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2 Executive summary

This report presents a timely and in-depth analysis of the successful and inclusive rural, regional transformation in Asian developing countries, with a specific focus on Bangladesh, China, Indonesia, and Pakistan. It aims to understand the dynamics of rural transformation (RT), its drivers, outcomes, and implications for policy and development strategies.

The primary objective of this study is to investigate the multifaceted process of rural transformation, characterised by the farming system moving from low-value agriculture towards high-value agriculture and the labour force shifting from farming activities to non-farm employment. It seeks to identify the key drivers of the success of rural transformation and effective strategies for promoting inclusive and sustainable rural development in rural areas, which can contribute to poverty reduction, enhance food security, and improve livelihoods in rural areas.

The methodology combines quantitative and qualitative research approaches, including statistical analysis of economic and demographic data, case studies of specific regions within the countries studied, and interviews with key stakeholders involved in rural development. Innovative techniques such as machine learning and spatial-temporal analysis were employed to uncover patterns and trends in rural transformation processes.

The project developed a framework of stages analysis of rural transformation. The findings reveal significant variations in the pace and characteristics of rural transformation across the countries studied. Factors contributing to successful rural transformation include effective institutional reforms, policy frameworks, and investment (IPIs). It pointed out common factors like irrigation that have a universally positive impact across the countries, alongside country-specific factors that address local challenges and opportunities such as rural infrastructure and services, access to markets, and the development of non-farm employment opportunities.

In all participating countries, the project found that RT positively correlated with rural income growth and negatively correlated with poverty incidence. The RT was found on the positive effects of food security and sustainability, especially highlighting the U-shaped relationship between water scarcity and RT indicators in China, indicating the complex interplay between natural resource management and rural economic activities. The project provided a comprehensive view of gender inclusiveness in RT processes across the countries, pointing out the positive impacts of female asset ownership, education and healthcare on RT over stages.

This report underscores the importance of a coordinated and inclusive approach to rural transformation, highlighting the need for targeted interventions that address the unique challenges and opportunities in developing countries. By implementing the recommended policies, governments and development partners can contribute significantly to achieving sustainable development goals and improving the well-being of rural communities.

3 Background

Rural transformation involves sweeping changes. These include shifts in the practice of farming, a change in the use of rural areas, the movement of people across locations and sectors, and new dynamic interactions between the primary and other sectors (Wang et al., 2023). Urban areas expand, and the rural regions transform into large consolidated communities. Land, labour and other resources move in these directions, and their productivity rises. Incomes also rise in rural areas, and poverty rates decline. These are the benefits of RT. Rural transformation is a multifaceted process characterised by a comprehensive societal shift. It involves diversifying rural economies, reducing their heavy reliance on agriculture, fostering connections with distant regions for trade and resource acquisition, urbanisation with the migration of rural populations to towns and cities, and the emergence of cultural changes that align rural areas more closely with urban centres (Berdegué et al., 2013).

The success of rural transformation can be defined from several dimensions: an increase in the welfare of the entire society in several ways: a poverty reduction (Benfica & Henderson; Imai et al., 2017; Liu et al., 2018), displacement of farmers from the farming[1] (Zhang et al., 2018; Zhang et al., 2021), diversification and commodification of agricultural production (Ecker, 2018; Himanshu et al., 2013; Keyder & Yenal, 2011; Li et al., 2016), food security and dietary transition (Masters et al., 2018; Schmidt et al., 2020), improvement of health and education (Andersson & Klinthall, 2015; Brown & Guinnane, 2018; Johnson & Taylor, 2019; Nguyen & Tran, 2014; Reardon & Timmer, 2014), greater inclusiveness through the provision of justice and contributions to gender balance (Heckert et al.; Mu & van de Walle, 2011; Zhou et al., 2016), and ultimately, productivity growth and structural change of the whole economy (Emerick, 2018; Gong, 2020; Kagin et al., 2016; You & Sarantis, 2013). Conversely, the world cannot achieve the U.N. 2030 Agenda and 17 Sustainable Development Goals (SDGs) without successfully transforming the rural sector and rural areas (Trivelli & Berdegué, 2019). The World Development Report regards rural transformation as an engine of growth for 'agriculture-based countries' (Byerlee, 2008). Diversification of agriculture and inclusiveness of rural transformation would give smallholder households access to sources of income beyond agriculture (de Janvry & Sadoulet, 2020).

Not all countries have experienced rural transformation successfully. In the preindustrial era, China had been farming ahead of many nations for thousands of years. However, the rural transformation only happened in China when industrialisation began. According to Hou (2008), in China, an increase in population density only resulted in a dynastic cycle, periodic dynasty changes associated with political and economic chaos, rather than reallocating excessive labour force to trigger industrialisation. This occurred because labour productivity had not increased in line with the increase in population density but 'stagnated', and the handicraft industry (the basis of a transition to industrial growth) was never disconnected from agriculture (Elvin, 1973). The underlying reason for this stagnation could have been institutional barriers, such as the lack of property rights protection and the burden of the land tax regime.

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[1] *The displacement of farmers could potentially increase societal welfare through increasing the economic efficiency, diversifying the economy, promoting structural change and enhancing the labour mobility between rural and urban areas.*

Another example is Indonesia's 'agricultural involution' in the seventeenth and eighteenth centuries. Most of Java was 'crowded with post-traditional wet-rice peasant villages: large, dense, vague, dispirited communities – the raw material of rural, non-industrialised mass society.' (Geertz, 1963, p. 129)

The main reason for the lack of progress was that the Javanese agricultural economy was a closed system. Given that the external demand for agricultural products was limited and more technological progress was needed, the internal increase in population density led to the intensification of agriculture rather than structural change. Output per unit of the area increased, but not per capita.

In these two cases, rural transformation failed, which was associated with a lack of technological advances and no industrialisation. Even worse than occurred in these two cases, for example, some other countries could fall into a Malthusian Trap (Malthus, 1798), in which the population, as it grew, could not feed itself.

In the modern era, we also witness several failures of rural transformation in developing countries, though the degrees vary. For example, in sub-Saharan Africa, the increase in per capita GDP from 2000 to 2014 did not reduce poverty, and agricultural productivity growth remains low (Barrett et al., 2017; Dercon & Gollin, 2014; Wuyts & Kilama, 2016). Although the share of agriculture in GDP and employment both declined, the off-farm labour has not moved towards manufacturing but to the non-tradable services (IFAD, 2016; Rodrik, 2016).

These experiences challenge policymakers to reflect on rural transformation in practice and principles. Not all the changes in a rural area should be taken for granted as examples of thriving rural transformation. For instance, Gollin and Kaboski (2023) document many findings on the market failure in rural development. Success can only be achieved with proper policy facilitation based on a better understanding of its nature. However, the relevant policy portfolios are diverse, depending on the issues in focus. For example, one concept of rural transformation originates from the technological change induced by relative price change. It influences the rural sector's competitive advantages and economy Field (Acemoglu, 2002, 2003), which expands the production (Cochrane, 1993) and captures economies of scale. This process, however, is likely to be confronted with market failures, and policy intervention is needed to address the distortion. A political economy framework, however, emphasises who controls and benefits from rural transformation and who would be the losers. In this regard, the policy focuses on gender, generational and ethnic justice rather than efficiency-driven corrections of market failures.

This project is based on the assumption that the RT in Asian developing countries would share similar patterns featured by shared pathways and stages. Also, those RTs can be accelerated through better institutional reforms, investment, and policies, which are short for IPIs of RT drivers. The stages, speeds and outcomes of RT vary among countries and between regions. There are likely to be some common elements, and this project aims to identify those. However, it is recognised that local systems, choices and conditions affect the stages, speeds and outcomes of RT and that these common elements are 'mediated by localised social structures, institutional frameworks, and local societies' so that, as a result, 'rural transformation between and within different countries has different consequences in terms of economic growth, social inclusion, and environmental sustainability' (Berdegué et al., 2013). Societies may also make deliberate choices about the speed and manner of rural transformation, seeking to achieve different

outcomes, such as environmental consequences. Stages, speeds, and outcomes of rural transformation vary because initial conditions differ among regions and countries. The complexity of local conditions will be taken into account while, at the same time, the common elements upon which recommendations for policymakers can be based will be identified.

One of the critical issues our project intends to address is the pervasive challenges developing countries face in managing this complex and often poorly understood process of rural transformation. While a substantial portion of the population resides in rural areas in these nations, they are disproportionately affected by poverty, highlighting the urgent need for research and intervention in these regions. Despite the significance of rural transformation, it remains a relatively under-studied field, with considerable gaps in existing literature.

Moreover, variations in rural transformation experiences across countries and regions need to be better understood, and the determinants of these differences still need to be understood. As we delve deeper into the literature, we also identify a pressing need to establish standard and quantitative measures for assessing rural transformation's various stages and speeds. This project seeks to bridge these gaps by examining the underlying determinants of rural transformation and exploring the impacts of Important Policy Initiatives (IPIs) on the different elements of this transformation process.

Notably, the existing research needs to comprehensively investigate how these driving factors, such as IPIs, influence the stages, speed, and ultimate outcomes of rural transformation. It is imperative to understand the specific mechanisms through which policies and interventions affect the trajectory of rural areas and whether they contribute to successful rural transformation. This project aims to fill this critical knowledge gap and shed light on the intricate relationships between policy initiatives and the transformation of rural communities in four distinct countries.

In summary, our project addresses the pressing issues of rural transformation in developing countries, aiming to uncover the underlying determinants, variations in experiences, and the impacts of Important Policy Initiatives on this complex process. By doing so, we contribute to a more comprehensive understanding of rural transformation, which is essential for formulating effective policies and strategies to reduce poverty and enhance the well-being of rural populations in these countries.

4   Objectives

This project aims to understand the nature, drivers and consequences of rural transformation in order to design changes in the IPIs that support success.

The project achieves this aim through the following five objectives:

4.1   Objective 1: Explain what is meant by rural transformation

The first objective focused on the nature and specific context of rural transformation. It sought a comprehensive summary of rural transformation's different stages and defining characteristics. Drawing from a robust methodology that included the creation of the RT measurement, this objective aimed to offer nuanced insights into the progression and diversity of rural transformation in the four countries.

This objective was achieved through literature reviews, interviews, and data collection activities. It includes developing a set of measures of RT progression in terms of the stage, speed and outcomes.

4.2   Objective 2: Recognise what success means

The second objective is to investigate the success of RT from three dimensions – inclusiveness, food security and sustainability.

4.2.1   Inclusiveness

The project focused more on inclusiveness from two directions, and we studied two indicators in each direction. The first direction is to answer whether RT has led to income growth that reduces poverty. The second dimension is to examine whether RT is inclusive regarding income inequality and leads to more gender balance.

4.2.2   Food security

Food security is important at both the national level (national food security) and the household level. This project is conducted at the regional level (regional rural transformation). Food security is important at the regional level only when the domestic and regional markets are isolated, mainly due to trade barriers among provinces (or states/districts) and poor road transportation. Now, this is not the case in China. Thus, this project does not conduct this topic in China.

Other country teams have attempted to answer whether the RT helps guarantee food security because there might be some regional trade barriers or regional transportation infrastructure issues in Bangladesh, Indonesia and Pakistan.

4.2.3   Sustainability

This project studied water scarcity, which is one important dimension of sustainability. The sustainability focus was on China's water scarcity. The sustainability of the resource base is an indicator of success, and its features also form part of the initial conditions that will drive the process of RT.

Water scarcity or sustainability is interconnected with rural transformation. Growth (income), equality (e.g., poverty) and sustainability are three important

components of development. However, our project clearly stated that we focused only on income and equity, given the study covered four countries with already huge work packages/workloads and limited budgets. Without additional funding to do this sustainable work, we decided to do this study only in China using CCAP's own resources.

4.3 Objective 3: Explain what determines success

The third objective is to sort out the drivers to promote a successful RT. In this project, we defined the drivers from the aspects of institutions, policies and investments, short for IPIs. For each country, we selected a set of major IPIs to investigate. Institutions include land tenure reform, regulations on the labour market, institutions' governance of rural finance/credit, water resource management, and others. Relevant policies include those that affect production incentives such as tax, subsidies, marketing policies, trade policies and prices of agricultural inputs and outputs. Investments of interest include those in agricultural R&D and extension, irrigation, rural transportation, rural market infrastructure, rural education and others.

