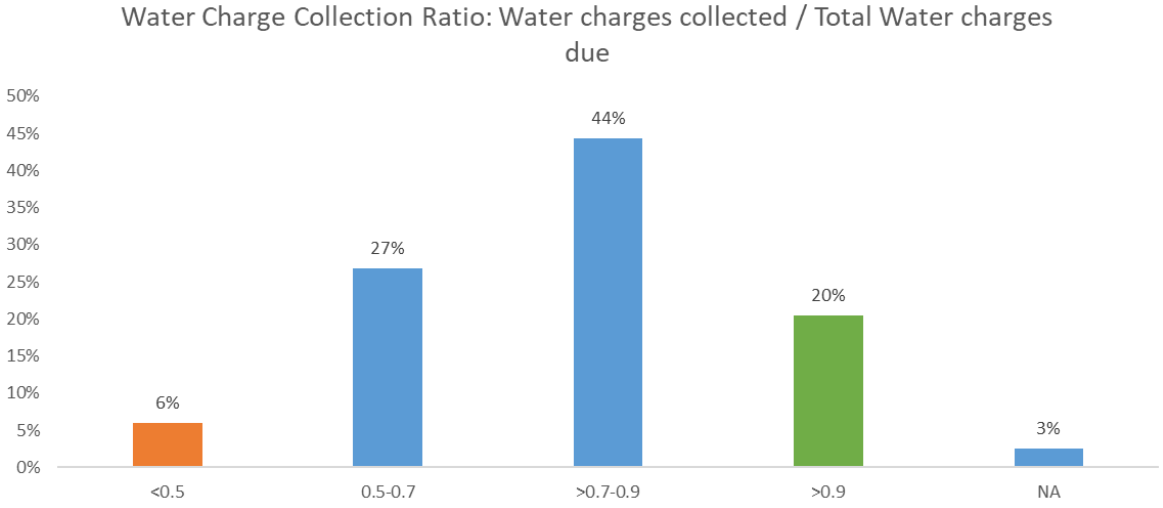


Graph 8: - Leadership selection method. Of all graded schemes, how was the leadership selected, following the available categories in the questionnaire

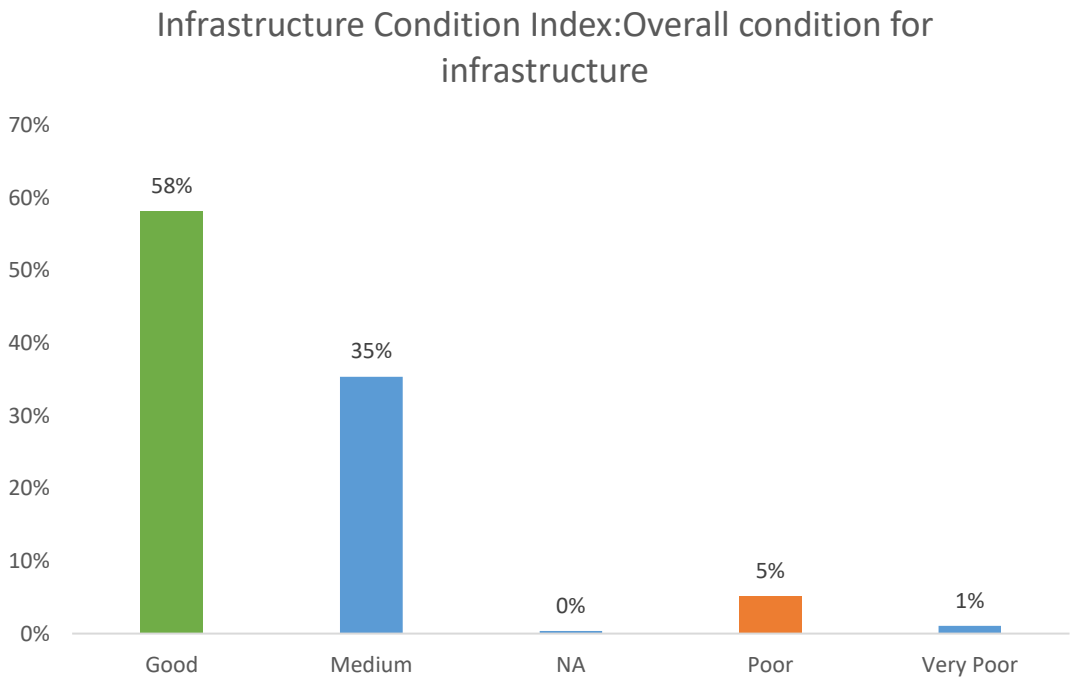
Graph 9: - WUA as local social institutional. Of all graded schemes, in what share of them the WUAs are acting as a water management forum vs. beyond that.