4.4 Objective 4: Lay out the lessons that can be shared among countries

The project conducted a cross-country analysis based on the partner countries' research and data. The nation's and cross-country analyses apply similar conceptual frameworks and analytical methods. This part of the work aimed to identify the lessons that can be shared, given the differences in the social settings, cultures and political systems across countries. The lessons were shared by national partners from the beginning to the end (to agree on the detailed research design) through monthly workshops and project implementation.

This objective also includes attention to the Australian experience. Australia has a long tradition of working on structural change in the economy and its implications for the transformation of rural Australia. The extent of change has also been dramatic. There is also a substantial body of work on the contribution of rural and other sectoral policies to this transformation. This experience has been reviewed, and relevant lessons were identified for the other participating economies.

4.5 Objective 5: Explain how policy changes can support successful rural transformation.

The project aimed to combine the results of all studies into a portfolio of recommendations that relate to each country's relevant policies, institutional reforms, and investments (IPIs). Policy briefs were co-created in a network of researchers and policymakers operating across participating economies. This also included organising a conference (conference thematic sessions), policy forums and workshops and seeking input from the researchers, policymakers, and other stakeholders.

5 Methodology

5.1 The guiding theory

Overwhelmingly, this project was guided by the classical economics theories of the Lewis and Todaro models.

The Lewis model, proposed by economist Sir W. Arthur Lewis in the 1950s, is a theory of economic development that explains the transformation of traditional agricultural economies into modern industrial economies. The model is based on the idea of a dual economy consisting of a traditional agricultural sector and a modern industrial sector.

According to the Lewis model, the traditional agricultural sector is characterised by low productivity, subsistence farming, and a large surplus labour force. This surplus labour force is known as the "Lewisian unlimited labour supply," which refers to the availability of labourers willing to work at low wages due to the lack of alternative employment opportunities in the agricultural sector.

The key concept in the Lewis model is the "capitalist sector," which represents the modern industrial sector. As the capitalist industry grows, it absorbs surplus labour from the traditional agricultural sector, transferring labour and resources from agriculture to industry. This process is known as "labour transfer" or "labour migration."

The growth of the capitalist sector is driven by investment in physical capital (such as factories and machinery) and human capital (such as education and training). As the capitalist sector expands, wages in the industrial sectors rise due to increasing demand for labour, leading to improved living standards and poverty reduction.

The Lewis model has been used to explain the process of industrialisation in many developing countries. Critics of the model argue that it oversimplifies the process of economic development and does not account for factors such as technological change, international trade, and government policies. Nonetheless, the Lewis model remains a valuable tool for understanding the initial stages of industrialization and the role of the agricultural sector in economic development.

The Todaro model, developed by economist Michael Todaro in the late 1960s and early 1970s, is a theoretical model that explains rural-urban migration in developing countries. The model is based on the idea that individuals in rural areas migrate to urban areas based on the expected income differentials between rural and urban areas.

According to the Todaro model, individuals in rural areas make migration decisions based on expected urban income and the probability of finding employment in urban areas. The model assumes that individuals have perfect information about urban job opportunities and make migration decisions based on expected income differentials rather than actual ones.

The key insight of the Todaro model is that migration is not solely driven by income differentials but also by the perceived probability of finding employment in urban areas. This means that even if urban incomes are higher than rural incomes, individuals may only migrate if they believe the chances of finding a job in urban areas are high.

The Todaro model has been criticised for its simplistic assumptions and focus on individual decision-making, which may not capture the complex social and economic factors that influence migration decisions. However, the model has influenced thinking about rural-urban migration and has been used to inform policies to reduce poverty and promote economic development in developing countries.

5.2 The Theory of Change (ToC)

As a partnership-based agricultural research project for development, the project design and implementation were guided by the Theory of Change (ToC) methodology. The ToC is an essential part of the change-maker's toolkit, guiding strategic decisions and enhancing the impact of policy interventions. It is an innovative approach and valuable tool for planning, implementing, and evaluating social and policy interventions and programs. It provides a clear and testable hypothesis about how change will unfold within a specific context and outlines the causal pathways by which desired outcomes are expected to be achieved. The ToC has gained substantial traction in various sectors, including international development, education, healthcare, and social justice, for its ability to construct a clear roadmap towards achieving complex social objectives. It provides a clear framework for conceptualising the change process and offers a structured approach to achieving desired outcomes.

The core of the ToC is not merely a tool but a detailed and holistic process that encapsulates the nuanced mechanisms of change. It includes research outputs that are evidenced by academic papers and project outcomes that are evidenced by policy change and capacity improvements. We focus on long-term goals before identifying the conditions that lead to those outcomes. The ToC process is iterative and reflective, involving researchers, policymakers and stakeholders in articulating and agreeing upon the change they want to see and understanding the steps necessary to make that change happen.

Applying the ToC to rural transformation projects offers a strategic framework to navigate the complexities of transforming the rural sector. The ToC helps researchers, practitioners, and policymakers visualise the stages and pathways through which IPIs can lead to improved policy practices, enhanced rural transformation, and sustainable rural development.

In this project, the ToC began by identifying long-term goals specific to accelerating rural transformation in participating countries and establishing a long-term partnership with building partners' capacities. These goals are set to realise an inclusive, sustainable rural transformation at the national and regional levels, which is meant by the success of rural transformation.

Once the long-term goals are established, the teamwork is backward from the long-term goals to identify research objectives and intermediate outcomes. These are the specific research topics and policy suggestions to benefit the experience of the rural sectors and communities as the project progresses. For example, outcomes might include the diversification of rural economies, the improvement of local infrastructures, or the adoption of some institutional reforms.

The specific interventions include two aspects. The first one is to influence the policymakers or stakeholders via the policy channel, such as advisory board meetings, policy briefs or other policy consulting jobs. Engaging various

stakeholders, including rural communities, government agencies, NGOs, and private sector entities, is vital in ensuring that the ToC is grounded in reality and considers the perspectives of those affected by the project. The second one is to impact the younger generation of researchers through the project capacity-building program, which includes training, workshops and networking.

The research implementation and outcomes are illustrated in Figure 1.
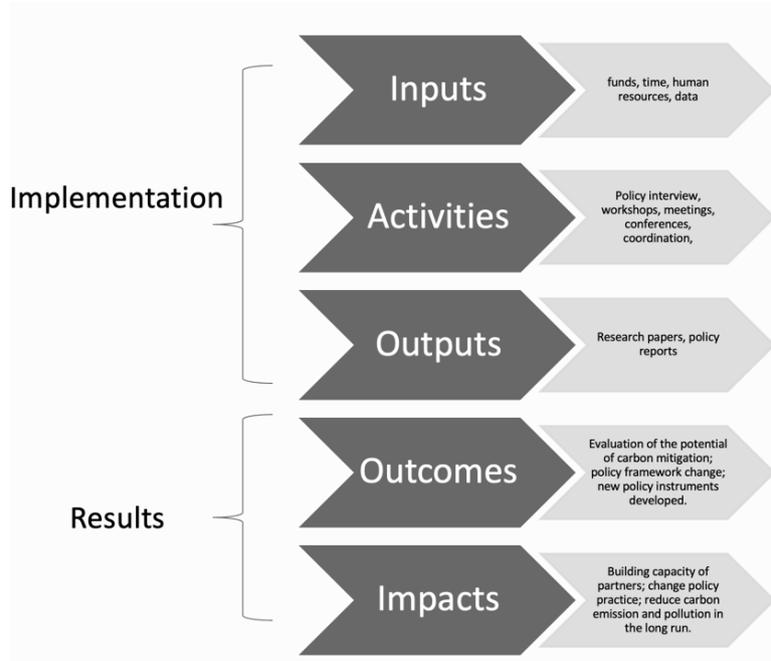
Figure 1. The project implementation and outcomes based on ToC

The impact pathway is designed following the framework of the theory of change. This project summarises the impact pathway in Figure 2, based on models provided by (Douthwaite et al., 2017). Each participating country will have separate pathways and a mechanism to share lessons across countries. There are three channels leading to impact results in terms of changes in the IPIs: policy reform, institutional reform and investment. The channels include research, capacity building and policy engagement.
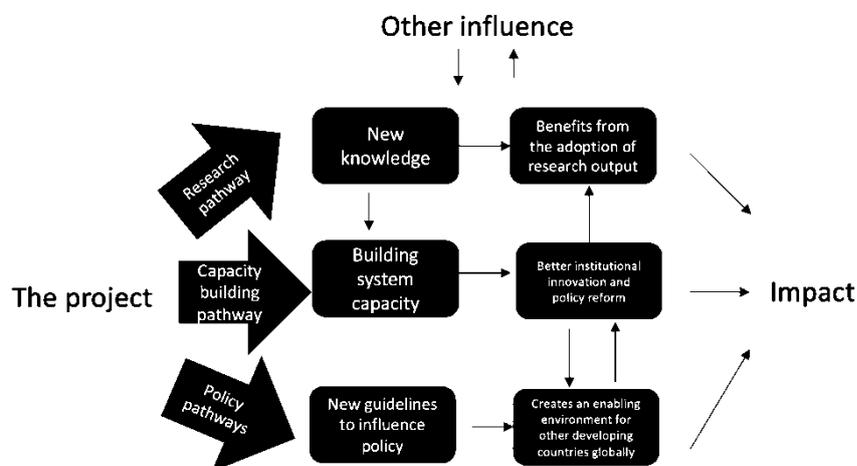
Figure 2. Impact pathways

In this case, the focus of the impact pathway is on the ways the project can influence partners with whom it works to bring about change and who include those who are ultimately responsible for the change.

In this perspective, decision-making matters inside government agencies and outside by other stakeholders (e.g., the private sector, NGOs, and media). There is both an inside and an outside track to consider. Influencing the inside track requires providing advice, while influencing the outside track involves the application of advocacy. Both advice and advocacy must be based on evidence. They must be applied to respond to issues that policy-makers regard as real problems and among their priorities for attention.

Table 1 below shows how all the objectives were addressed according to the timeline of this project.

Table 1. Project implementation timeline

Objective	Activity (by month(M))	M1-6	M7-12	M13-18	M19-24	M25-30	M31-36
Objective 1	1. 1a Literature review and 1b Interview policy makers and experts	▓					
	1.2 Select regions of study	▓	▓				
	1.3 Data collection	░	▓				
	1.4 RT Measures		▓	▓			
Objective 2	2.1 Income Growth		▓				
	2.2 Inclusiveness			▓			
	2.3 Food Security				▓		
	2.4 Sustainability					▓	
Objective 3	3.1 Identify the drivers				▓	▓	
	3.2 Missing services				▓	▓	
Objective 4	4.1 Cross-country study				▓	▓	▓
Objective 5	5.1 Policy recommendations						▓

5.3 Qualitative methods

Qualitative methods in rural transformation studies offer a deep understanding of the historical context of social, institutional, economic, and environmental dynamics that characterise change in rural areas. Therefore, the project uses this method to address objective 1 mainly. These methods are essential for capturing the distinct perspectives of rural residents, policy practitioners, and stakeholders, understanding the complex change processes, and gathering rich, detailed data that quantitative methods alone may not reveal. Here are several qualitative methods employed by this project:

- **In-depth Interviews**: These provide a platform for detailed exploration of individual expert perspectives. Interviews, which are structured, semi-structured, or unstructured, are conducted by partners in the home country, allowing researchers to gather personal narratives, opinions, and experiences regarding rural transformation.

- **Focus Group Discussions (FGDs)**: FGDs bring together a small, diverse group to discuss specific issues or topics. They are handy for exploring social norms and rural community dynamics, as the group setting can stimulate conversation and reveal consensus or diversity of opinion. Our partners apply this method by establishing advisory board meetings and frequently engaging with stakeholders.

- **Historical and literature review**: the historical and literature review of rural transformation studies provide an extensive examination of the evolution of the concept, key theoretical frameworks, empirical findings, and the changing contexts of rural transformation over time. It is a synthesis of the major themes and developments in this field. The literature encompasses many theoretical approaches and empirical studies reflecting rural change's complex and multi-dimensional nature. The review also points to an increasing awareness of the need for sustainable and inclusive approaches to rural transformation that address contemporary global challenges.

5.4 Data collection and indicator selection

The research for this project was conducted in four diverse countries: Bangladesh, China, Indonesia, and Pakistan. These countries were chosen due to their shared characteristics, which include a predominant reliance on grain production in their agricultural sectors, substantial rural populations, and significant rural transformation over the past few decades. In 2022, the distribution of rural populations in these countries was as follows: China (36%), Indonesia (42%), Bangladesh (60%), and Pakistan (62%). This selection of locations was crucial for investigating rural transformation in regions with commonalities and variations.

The partner teams collected secondary data from their government agencies. The whole team meeting discussed the criteria for data use and indicator selection. The key indicators of RT are the share of high-value agriculture and non-farm employment. The major outcomes of RT are measured by income growth and poverty reduction. The key indicators are listed in Table 2.

Table 2. Indicators for measuring rural transformation and outcomes

Dimensions	Indicators	Definitions
Rural transformation	**RT1:** Share of high-value agriculture	The value of high-value agricultural products divided by the gross agricultural output values
	RT2: Share of rural non-farm employment	Rural non-agricultural employment divided by total rural employed labours
Outcomes	Per capita rural income	Per capita net income of rural households in real terms
	Poverty reduction	Poverty incidence rate

The primary data sources are listed in Table 3.

Table 3. The main data source of the project

Variable	Data Source			
	Bangladesh	**China**	**Indonesia**	**Pakistan**
RT1	Agricultural Year Book (BBS)	Provincial Statistical Yearbook (various years)	BPS (Badan Pusat Statistik - Statistics Indonesia)	Pakistan Bureau of Statistics (PBS) and Various Annual Reports of Pakistan Economic Survey(PES)
RT2	Statistical yearbook and Labor force survey	Provincial Statistical Yearbook (various years)	BPS	Pakistan Bureau of Statistics (PBS)
Outcome1-rural Income	Household income-expenditure surveys(HIES) (BBS)	Provincial Statistical Yearbook (various years)	BPS	PBS
Outcome2-rural Poverty	HIES report & Poverty Maps of Bangladesh	Provincial Statistical Yearbook (various years)	BPS	PBS and PES

5.5 Machine learning (ML)

Our methodology employed a multifaceted approach to analyse and comprehend the objectives of rural transformation across these four countries.

The application of machine learning (ML) approaches to rural transformation studies represents a cutting-edge frontier where data science intersects with socio-economic analysis. By leveraging our datasets, ML can unearth patterns of stages of RT and provide insights that might not be discernible through traditional statistical methods. Particularly, ML can be used to diagnose the problems faced by local governments.

A systematic process was followed to delineate the stages of rural transformation. We began by constructing a single indicator by combining RT1 and RT2, referred to as the Rural Transformation Index, using Principal Component Analysis (PCA). Subsequently, a panel dataset of this Index was created. By employing a data-driven method that is unsupervised learning clustering techniques, we determined the observable stages within the dataset, selected representative data points for each stage, and calculated the similarities between other data points and these representatives. This process was iterated until a stable result was achieved, allowing us to display the stages on a timeline.

Incorporating machine learning into rural transformation studies offers the potential to significantly enhance the understanding and shaping of rural development processes, enabling data-driven decisions that can lead to more effective and sustainable outcomes.

5.6 Spatial-temporal analysis

Based on Geographic Information System (GIS) principles, the spatial-temporal analysis is one aspect of our methodology. We use this method to display the dynamics of key indicators of RT at the regional level. It provides some insights into the related policies. The spatial-temporal analysis examines how rural transformation unfolded in different geographical areas and over time, considering regional variations and temporal trends. We have statistical maps over the years to identify the spatial-temporal dynamics of RT and its outcomes in all countries.

5.7 Econometric modelling

5.7.1 Modelling the nature and outcomes of RT

We applied graphic illustration and regression models to investigate the potential relationship between RT and its outcomes. The method can display the relationship of RT1 or RT2 against per capita rural income or rural poverty rates with graphs. Meanwhile, using ordinary least square (OLS) and provincial fixed effect (FE) methods, the regression method revealed the correlation between RT indicators' path and consequence. Moreover, we calculated the 'turning point' based on the estimated parameters.

Two basic models are listed as follows:

OLS model: (1)
$$Outcome_{it} = \alpha_1 RT1_{it} + \alpha_2 RT1_{it}^2 + \alpha_3 RT2_{it} + \alpha_4 RT2_{it}^2 + X + \xi_{it}$$

FE model: (2)
$$Outcome_{it} = \lambda_1 RT1_{it} + \lambda_2 RT1_{it}^2 + \lambda_3 RT2_{it} + \lambda_4 RT2_{it}^2 + X + v_i + \eta_{it}$$

The OLS model, denoted as the model (1), considered per capita rural income and rural poverty incidence outcome variables, with high-value agriculture and non-farm employment as independent variables. Squared terms of these independent variables were introduced to capture potential non-linear relationships. Additionally, control variables were included. The FE model, presented as a model (2), extended the analysis by introducing regional fixed effects. It's important to note that the relationships between rural transformation and its outcomes differed in Bangladesh and Pakistan, and this was accounted for by dropping the square terms in the regressions in these specific cases.

Furthermore, to examine the relationship between provincial RT and per capita income and poverty incidence in rural China, we employed the Locally Weighted Scatterplot Smoothing (LOWESS) and the Polynomial methods. These methods were conducted to fit the data of 24 provinces from 1978 to 2018. Although the results based on the two methods were largely consistent, we found that the former one performed better in fitting lines for the relationship between provincial RT and per capita rural income. At the same time, the latter one fits better for the relationship between provincial RT and rural poverty incidence.

Both ST of agricultural output over total GDP and RT have important implications for farmer's income. To examine the potential correlation between per capita rural net income and RT and ST, we first apply the graphic analysis using the Locally Weighted Scatterplot Smoothing (LOWESS) method. Based on these analyses, we develop a typology for rural transformation and farmer's income. Despite some

common features of provincial rural transformation, we analyse the data by agricultural production zones to better understand the relationship between farmers' income and RT or ST.

5.7.2 Modelling the stage and IPIs

To investigate the drivers (IPIs) of RT and its impacts on different stages, we employ the instrument variable approach and dummy variables to sort out the results.

Let's define Y_{it} as the stage and speed of rural transformation in the ith region at year t and Qit as the outcome (e.g., income or poverty) of RT. Both Y_{it} and Q_{it} are functions of initial natural or physical conditions or endowments (Eio) and a set of IPI interventions (P_{it}) as well as other control variables (Z_{it}). A general form of the model can be specified as:

$$Y_{it} = f\ (E_{io};\ P_{it};\ Z_{it};\ IVs_{it}) \qquad (1)$$
$$Q_{it} = g\ (Y_{it};\ E_{io};\ P_{it};\ Z_{it}) \qquad (2)$$

In the empirical work and data collection, we will pay particular attention to identifying potential *IVs* that do not affect *Q* directly but affect *Q* only through *Y*.

The same IPI would impact the speed and outcome differently in different stages of rural transformation. That is the sequence of *IPI*s in facilitating the speed and outcome of RT.

To test this hypothesis, equations (1) and (2) are expanded as follows:

$$Y_{it} = f\ (E_{io};\ P_{it};\ D_{ij}*P_{it};\ Z_{it};\ IV_{it}) \qquad (3)$$
$$Q_{it} = g\ (Y_{it};\ E_{io};\ P_{it};\ D_{ij}*P_{it};\ Z_{it}) \qquad (4)$$

In this specification, *P* may impact Y or Q differently in different stages (D_j), where *Dj* is a set of dummy variables for the jth stage. The result of testing this specification generates significant policy implications in developing countries.

Rural, regional transformations often occur in ways that make them spatially correlated. Developments in one region of a country can affect the neighbouring areas of the country.

The engagement with stakeholders is surely important/valuable to identify priority policies; data analyses can also inform the significance of these policies on RT outcomes.

6 Achievements against activities and outputs/milestones

The project was officially launched on 18 January 2021 and implement for three years. The research team has 44 formal members from participating countries (Bangladesh, China, Indonesia and Pakistan), plus some who are partly or dynamically involved in some stages.

The project has achieved all objectives as described in the proposal. Significant impacts were made at the policy level in all participating countries. Based on the project, all participating countries have established a platform to interact with policymakers and make impacts. Bangladesh, Indonesia, and Pakistan established advisory boards that include high-level policymakers and stakeholders. Each country team meets the advisory board twice per year. China team set up a communication channel based on CCAP's network, which has delivered eight policy consultations at the central and provincial governments and 18 media interviews to make an impact.

The project has produced 80 research outputs. Among them, 50 outputs were co-designed by ANU and all partners and were conducted according to the research proposal. Partners also produced 30 additional outputs based on the project resource and provided capacity. The research outputs include 16 journal articles, four book chapters, ten conference papers, seven student theses, 34 working papers, eight policy briefs, and one set of capacity-building materials.

The team organised two special issues in Q1 ranking journals to disseminate results and make impacts. One special issue of the *Journal of Integrative Agriculture* (JIA) was published in November 2023, which includes five research papers (with another paper published in the JIA regular issue). Another special issue is organised by the *Asia and the Pacific Policy Studies* (APPS), which will be published in early 2024 and planned for ten papers to be submitted.

The team organised four thematic special sessions in the international conferences. Three are for the Agricultural and Resource Economics Society (AARES) annual conference in 2022, 2023, and 2024, and one is for the 11th Asian Society of Agricultural Economists (ASAE) International Conference held in Japan.

The project team organised three international conferences. The first International Conference on Agriculture, Natural Resources and Rural Development (1st ICANaRD) was held by the Indonesian Center for Agricultural Socio-Economic and Policy Studies (ICASEPS). The first end-of-year conference 2021 held by the IPB University, named by the First International Conference on Economic Transformation, Agriculture, and Rural Development (ICETRA). The End-of-Project conference was held in December 2023 by the CCAP in Beijing.

The ANU team organised 32 monthly workshops to discuss the research results and project management issues. All data and project documents are stored in the ANU repository and managed by the ANU team.

Objective 1: To explain what is meant by rural transformation

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	a. Literature review	Complete a stocktake of the measures of rural transformation proposed in the literature, identify more specific hypotheses concerning the key IPIs to consider, in the context of feedback from policy makers on the key issues they face	30 June 2021	Completed two papers – one is on the definition, measurements, and indicators of rural transformation in Asian developing countries (Wang et al., 2023); the other is a systematic literature review of gender and rural transformation (Rola-Rubzen et al., 2023). The two review papers are both published in the *Journal of Integrative Agriculture. (A*) -Each country completed two review papers – one is about the country-level RT stage and speed, and the other is about the IPI review. (*PC*)
	b. Interview policy makers and experts		30 June 2021	*PCs* established their own advisory board, including policymakers and industry experts. China used existing communication channels. All *PC*s set a channel for external communication and the interviews have been conducted through the advisory board meeting or fieldwork. Bangladesh held the Key information interviews and Advisory Committee meeting twice per year; Indonesia held the Focus Group Discussion and Advisory Committee meeting twice per year; Pakistan held the AC interview twice per year.
1.2	Select regions of study	Identify the list of study regions	31 December 2021	China selected 26 provinces (84%); Indonesia 30 provinces (88%); Pakistan 46 districts (29%); Bangladesh 32 districts (50%).
1.3	Data collection	Necessary raw data compiled for analysis in each country for each region selected	31 December 2021	The raw data has been collected and compiled. All data are kept and managed by ANU team.

| 1.4 | RT measures | Stage, speed and outcome measures are selected, compiled and reported, available to all researchers in a shared database. | 30 June 2022 | Indicators have been determined, and data collection is completed. The online data repository is created, and each *PC* can access the data by request. Each *PC* completed one paper on the stage, speed, outcomes and associated IPIs of rural transformation. The China team's paper has been published in *China Agricultural Economics Review*. (Huang & Shi, 2021) |

PC = partner country, A = Australia

Objective 2: To recognise what success means

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Income growth	One paper on RT, income growth and poverty reduction.	31 December 2021	Each PC completed one paper on RT, income growth and poverty reduction. The papers were all presented in the first End-of-Year conference in Indonesia (2021). China, Indonesia and Pakistan papers are published in the *Journal of Integrative Agriculture.*(Abedullah et al., 2023) (Shi & Huang, 2023) (Sudaryanto et al., 2023)
2.2	Inclusiveness	Series of papers on RT and inclusiveness, including at least one on gender inclusiveness.	30 June 2022	Each *PC* completed one working paper on the rural income inequality consequences of rural transformation (4 papers in total). Each *PC* also completed one paper on the gender inclusiveness of rural transformation with *A* (4 papers in total). The Bangladesh gender paper was presented at the 2022 Annual AARES conference. The paper now is accepted by the *Journal of Integrative Agriculture*.
2.3	Food security	Paper on RT and Food Security	30 October 2023	The team have produced three working papers on this subject which focus on Bangladesh, Indonesia and Pakistan.