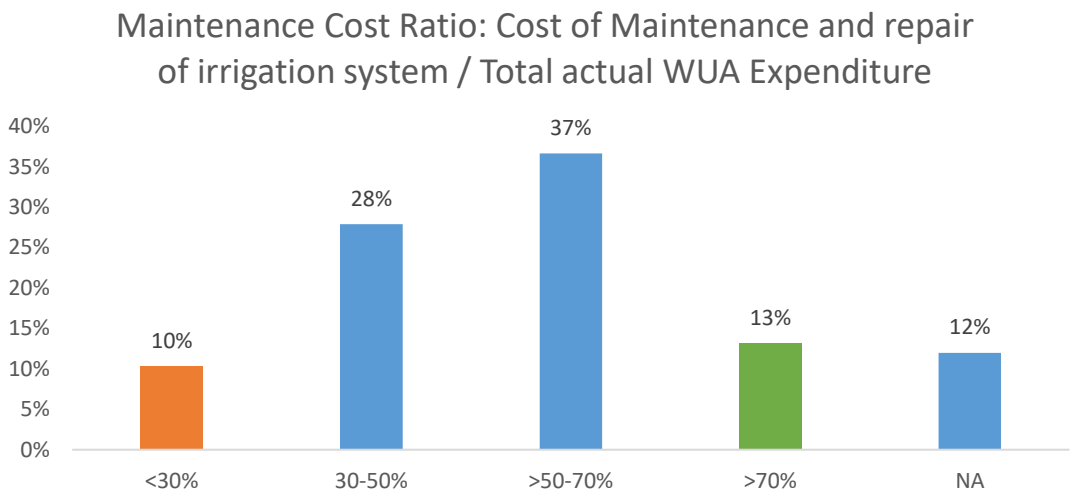
Graph 10: - % of water fees paid. Of all graded schemes, what is the share of water fees that are properly paid by WUA members



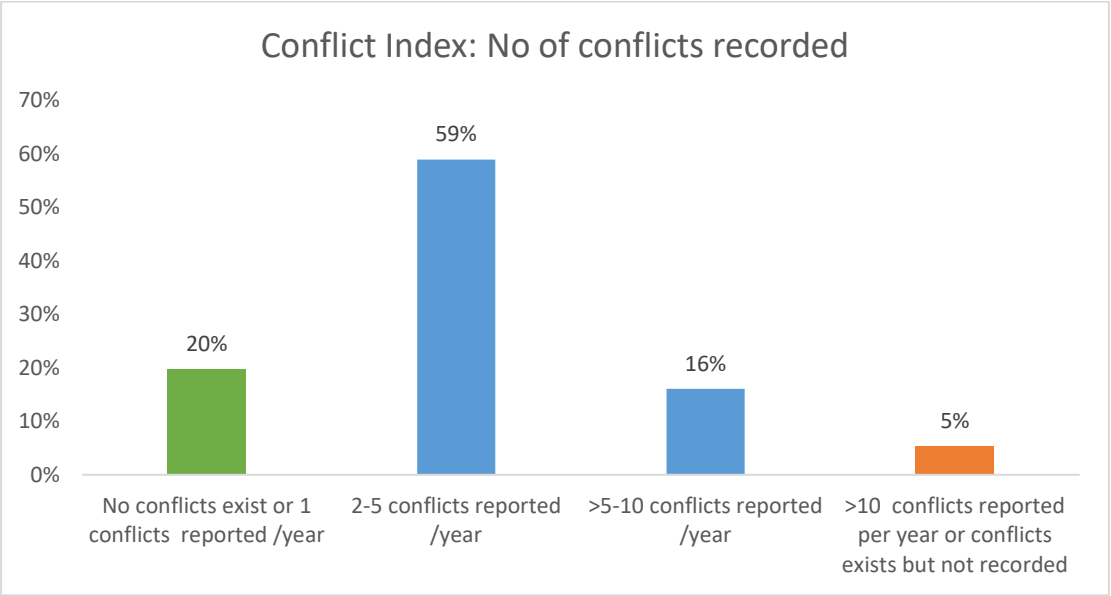
Graph 11: - Overall condition for infrastructure. Of all graded schemes, what is the share that has good, medium and bad infrastructure