2.4	Sustainability	Paper on RT and Sustainability	20 November 2023	The project planned to produce one paper on RT and sustainability which is led by the ANU and CCAP team. The paper on China was produced and prepared to submit to Asia and the Pacific Policy Studies (APPS) Special Issue.

PC = partner country, A = Australia

Objective 3: Explain what determines success

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Identify the drivers (IPIs)	Series of papers on the drivers of stage, speed and success	30 October 2023	16 IPI papers were produced. Each country had 4 papers: 1 IPI review paper plus 3 IPI empirical papers. China team's IPI review paper was published in Engineering, and one paper on urbanisation and associated institutional reform was published in *World Development (Sheng et al., 2022b)*. Other countries' review papers are ready to submit to Asia and the Pacific Policy Studies (APPS) Special Issue.
3.2	Missing services	One paper on the nature of 'missing services' and their impact on the stage, speed and outcomes of RT, including policy proposals for resolving the issue of their absence.	30 November 2023	ANU team collaborate with a researcher from the Utrecht University produced one paper on the missing services in the RT.

Objective 4: Lay out the lessons that can be shared among countries

No.	Activity	Outputs/ milestones	Completion date	Comments
4.1	Cross-country study	A significant report on the results of the cross-country study, identifying the lessons that are relevant across the participating economies, while stressing the impact of local conditions on the application of those lessons. A second paper on the lessons of the Australian experience of RT for other economies.	30 November 2023	One paper on the cross-country study and one paper on the Australian experience of RT were produced by ANU and CCAP team. The two papers are prepared to to submit to Asia and the Pacific Policy Studies (APPS) Special Issue.

Objective 5: Explain how policy changes can support successful rural transformation

No.	Activity	Outputs/ milestones	Completion date	Comments
5.1	Policy recommendations	A portfolio of policy recommendations to support successful RT, according to income growth and inclusiveness.	30 November 2023	Each PC produced two policy briefs for their governments to raise suggestions based on the findings from the project.

Capacity building (CB)

No.	Activity	Outputs/ milestones	Completion date	Comments
CB.1	Training on data and overall methodology	Evident improvement in the capacity of participants to contribute to the research (indicated by their joint authorship of papers)	1 December 2021	Four general training sessions were delivered in 2021. The contents covered the basic theories and practice issues, data management and modelling skills, and gender issue case studies. PC researchers have applied those skills in their research papers.
CB.2	Training on econometric analysis	Evident improvement in the capacity of participants to apply econometric methods in the research activity (indicated by the use of that methodology in their papers).	30 April 2022	ANU and CCAP delivered two sessions for each PC. The training targeted the econometric problems that PC faced during the research. The panel data econometrics, IV approach, and modelling skills were covered. The methodologies have been applied in all PC work subsequently.

PC = partner country, A = Australia

Workshops and dissemination

No.	Activity	Outputs/ milestones	Completion date	Comments
WD.1	Inaugural workshop	Presentation of a list of datasets to be examined and work plan for all participants	20 January 2021	Completed in January 2021. We organised a three-day workshop to discuss the datasets and exchange knowledge of PC.
WD.2-4	Workshops	Workshop report on papers presented, key results and next steps	22 November 2023	Completed 32 monthly workshops. The Workshops are normally arranged in the last week of the month.
WD.5	Writing camp	Evidence of the development of a series of research papers	NA	Due to Covid, we cancelled the in-person writing camp, but papers can demonstrate insensitive writing activities.
WD.6-7	Present papers in international conferences	Details of papers presented and of the events and audiences, plus monitoring the	30 November 2023	The project organised two international conferences that the IPB and CCAP teams hosted separately. Plus, three thematic sessions of AARES and ASAE international conference.

		translation of these presentations to publications.		
WD.8-9	Policy Briefs	At least 5 policy briefs a year in the second and third years (4 countries + 1 regional)	30 November 2023	One policy briefs writing workshop was delivered. Each country delivered two policy briefs to their policymakers.
WD.10	Final project conference	Summary of proceedings and commentary on the policy proposals	30 November 2023	The final project conference is hosted by CCAP in December 2023 in Beijing.

PC = partner country, A = Australia

Additional achievements beyond the proposal

Apart from the activities planned in the research proposal, the team achieved additional outcomes during the past three years.

The first research topic added is the relationship between RT and international trade. The CCAP team completed this task. One paper on China was produced. The paper is prepared to submit to the APPS special issue in early 2024.

The second research topic added is the relationship between RT and FDI. Two papers were produced – one from China and one from Indonesia. The Chinese paper has been published in *Applied Economics*.

Each country conducted two engagements with private sector stakeholders. For example, CCAP engaged with CP Group and Alibaba Group, and the Pakistan team engaged with the seed dealers. The team members disseminate research results to our stakeholders to discuss how the project can help their business. The China team received feedback from the Alibaba Group that digital agriculture and e-commerce services would be a solution to help farmers increase their accessibility to the global market and enhance their food standards. The Pakistan team also suggests addressing the missing service problem of the inputs market to help farmers increase their knowledge and information for farming activities.

7 Key results and discussion

7.1 Objective 1: the meaning of RT, measures (RT1 and RT2), and stages

Based on the literature review and discussion, the team agreed to adopt the definition of RT provided by Huang and Shi (2021) and Wang et al. (2023). Although rural transformation has many dimensions that can be addressed from different disciplines, in this project, we follow IFAD's works on Rural Transformation (IFAD, 2016), which states, "Rural transformation (RT) involves rising agricultural productivity, increasing commercialisation and marketable surpluses, and diversification of production patterns and livelihoods. It also involves expanded decent off-farm employment and entrepreneurial opportunities, better rural coverage and access to services and infrastructure, and greater access to, and capacity to influence, relevant policy processes. All of this leads to broad-based rural (and wider) growth and to better managed, more sustainable rural landscapes."(p.23). We further improved IFAD's study that included all rural areas by using our RT1 and RT2 as we selected the provinces/districts that started grain production and then moved towards non-grain or high-value sectors – and this is a major part of Asian agriculture. All data were collected from partner countries' published statistical databases or books provided by our partner teams. Farming business and non-farming (off-farm) employment are two major (or almost all) components of most Asian rural households. The definition is illustrated in Figure 3.

Figure 3. RT definition in this project

The project identifies the pathways and stages of RT. This framework was initially developed by CCAP based on China's experience, which is also similar to the pattern of many Asian countries. The partner countries reviewed this framework and made sure it applies to other countries. One of the main scholarly contributions of this project is to identify the stages of RT and how these apply to different country contexts. This section can be improved by highlighting this and

providing more explanation on the suitability of the stages conceptualised by China to other developing countries and whether any adjustments should be made when applying to other countries.

The stages of rural transformation include five stages, see Table 3.

- **Stage I:** Agriculture is dominated by the grain sector to meet the basic and necessary demand for food grain. Most labour and land in every province are used for grain production during this stage.

- **Stage II:** During this stage, agriculture starts diversification. The production and commercialisation of labour-intensive and high-value cash crops (e.g., vegetables and fruits), livestock and fishery grow rapidly. Rising grain production and an overall increase in agricultural productivity enable farmers to allocate more land, labour and capital to high-value commodities, which has significantly contributed to the rapid growth of farmer's income because the production of commercialised high-value commodities is normally more profitable than the production of grain and other staple crops.

- **Stage III:** Agricultural specialisation is enhanced, the share of high-value agricultural commodities continues to rise, and rural labour's non-farm employment occurs.

- **Stage IV:** non-farm employment grows rapidly. During this stage, agricultural mechanisation and urbanisation significantly facilitate rural transformation and increase agricultural productivity. Rural labourers increasingly shift from farm to non-farm employment.

- **Stage V:** High-value and sustainable agriculture and integrated urban-rural development are major rural transformation features in this last stage. During this stage, while high-value agriculture continues to rise, the most significant changes occur in a move to the more sustainable development of agriculture. The growth of agriculture in the previous stages had come at the expense of resources and the environment and had been raising the income gap between rural and urban areas. More recently, in response to the challenges of natural resources and environmental degradation, sustainable agriculture has become a rural development goal.

Table 3. Stages of rural transformation

Stage	Explanations
I	Primary on staple grain production (mainly food grain)
II	Agricultural commercialization and diversification, gradually rising labour intensive and high-value agricultural commodities
III	Agricultural specialization, rising high-value agricultural commodities and non-farm employment
IV	Increasing specialization on either farming or non-farm employment and rapid mechanization and more non-farm, especially off-farm migration

| V | High-value agriculture, sustainable agriculture and integrated urban-rural development. |

Based on the expert knowledge and RT data collected at the regional level, we can identify the stages the four countries experienced, the results can be seen in Table 4.

Table 4. pathways and stages experienced by countries

Stage	Paths of RT	Bangladesh	China	Indonesia	Pakistan
1	Staple food production	Before 1990	Before 1980	Before 1990	Before 1990
2	Agri. diversification & commercialization	1990 to 2000	1980s	1990-2005	1990 to 2010
3	Farming + part time non-farm employment	2000 to date	Early 1990s to 2000s	2005 to 2015	2010 to date
4	Specialisation/mechanization + full time non-farm employment			Since 2015	
5	Integrated urban-rural + sustainable rural development		Since 2010s		

7.2 Objective 2: the success of RT means

This project examined the success of RT from a number of dimensions – income growth, poverty reduction, income and gender inclusiveness, food security, and sustainability.

7.2.1 RT, income growth and poverty reduction

The empirical regression results verify a correlation between RT and income growth and poverty reduction. Rural transformation may significantly increase rural income and reduce poverty by increasing high-value agricultural production and non-farm jobs, though the degree varies across the countries. To reduce poverty, policymakers can promote rural transformation by using some instruments, though it would also consider the stages. The economic mechanism between RT and its outcomes as well as the IPIs is developed by Abedullah et al. (2023), see Figure 4.
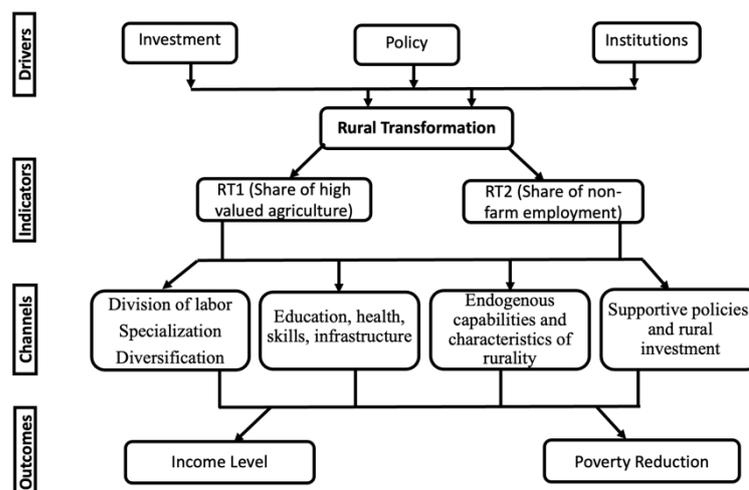
Figure 4. The mechanism of RT, income growth, poverty and IPIs. (Source: Abedullah et al. (2023))

Bangladesh

Even though Bangladesh has had moderate rural and structural transformation, RT and ST rates have varied widely across the country over the last three decades. Rural transformation results from rural structural change and rural labour shifts from farm to non-farm employment. An important element of agricultural ST is the shift from low-value commodities to high-value commodities like vegetables and fruit. Despite the enormous growth in agriculture, agricultural GDP and employment have declined in all districts. Rural and structural transformation has increased rural per capita income in all regions, but the growth rate varies. Our research shows a relationship between RT (or ST) and rural income. Enhancing the expansion of RT and ST is essential for accelerating rural income. Research on raising rural income per capita has various policy implications. The country team research demonstrates that the effects of RT and ST on rural income and the incidence of poverty are notably significant, specifically in districts where rural per capita income is low, and the incidence of poverty is high.

The results inform that the Bangladesh government should speed up rural transformation by switching from low-value to high-value agriculture and rural workers from farm to non-farm employment, particularly in underperforming areas. In the 8th Five Year Plan, National Agricultural Policy 2018, Sustainable Development Goals, Delta Plan-2100, and other planning documents, the government has been putting all efforts into agriculture's overall expansion. Rather than that, the history of rural Bangladesh from the 1970s strongly suggests that rapid population increase exacerbated poverty. If villages had remained to rely on traditional agriculture in isolation from urban market processes, life might have been hard, brutish, and brief.

However, things could have been far better if the market had performed more beneficial functions, such as tightening, increasing efficiency, and coordinating complicated economic activity. The global coronavirus epidemic (COVID-19) has also impacted Bangladesh's agriculture sector. The agricultural sector's primary issues currently include providing food and nutrition security for Bangladesh's large population and safeguarding the lives and livelihoods of farmers, farm

labourers, and those involved in agriculture in light of the looming famine in the post-Corona world. Subsidies on agricultural inputs have been increased, agrarian inputs have been made more accessible, and the breadth of agricultural financing has been expanded in response to Corona's effects.

Given the critical nature of raising agricultural product output, the government allocated a budget of TK 9,000 crore in FY2019–20 and TK 9,500 crore in FY2020–21 for fertiliser and other agricultural input subsidies. Decision-makers in central and local governments, as well as development agents working in local districts, can utilise the data on rural transformation categories to understand better where each district is now and where they should focus their efforts in the future. Appropriate institutional innovations, governmental assistance, and investments should be explored to facilitate a more rapid and inclusive rural development. Inequality

China

China has achieved successful rural transformation over the past four decades. Such a process is characterised by a gradual movement from grain-dominated agriculture to more diversified high-value agriculture and a significant shift from farm to non-farm employment in rural labour. Specifically, on the one hand, agricultural transformation is based on the premise that primary food grain production has been growing at a steady rate, which allows more land, water resources, and other production factors to be allocated to produce cash crops, livestock, and aquatic products to meet the diversified food demand in China. On the other hand, driven by urbanisation and industrialisation, ST has created massive employment opportunities for rural labour and rising agricultural labour productivity, enabling rural labour to work in non-farm sectors.

However, the level of RT differs across provinces (including autonomous regions and municipalities) in China. In particular, provinces in the eastern region have transformed their rural economy faster than many provinces (including autonomous regions and municipalities) in the central, western, and north-eastern regions. Our provincial analysis shows that the level of RT is strongly and positively correlated with per capita rural income and negatively associated with rural poverty incidence. Considering the non-linear relationship between the path and outcome of RT, the marginal contribution of high-value agriculture or rural labour employment in non-farm to per capita rural income is increasing. The presence of either the left-hand side of a U-shaped curve or the right-hand side of an inverse U-shaped curve indicates that promoting rapid RT will likely reduce rural poverty.

This project has several important policy and research implications for rural income growth and poverty reduction in the process of RT in China. First, accelerating RT either by agricultural transformation towards high-value products or rural labour employment transformation towards non-farm sectors is crucial. Second, the categories of provincial RT provide helpful information to decision-makers in central and local governments as well as development agents working in local provinces (including autonomous regions and municipalities). It helps identify the current status of each province (including autonomous regions and municipalities) and provides guidance on the desired direction for future progress. Third, appropriate IPIs should be explored to promote more rapid and inclusive RT.

Indonesia

In Indonesia, both RT1 and RT2 indicate a positive association with the growth of rural household income and the reduction of rural poverty incidence.

Based on the relationship between the share of agriculture GDP, the share of high-value agriculture, and rural income, and the poverty rate, each province of Indonesia shows different patterns, which indicate different speeds of ST, RT1, RT2, rural income, and poverty reduction. South Sulawesi and West Papua regions show fast speed in terms of ST, RT1, and rural income. On the contrary, the provinces of Aceh, North Sumatra, Riau, and West Kalimantan show slow speed in ST, RT1, and rural income. Furthermore, the provinces of South Sulawesi, Maluku, and West Papua indicate fast speed on ST, RT2, and rural income. In contrast, the provinces of West Sumatra and Riau show slow speed on ST, RT2, and rural income growth.

Based on the speed of the changes on ST, RT1, and the poverty rate, East Java and North Maluku provinces are categorised as fast speed. In contrast, North Sumatra and North Kalimantan are classified as low-speed. On the other hand, based on the speed of changes in ST, RT2, and the poverty rate, the four provinces of Central Sulawesi, South Sulawesi, West Sulawesi, and North Maluku are categorised as fast speed. In contrast, the provinces of Bali and North Kalimantan are categorised as low-speed.

Our project also confirms that the different typologies of ST, RT, rural income growth, and poverty rates across regions are associated with the different drivers, including institutions, policies, and investments (IPIs). Promoting institutions to strengthen farmers' groups and partnerships contributes to significant agricultural growth, including high-value commodities. However, a biased government incentive policy toward developing food crop sectors may have somewhat slowed the growth of high-value commodities. On the investment side, the varied intensity of infrastructure investment across regions partially explains the different typologies of ST, RT, rural income, and poverty rates in the corresponding regions.

There are relatively strong relationships of rural transformation, both RT1 and RT2, to rural per capita income and rural poverty rate. From the panel data correlation analysis, it can be inferred that the relationship between RT1 and RT2 with rural income is positive. In contrast, the relationship between RT1 and RT2 with the rural poverty rate is negative. The results imply that accelerating rural household income and reducing poverty incidence should be done through an integrated policy, i.e., promoting high-value agriculture and expanding rural non-farm employment. Furthermore, regional development policy should emphasise the provinces in the slow-speed category regarding the growth in ST, RT1, RT2, rural income, and the reduction of poverty incidence.

The dynamic relationship between RT1 and RT2 on per capita income and rural poverty is evident during the reform period. These are characterised by the significant coefficients of per capita rural income lags and rural poverty. Furthermore, the relationships between RT1 and RT2 on rural income become Inverted-U. The relationships between RT1/RT2 and rural poverty during the reform period produce different patterns. RT1 tend to produce negative and linear relations, while RT2 produce a negative exponential relationship. Hence, an increase in rural non-farm is expected to speed up poverty alleviation in rural areas.

Typology analysis and regression analysis confirm that a higher level of rural transformation is strongly associated with higher per capita income of rural households and lower rural poverty reduction. Identifying the status and category of RT1 and RT2 at the provincial level can provide helpful information for the decision-makers at the Central and local governments on the direction of facilitating local rural transformation to raise rural income and have more inclusive income growth in the future.

Pakistan

Although RT1 and RT2 both correlate with income growth and poverty reduction in Pakistan, the coefficients (contributions to the outcomes) are different. The empirical finding reveals that the contribution of RT1 is more than double that of RT2, suggesting that policies, institutions, and investments need to divert to increase the share of high-value crops to achieve the objective of high rural per capita income. Similarly, the larger magnitude of the coefficient of RT1 compared to RT2 demonstrates that efforts to increase the share of high-value crops could play a vital role in alleviating rural poverty. Our project suggests that a better education and women's economic inclusion would be helpful to address the challenges of rural poverty. Similarly, urbanisation in the region helps generate more economic opportunities in rural areas.

7.2.2   RT and inequality

Bangladesh

The rural transformation plays a key role in shoring up income and employment opportunities for the rural workforce. Using six waves of nationally representative Household Income and Expenditure Surveys, our project studied the impacts of rural transformation on rural income inequality in Bangladesh. We focus on rural income inequality at the district level measured by the Gini coefficient and the share of high-value agriculture and rural non-farm employment as rural transformation indicators. We find that rural income inequality, share of high-value agriculture, and share of rural non-farm employment have increased over the last three decades in Bangladesh. Accounting for the potential endogeneity of rural non-farm employment and other exogenous variables, we find that rural income inequality is negatively associated with the share of high-value agriculture and positively associated with the share of rural non-farm employment. We also find that rural income inequality is negatively associated with the per capita healthcare expenditure and positively associated with per capita education expenditure and use of basic drinking water. We suggest developing farm and non-farm sectors simultaneously to reduce rural income inequality. Human investment, rather than economic growth, is critical in reducing rural inequality at the district level. Hence, formulating policies focusing on district characteristics would help alleviate rural inequality.

China

Rural and structural transformations have been accompanied by significant rural per capita income growth in every province in China, but again, increase in rural income also varies among provinces. We find a positive correlation between the RT (or ST) level and the rural GINI coefficient. Nearly all the provinces follow a

similar trend: the higher the RT (or ST) level, the higher the rural GINI. There is also evidence of a negative relationship between the speed of RT1 and rural GINI and a non-linear relationship between RT2, ST and rural GINI.

China's study has several policy implications for rural development. In general, the government should accelerate rural transformation by moving agriculture from low-value to high-value commodities and shifting rural labour from farm to non-farm employment, particularly for those provinces that fell behind in rural transformation in the past. Previous studies have shown that appropriate institutional innovations, policy supports, and investments can improve agricultural productivity, speed up rural transformation from the lower to the higher stage and raise rural income. In the meantime, structural transformation is also critically important to raise rural income. By 2019, China had more than 288 million rural labourers in non-farm employment for more than six months, of which 40% worked locally and 60% were migrants. However, the percentage of rural labourers shifting from farm to non-farm employment differs largely among provinces. Urbanisation, industrialisation in urban and rural areas and reforming *Hukou* registration institutions are essential for creating more jobs for rural labourers. More importantly, income disparity is accompanied by income growth.

Indonesia

In Indonesia, the income inequality in rural areas varied widely within and between provinces from 2000-2020. Rural income inequality increased in Java from 2000 to 2015 but decreased from 2015 to 2020, except in West Java and Banten. Most provinces outside Java followed the pattern of income distribution changes as in Java. The result shows that the Government has successfully reduced income inequality (disparity) in rural areas from 2015 to 2022.

The poverty incidence in Indonesia continued to decline during the period 2000-2020, both in terms of the poverty gap index and the poverty severity index. Thus, we can see that Indonesia's structural and rural transformation has successfully reduced poverty in all provinces. The share of high-value agriculture (RT1) increased from 2000 to 2020, except for a few provinces outside Java. The increase in the share of high-value agriculture also occurred in Java, although the trend was relatively flat. The share of non-agricultural employment (RT2) increased significantly from 2000 to 2020. However, there has been an increase in rural income inequality in almost all provinces in Indonesia during the 2000-2015 period. It means that non-agricultural employment opportunities are not equally accessible to rural communities.

We conclude improving the quality of human resources and developing public infrastructure in rural areas is necessary to improve people's welfare and reduce income inequality. The Indonesian results also show that three variables of IPIs influence the poverty rates in rural areas, namely (a) irrigation area (IRI), (b) electricity customers (PEL), and (c) modern market (MOM). The irrigation infrastructure is essential to increasing income in rural areas. The facilities accompanying these irrigated agricultural lands boost income generation and, in turn, reduce poverty. Therefore, efforts to protect irrigated land must continue to be pursued because this will positively influence farmers' incomes and food sufficiency for people experiencing poverty.