Graph 12: - Share of WUA expenses going to maintenance. Of all graded schemes, what is the share of the WUA collected money that goes to maintenance



Graph 13: - Number of conflicts. Of all graded schemes, what share of them register conflicts on a yearly basis, and how often



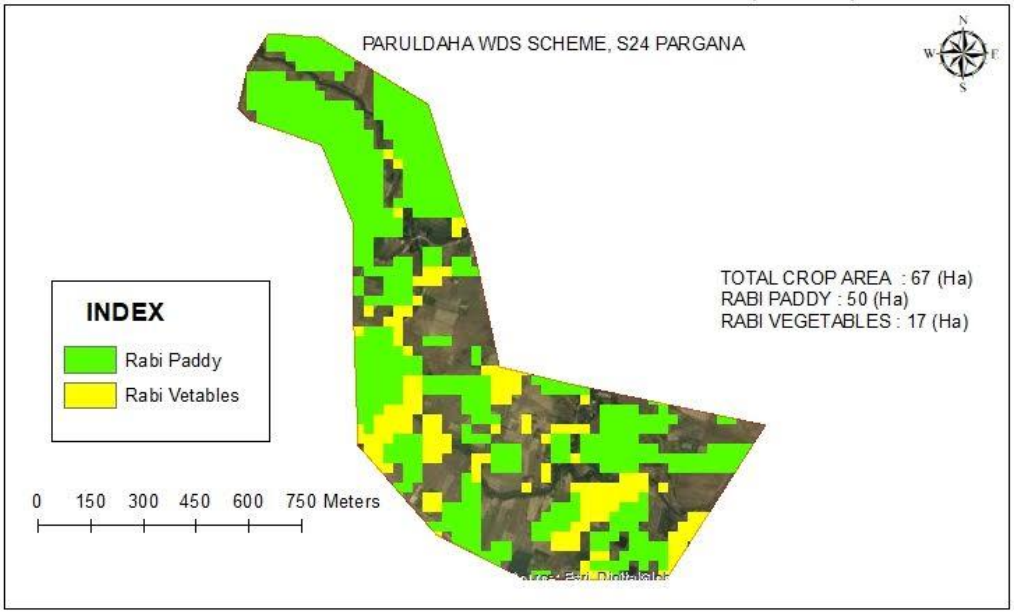
APPENDIX 5.1 – DATA STRUCTURE OF PANEL DATA TO BE EXTRACTED FROM SATELLITE IMAGE

All the data below is fictional. It is provided just as an example of the required data format. More details in Section 5.

Project	Scheme Type	Scheme ID / Lat-Long	District	Block	Cost (MM Rs)	Construction ended	Command Area	Cultivated Area (from Landsat8)									
								Rabi 2014	Pre-Kharif 2014	Kharif 2014	Rabi 2015	Pre-Kharif 2015	Kharif 2015	(...)	Rabi 2018	Pre-Kharif 2018	Kharif 2018
ADMI	TW	01-02-086-05-173	Bankura	A	$ 4.20	07/21/2014	30	11	22	22	5	12	5	18	19	18	20
ADMI	CD	01-02-007-05-171	South 24 Parganas	B	$ 0.84	09/09/2014	25	5	11	17	4	22	16	21	23	21	1
RIDF	CD	23.8778800, 87.2892910	Nadia	C	$ 1.68	02/21/2018	70	44	70	9	18	9	66	36	3	36	41
RIDF	TW	23.8904658, 87.2123098	Birbhum	D	$ 1.09	08/10/2017	120	35	110	16	63	79	17	40	12	40	85
CADA	PDW	23.8123098, 87.2785455	Purulia	E	$ 3.28	04/01/2016	50	6	31	26	18	8	0	38	45	38	2
CADA	SFMIS	23.8335698, 87.26577655	Darjeeling	F	$ 1.64	10/29/2015	45	23	12	19	26	23	20	37	11	37	10

APPENDIX 5.2 – EXAMPLE OF GIS ANALYSIS OF CULTIVATED AREA GOR ONE SCHEME (PROVIDED BY GIS TEAM)

CROP AREA AFTER PROJECT(2018)



CROP AREA BEFORE PROJECT(2014)