Additionally, increased availability and affordability of public electricity will reduce poverty and inequality in rural areas. Therefore, future electricity distribution to

rural areas should be maintained. Indicators of electricity use per capita need to be continuously monitored in line with population growth if poverty alleviation is one of the Government's primary concerns. Rural infrastructures, in general, are expected to promote economic development and alleviate poverty. Thus, the Government needs to increase the availability and affordability of public infrastructure in rural areas to reduce income inequality and accelerate poverty alleviation. The public facilities indispensable for this purpose include roads and transportation, ports, markets, health, and education.

Pakistan

The Pakistan analysis is carried out at the district level, where the panel dataset has four rounds from 2004 to 2019. The study reveals that rural transformation could be faster in the country, primarily attributed to the rising share of livestock and rural non-farm employment. Ominously, the high-yield crops have a minor share with no overtime improvement. The findings suggest that rural transformation significantly impacts poverty, mainly due to livestock and non-farm employment. The impact on inequality is mixed, where crops and rural non-farm employment positively impact inequality, whereas livestock harms inequality. Access to the rural infrastructure, i.e., metallic roads, education, and market linkages, is much heterogeneous across districts where people experiencing poverty are mostly deprived of it. The benefits from public policies are mostly skewed towards the high-income groups. Women's inclusion is mainly missing in rural areas while accessing socio-economic opportunities.

7.2.3   Gender Inclusiveness in RT

Bangladesh

Gender inclusiveness is important in Bangladesh's rural transformation process, as rural women play key roles in agricultural and non-agricultural sectors. Gender inclusiveness also leads to gender equity. This project empirically evaluates relationships between rural transformation and gender inclusiveness in Bangladesh. We consider three rural transformation indicators: high-value

Commodity's' share in agricultural output values, non-farm employment's share in rural labour employment, and non-agricultural GDP's share in total GDP. Indicators capturing gender inclusiveness include males' and females' per capita rural income, the ratio of investments into gender programs, female access to education, healthcare, employment participation, land ownership, and asset ownership. We test the effect of the difference in per capita rural income of males and females and the ratio of their incomes and check for the robustness of the gender variables across different model specifications. We find that female land and asset ownership and access to education and healthcare are robust determinants of various stages of rural transformation. Thus, our results suggest that improving women's ownership of land and assets and investing in women's education and healthcare will likely contribute to a more inclusive rural transformation.

China

A lower spousal education gap does not reduce agricultural income because it substantially increases the wife's labour participation and mechanisation. We roughly calculate that eliminating the existing spousal education gap could reduce

cross-family income inequality in rural China by 10%. We explain this substantial effect by the mechanisms that lower spousal education gaps and reduce fertility and migration costs. We roughly calculate that about 10% of rural China's existing cross-family income inequality can be explained by cross-village differences in spousal education gaps. Therefore, there are outstanding achievements in reducing gender education inequality in rural China.

Over the past decades, family income has substantially improved, and cross-family income inequality has been reduced.

Indonesia

Indonesia has been experiencing rural transformation in the past three decades. While women play a vital role in rural transformation in Indonesia, the gap in gender equality persists. This project examines the empirical relationship between gender and rural transformation in Indonesia. Here, we explore several factors, including the share of non-farm labour in rural areas, the share of non-agricultural GDP, women's income per capita, men's income, women's access to health care, women's access to education, irrigation, homeownership, access to technology, access to electricity, rice productivity, and access to clean water, using longitudinal data from the National Labour Force Survey (SAKERNAS). The findings showed that improving women's access to education and healthcare affects their per capita income. However, women's total income remained lower than men's, showing that income disparities between men and women continue to perpetuate. Access to electricity and clean water was also a key driver of women's GDP growth in the non-agricultural sector. Concentrating on women's access to health and education is also important in boosting women's roles in increasing non-agricultural GDP in Indonesia. Moreover, strengthening rural infrastructure will indirectly boost rural transformation.

Pakistan

In Pakistan, Our empirical findings underscore the pivotal role of educated women in propelling the wheels of rural transformation, as they exhibit a profound understanding of the agricultural production system and related information. The study further investigates the impact of female employment rate, female labour force participation rate and per capita income on rural transformation. Hence, it is likely that females are contributing to an enhanced share of high-valued agriculture while simultaneously capitalising on diverse opportunities in the off-farm sector. Notably, these impacts vary in magnitude across regions and stages of rural transformation.

7.2.4   RT and food security

Bangladesh

Non-farm income has a positive effect on food security. Besides, the paper also found that house head age, gender, family size, education, off-farm, farmland size, and Access to training significantly affected participation in non-farm employment (Omar et al., 2023).

Indonesia

RT1 and RT2 have significant and positive impacts on food security, the possibility of a non-linear relationship between RT2 and the food security index, and the possibility of a non-linear relationship between RT2 and food security.

Pakistan

RT positively affects food security across Pakistan's regions, though the degree varies.

7.2.5   RT and sustainability

In this project, we explore the relationship between RT and sustainability, indicated by water scarcity, as water is a crucial natural resource for agricultural production and rural development. The case is conducted in China. We find a U-shaped relationship between per capita water resources and RT indicators – RT1 and RT2. See the Figure 5.
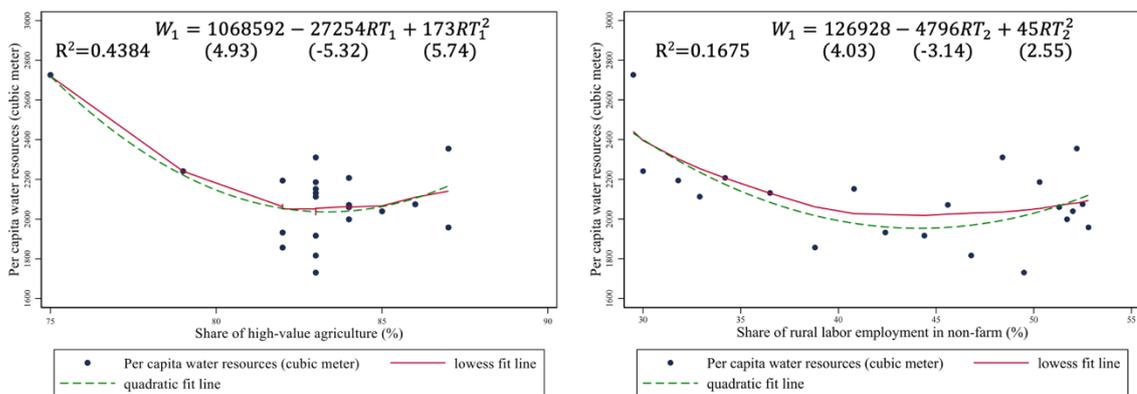
Figure 5. The relationship between per capita water resources and RT

The findings confirm that rural transformation first exacerbates and then alleviates water scarcity in China. The relationship differs substantially across regions in different stages of rural economic transformation. IPIs have contributed significantly to reconciling the conflicting relationship between rural transformation and water scarcity.

7.3 Objective 3: Drivers of RT (IPIs)

Based on rounds of discussions and historical review, the team have found that some specific IPIs are key drivers of RT in each country, see Table 5. Some of those factors are common for all countries (like irrigation), while the others are particular factor(s) of one country. The summary contributes current knowledge of RT, which can be used to think about what policy focus could promote RT. Given the data availability and capacity limitations, the team agreed to a limited set of factors to investigate to provide robust results empirically. Each country will conduct four empirical research projects focusing on four main factors – irrigation and FDI as common factor for all countries and two other particular factors of different countries.

Table 5 IPIs selected

Country	Institution	Policies	Investment
Bangladesh	Land, technological innovation	Agricultural credit disbursement, access to credit, FDI	Irrigation, rural electricity
China	Land, urbanisation, labour, credit	Agri-tax, subsidy and price policies, trade liberalisation, R&D and extension	Irrigation, road infrastructure, education
Indonesia	Land, reform on the financial institution, the partnership of large corporations with smallholders, farmers' organisation	Subsidies and credit, trade policy, food law, early green revolution, special economic zone, rural development fund	Irrigation, electricity, market infrastructure, R&D, human resource, and road infrastructure.
Pakistan	Credit, land	Market access, trade policy	Irrigation, road, education

7.3.1   Irrigation

Bangladesh

The share of irrigated land has a positive effect on both rural transformation indicators and per capita rural income. The share of irrigated land has a greater impact on the higher stages of the share of high-value agriculture and the share of rural non-farm employment but not on rural income per capita. The government of Bangladesh should prioritise the construction of irrigation infrastructure and the encouragement of private sector investment in irrigation in order to increase high-value agricultural production, rural non-farm employment, and rural income. (Saha et al., 2022)

Indonesia

As one of the determinants for rural transformation, irrigation positively impacts rural transformation in Indonesia, especially for RT2. This irrigation impact seems weak on RT1 because irrigation in Indonesia was purposed for increasing staple food production, not high-value agricultural output such as horticulture and plantation outputs. The effect of irrigation on rural income is also relatively weak and may have contributed to rural poverty.

China

Irrigation has promoted the production of bulk commodities (e.g., grain, cotton, oil and sugar crops) in the early stage of rural transformation, and then played an increasingly important role in producing non-bulk commodities (or high-value agricultural crops, e.g., vegetables, fruits and horticulture) in the middle and later

stage of rural transformation. Similar results are also obtained regarding rural labour employment in the non-farm sector. More rural labour is released for non-farm employment with rising agricultural productivity. Irrigation has also played an essential role in raising grain production to meet grain security in the early stage of RT, and then played an increasingly important role in shifting to high-value agriculture in the middle and later stages of RT; similar results are found in rural labour non-farm employment through rising agricultural productivity so that more labour released for non-farm employment. (Shi & Huang, 2022)

Pakistan

Irrigation contributes positively to the process of rural transformation both in RT1 (share of high-value crops) and RT2 (share of off-farm employment)) but only at higher stages of rural transformation. In a nutshell, irrigation has the potential to accelerate rural transformation, making it imperative for the government to prioritise the expansion of irrigation facilities as a part of its policy, particularly in the districts which have crossed the initial stage of rural transformation. (Naz et al., 2023)

7.3.2 Institutional reforms and policies

Bangladesh

Institutional arrangements in the financial system, specifically credit disbursement, positively affect rural transformation indicators (the share of high-value agricultural commodities and the share of rural non-farm employment) at the regional level in Bangladesh.(Saha et al., 2023)

The land tenure system in terms of land rented out positively impacts both indicators of rural transformation at the regional level in Bangladesh. Initiatives and policies taken by the government on land have contributed significantly to this transformation. Continuous efforts towards land redistribution and an efficient land tenure system can bring more positive changes in rural areas. It is of the utmost importance to ensure that land is accessible to small and marginalised individuals, as this will contribute to sustainable rural transformation.

China

The rapid process of urbanisation boosted by institutional reform significantly increased off-farm employment of rural households in China over the past two decades. Between 2000 and 2018, urban growth throughout the nation, on average, has generated off-farm employment opportunities by 15–18 million annually by using a nationwide farm household survey for six provinces, accounting for a significant proportion of rural migrants. It would lead to the rural-urban sustainable development model that facilitates rural development by enabling farmers to obtain more off-farm income. Moreover, the positive impact started with the emergence of a few large metropolitan cities but ended with the growth of local, relatively smaller ones. This implies that off-farm employment creation is a nationwide phenomenon and could be driven by different types of urban growth in different stages of structural transformation. These findings provide valuable insights for policymakers who want to facilitate rural transformation through speeding up urbanisation in China and should consider its sequential strategy, as well as in other developing countries. (Sheng et al., 2022a)

Indonesia

Indonesia has experienced a shift towards high-value commodities and commercialisation in agricultural production, a move away from subsistence farming towards market-driven practices, and a shift towards the non-farm sector as the primary source of employment. However, income inequality remains a significant concern, and poverty reduction efforts have been unevenly distributed nationwide. Market institutions, including traditional markets, conventional markets, and shopping centres, significantly affect rural income, and their growth rates vary across regions. Indonesia's economic development is shifting towards a more market-driven, diversified economy. While this shift can potentially create new opportunities for employment and growth, income inequality remains a significant challenge. Additionally, market institutions are essential to the country's economic development and can significantly affect rural income and regional growth rates (Dermoredjo et al., 2023).

The effects of better access to agricultural credit on RT1 are positive, while the effects of irrigation on RT1 are negative; the effects of agricultural credit on RT2 are negative, while the effects of irrigation on RT2 are mixed.

The fertiliser subsidy in Indonesia is one policy instrument to improve farmers' welfare and rice production. The fertiliser subsidy policy in Indonesia has had a practical positive impact on agricultural development and rural transformation. Fertiliser subsidies increase the proportion of rural non-farm employment (RT2), reduce poverty and increase incomes.(Purba et al., 2022)

Pakistan

A preliminary result shows that increasing access to agricultural credit for small and medium farmers can promote the level of RT in Pakistan. (Farooq & Abedullah, 2023) In Pakistan, education enhances the share of high-value agriculture in districts at their second and third stage of rural transformation compared to stage one.

Similarly, education is also causing a structural shift, where education may lead to a shift from farm to off-farm employment.

7.3.3   Trade and FDI

China

China can further open up to the outside world and attract more foreign enterprises to China's rural areas. The introduction of foreign capital investment should pay attention to technology-intensive and emerging service industries in recent years and attract more labour-intensive industries in rural Chinese areas. China should improve the regional distribution structure of foreign investment and introduce more FDI to the central and western regions, especially the inland rural areas. Upgrade the industrial structure, increase fixed assets and R&D investments, improve rural education level, expand the export scale, and promote urbanisation (Hu et al., 2023).

The reduction in tariffs faced by industrial exports significantly increases the proportion of off-farm employment; for every 1 percentage point tariff cut, the proportion of off-farm employment in rural labour will rise by 0.35 to 0.62 percentage points, which accounts for about 7.7% of the increase in rural off-farm employment between 2000 and 2018, equating to 10.6 million off-farm

employment created over the past two decades (given 288 million off-farm employment in 2018, up from 150 million in 2000). Tariff cuts on agricultural imports also boost off-farm employment, and tariff reduction is mainly concentrated in the accession stage; we think its effect is primarily in the early stage, but the robustness of its effect is relatively weak, and its impact channel needs to be further explored. (Preliminary results from this period, the paper is under drafting)

Indonesia

The provinces that received the highest FDI flows were DKI Jakarta, West Java, East Java and Bali, and East Kalimantan, Central Sulawesi and Papua, for the last periods of 2011-2020. In general, the value of FDI tends to increase over time. During the 2000-2020 period, the largest FDI realization flowed to the industrial sector, followed by the transportation, warehousing and communication sector, trade, hotel and restaurant sector, as well as electricity, gas and water sector, and mining sector for the last period 2011-2020. The results of panel data regression show that FDI has played a positive role in rural non-farm employment and a significant positive role in rural labourers' per capita income and income distribution in rural areas. FDI significantly increases rural labourers' income and tends to reduce income inequality in rural areas. The government should continue to promote FDI through the improvement of infrastructure, quality of human resources, and better regulatory framework. Priority policy should be focused on the sector with the lower value of FDI and in provinces other than DKI Jakarta and other provinces in Java.

7.4 Objective 4: cross-country comparison and the lessons can be shared

7.4.1 Stages comparison

Based on the regional-level panel data, the ML results show the regional-level patterns of RT stages in Figure 6. Different colours represent different stages, according to Table 4 and Table 5. In Figure 6, the vertical axe is the RT index, established by RT1 and RT2 using the PCA method. Each dot point represents one region (province for China and Indonesia; district for Bangladesh and Pakistan). The thickness represents the regional disparities (spatial heterogeneity). We can see from the chart that larger regional disparities lead to longer periods of stages transitioning from one to another. Also, the results are consistent with experts' evaluation summarised in Table 4 and Table 5.
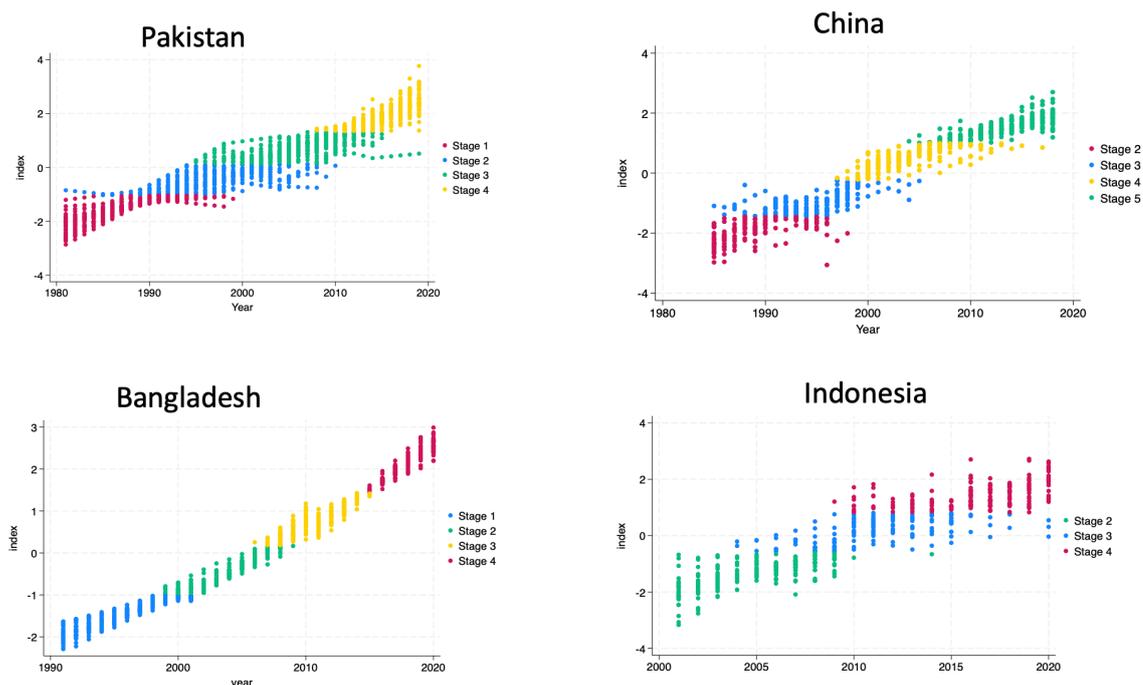
Figure 6. Regional level pathways of RT across countries.

We found similar RT and ST patterns defined by the share of agricultural GDP across countries. The shares of agriculture in both GDP and employment have been falling with the per capita GDP growth. For all participating countries, the gap between agricultural GDP and employment share has been generally narrowed over time – convergence. See Figure 7.

It suggests that labour productivity among sectors is converging. i.e. Agricultural labour productivity (or farm labour's income) approaches non-agricultural labour productivity (or urban worker's income) when this gap approaches zero. We find in all countries, the declining share of agriculture GDP and share of agriculture employment tends to converge during 2000-2020; the decline of the share of agriculture to GDP and increase in nonfarm employment could be because of the rise of new sectors like ICT and other service sectors, like barbers. This process is consistent with the evidence of rural transformation as indicated by the increasing trend of high-value agriculture production (RT1) and the share of rural non-farm employment (RT2).
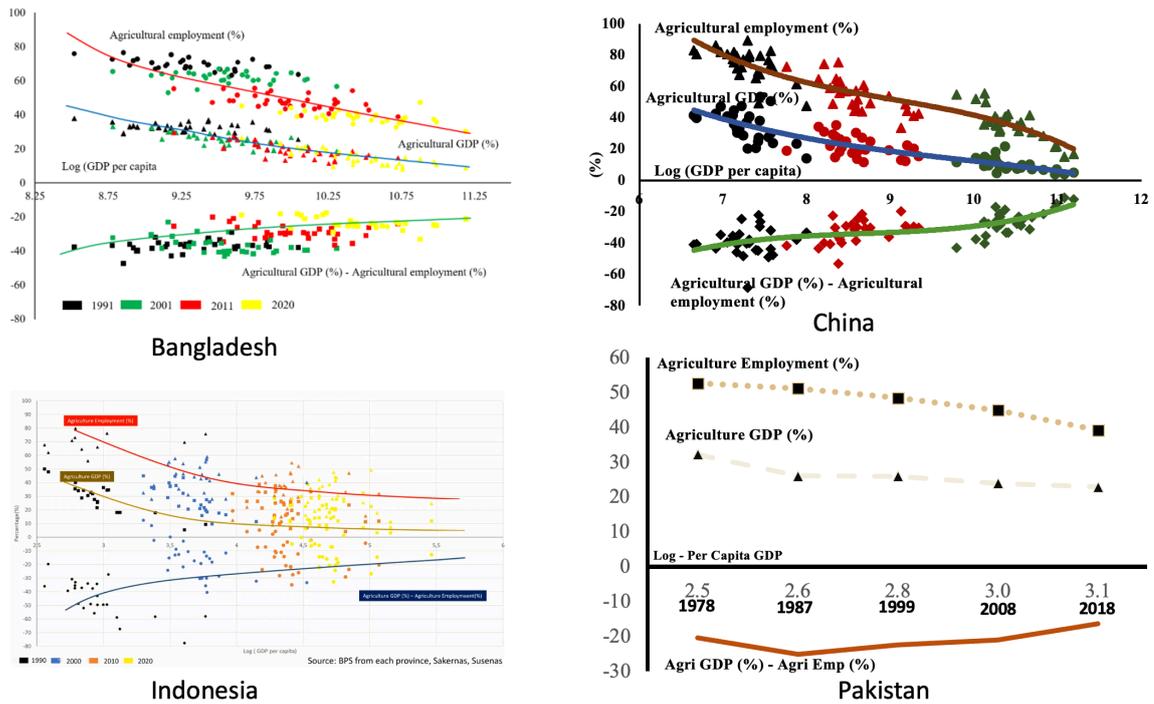
Figure 7. Convergence of ST and RT

7.4.2 Technological change

We further model the technological change across four countries. The comparison can be seen from Figure 8. Only China observed an increasing trend, implying that continuing technological improvement is the key to China's success.

Figure 8. The technological improvement comparison of all countries

7.4.3   Australian lessons

The journey of Australian agricultural sector deregulation reforms, starting in the 1970s, marks a pivotal transformation in the Australian agricultural landscape. While initially challenging, these reforms have significantly contributed to the sector's resilience and adaptability, fostering an environment conducive to innovation and efficiency. The critical role of agricultural research, development, and extension (RD&E) in underpinning this evolution 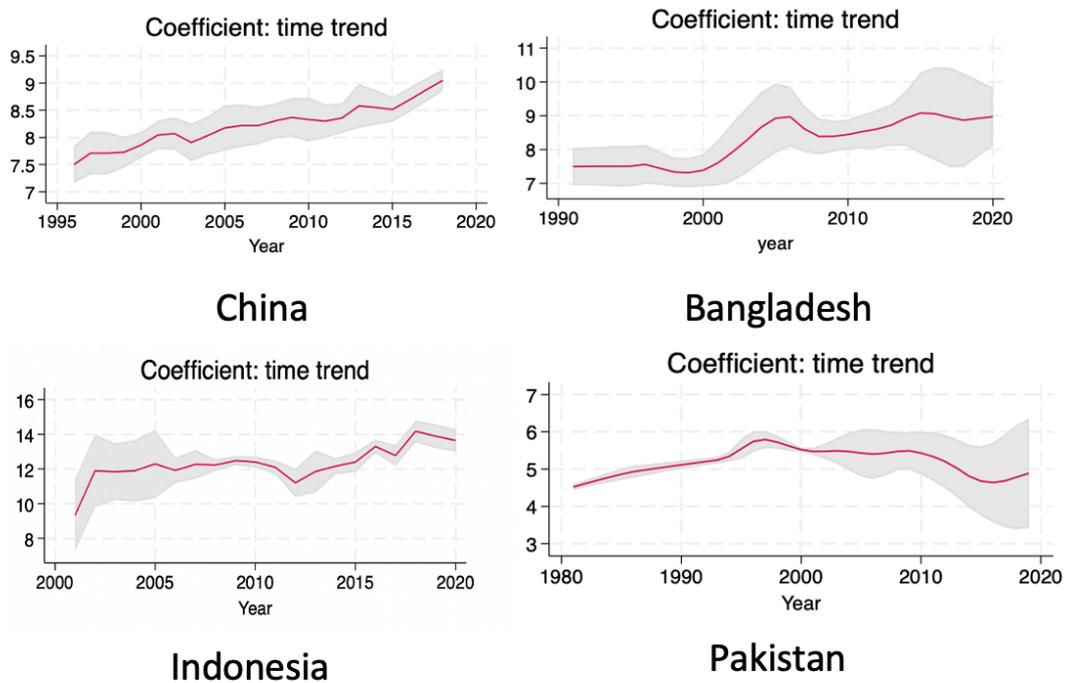cannot be overstated. These efforts have enhanced agricultural productivity and ensured sustainable practices that align with global environmental and health standards. The case of the dairy industry, for instance, illustrates the positive outcomes of deregulation in fostering competitiveness and market responsiveness. The water use and management reforms, particularly in the Murray-Darling Basin, underscore the necessity of adaptive and forward-thinking policies in safeguarding agricultural productivity and ecological sustainability.

As the global agricultural sector continues to navigate the complexities of climate change, technological advancements, and evolving market demands, the lessons drawn from Australia's experience are relevant and timely.

7.5   Objective 5: Policy recommendations

7.5.1   Summary of national level recommendations

In China, accelerating rural transformation requires a multifaceted approach. Land reform has been tested successfully, and it is crucial to ensure secure land tenure for farmers and promote efficient land use in the future. This can be achieved through policies that facilitate a better land regulation system, clarify land-related rights, and encourage attempting the transfer of land use rights based on market principles. Technological innovation is the key to the success of China's rural transformation, with a focus on research and development to promote sustainable practices and enhance productivity. This may include agricultural biotechnology, precision farming, and digital agriculture investments. Improving access to credit is another key policy area. This can be achieved by expanding microfinance programs and rural banking services. Foreign direct investment (FDI) in agriculture can also significantly promote modernization and technology transfer. Policies that facilitate FDI, such as providing incentives and streamlining regulations, can help attract investment in the agricultural sector. Irrigation is another important thing associated with policies and investment strategies. Increasing the share of irrigated farmland can help produce more high-value crops and accelerate the rural transformation.

In Pakistan, enhancing irrigation infrastructure is critical to improve water management and increase agricultural productivity. This includes investments in irrigation systems, such as canals, dams, and water storage facilities. Access to rural electricity is also essential, as it can enhance productivity and improve the quality of life for rural communities. Policies promoting rural electrification expansion, such as subsidies for off-grid renewable energy systems, can help achieve this goal. Land reform is another important policy area in Pakistan. Implementing land reforms to ensure equitable access to land and reduce land disputes can help promote rural development. Technological innovation, particularly in adopting modern agricultural technologies, is also essential. This includes investments in research and development to develop drought-resistant

crops, improve soil health, and increase yields. Increasing the literacy rate, particularly for females, is extremely important for Pakistan for the other three countries.

In Bangladesh, managing urbanisation is crucial to reduce pressure on rural resources and promote balanced development. This includes policies that promote sustainable urban planning and development, such as investing in infrastructure and services in rural areas. Labour productivity can also be enhanced through investments in rural skills development. This includes vocational training programs that equip rural populations with the skills needed for employment in non-agricultural sectors. Access to credit is another essential policy area in Bangladesh. Strengthening credit disbursement mechanisms for farmers, such as microfinance programs and rural banking services, can help improve access to finance for agricultural activities. Additionally, policies that support agriculture, such as tax incentives, subsidies for inputs, and price support mechanisms, can help promote rural development.

In Indonesia, land reform is essential to ensure secure land tenure for farmers and promote efficient land use. This includes policies that clarify land rights and facilitate land consolidation. Reforming financial institutions to improve access to credit for rural communities is also important. This can be achieved through the expansion of microfinance programs and the development of rural banking services. Encouraging partnerships between large corporations and smallholders is another key policy area in Indonesia. This can help improve market access for smallholder farmers and facilitate technology transfer. Supporting the development of farmers' organisations can also help improve their bargaining power and access to resources. Additionally, providing subsidies and credit facilities to smallholder farmers can help improve their productivity and income.

These policy recommendations aim to address key challenges and opportunities for rural transformation in China, Pakistan, Bangladesh, and Indonesia. By implementing these policies, policymakers can promote inclusive and sustainable rural development, improve livelihoods, and reduce poverty in rural areas.

7.5.2 Other recommendations at the regional level and cross-country level

Bangladesh and Pakistan have many aspects of similarities, but the two conditions are quite different – water resources and women's education. The women's literacy rate in Bangladesh was over 70%; Bangladesh has an annual average rainfall of 2300 mm and over 700 rivers. This situation is similar to what the Jiangsu and Zhejiang regions (the lower Yangtze River plain) experienced from 1980 to the 1990s. Given this, Bangladesh can develop the garment industry and take over some production capacity from China. However, they may face water pollution problems similar to what China experienced. It alters Bangladesh policymakers to learn from China, particularly in the Yangtze region, on water management and pollution control policies. Australia is also a global leader with many experiences in water management and pollution treatment, like the water accounting system or the Gippsland Lake practice in Victoria.

Pakistani annual rainfall is less than 500 mm; for some regions in Balochistan and Sindh, it is less than 200 mm. The education year of schooling of rural females is less than four years. Thus, the Pakistani cost of developing high-value agriculture and rural industry would be higher than in Bangladesh. But it is similar to the situation in the northwest of China. Therefore, we suggest Pakistan pay attention

to the lessons of the northwest of China. In some regions that lack rainfall but have abundant solar resources, the government may consider using solar resources to generate income for farmers. For example, China's solar power poverty alleviation program would be the case. India also has some successful cases worth learning.

We find the south Punjab of Pakistan worth comparing with the northeast of China. The two regions' RTs were both dominated by RT2, and the speed has declined in past decades. However, we observed the poverty rate increased in South Punjab but decreased in the northeast of China. Policymakers from the two countries need to share more experiences and insights on this phenomenon.

One unexpected finding in Pakistan is that the farm size has become smaller over decades. After the three land reforms in 1959, 1972, and 1980, three-fourths of the farmers are small farmers now, holding a small piece of land (below 0.5 acres). It may contradict some principles of economics, but the research also suggests it would help to feed more people. It is a debatable issue that is under more scrutiny by researchers.

Indonesia has some distinctions as it is a diverse island economy. The main phenomenon of Indonesia is the more considerable disparities across regions than the other countries. This is because the transportation costs between islands would be higher, hindering the speed of technology and information diffusion.

In the eastern Jawa region, we observed that the increase in the poverty rate was in line with the accelerated speed of RT. It alerts policymakers to review the potential inequality issue in this region.

The Kalimantan developed fast in recent decades; however, given the large peatland resources, Indonesia would need to be more careful in implementing sustainable development plans, and more environmental monitoring systems would be needed in this region. It would consider to promote Indonesia-Australia cooperation in renewable energy – using Australia's renewable energy to develop the manufacturing and mining sector.

8 Impacts

8.1 Scientific impacts – now and in 5 years

8.1.1 The RT Database

Our study has, for the first time, developed a long-time and regional-level RT database that covers many provinces/districts for Bangladesh, Indonesia, China and Pakistan. The database can be used to monitor and evaluate rural transformation in the four participating countries. It is also a good resource for cross-country comparative studies. The database will continue to grow as the project moves forward and will be available for all team members for their research. The database will then continue to impact policy decision-making in the participating countries and others for which the data are relevant after the project is finished.

The data are collected from the participating countries' official datasets and may include some survey data on the contingent through partners' fieldwork in the following steps of the project. The data include national and regional information. Bangladesh and Pakistan data are collected at the district level. 32 districts of Bangladesh and 46 districts of Pakistan are selected. China and Indonesia data are collected at the provincial level. 26 provinces of China and 30 provinces of Indonesia are selected. The data covers the past three to four decades to capture the historical pattern of rural transformation in those countries.

8.1.2 Theoretical framework

The project has developed a theoretical framework to analyse the stage, speed and associated IPIs in Asian developing countries. This framework summarises the whole procedure of rural transformation in five stages and identifies the major paths from stage to stage. The main features of each stage are the extent of (1) staple food production, (2) agricultural diversification and commercialisation, (3) farming and part-time non-farm employment, (4) specialisation/mechanisation and full-time non-farm employment, and (5) urban-rural integration and sustainable rural development. The framework identifies the policy options for each stage to promote RT. Our partners use this framework to assess the status of RT in their country and review the associated policies. The partners share country knowledge and success stories in the project workshops and compare their situations. The partners deliver the reports to policy makers through advisory board meetings and raise policy recommendations for future rural policy decision-making. This framework contributes to theory and policy design, which can be extended to an analysis of other developing countries.

8.1.3 Indication methods and analytical tools

The project has identified a set of indicators for measuring RT and the associated IPIs. It includes the RT definition, outcomes and major indicators of IPIs. This indication method can be a paradigm to measure and analyse the path, stage and speed of rural development and rural transformation in developing countries. We also developed a novel index to quantitatively identify the RT stage in which an economy is located, called the Aggregate Index (AI). Based on the indicator methods, we develop a general typological analysis of rural and structural transformations and rural income. This analytical typology tool is helpful for

policymakers to navigate the whole process of RT and conduct a cross-region comparison. It provides a scientific way of discussing the IPIs on RT. Also, the combination of ML, GIS and Econometrics offers a set of toolkits for policy analysis and diagnosing the RT problems at the regional level. That methodology will impact academics, think tanks, and policy consulting agencies in the long run.

8.1.4   Gender knowledge

A literature review on gender and rural transformation was completed by the UWA team. This will contribute to the stock of knowledge on the evidence on (1) the gender impacts of rural transformation and (2) the impact of gender inclusiveness on rural transformation based on previous and current literature in this area, as well as to identify the research gaps. Besides, the project also conducts four country-level studies on the relationship between gender inclusiveness and RT. Based on those outputs, the team also delivered eight policy briefs for partner countries' governments on promoting gender inclusiveness.

Our extensive data collection efforts have provided a comprehensive understanding of the current dynamics surrounding gender in rural transformation. Our research has not only illuminated the business case for promoting gender equality and inclusivity within the context of rural transformation. Still, it has also highlighted the abundant opportunities available for rural women in this framework. Simultaneously, our findings shed light on rural women's significant challenges and constraints, encompassing issues of limited resource access and socio-cultural barriers. Additionally, our research delves into the nuanced impacts of rural transformation on women, both positive and negative, emphasizing economic empowerment and improved living conditions and underscoring the need to mitigate potential adverse effects. This holistic analysis offers a solid foundation for informed decision-making and evidence-based policy development in gender and rural transformation.

8.2   Capacity impacts – now and in 5 years

A capacity-building plan has been developed to equip the research skills of participating countries. The capacity-building activities include three stages of training. We have completed three stages of training during the project.

Stage one was conducted in October-November 2021, focusing on the general agricultural and rural development issues from an economic and statistical perspective. The training includes the basic theory and practice in economic growth and structural transformation, as well as agricultural and rural development issues, national account statistics and indicators for agricultural and rural development, some basic econometric methods and regression techniques, etc.

Stage two was conducted in April 2022, focusing on each country's country-specific agricultural and rural development issues, including Bangladesh, Indonesia and Pakistan. We organise two training workshops for each country. The content includes identifying particular research questions, indicators, and methods to analyse the three countries' agricultural and rural development issues. In addition, cross-country comparisons will also be covered in these training sessions. During stage two, the ANU and CCAP team provided a consultation

session for Bangladesh, Indonesia and Pakistan to solve particular problems in the research being undertaken in those countries.

Stage three, covering policy writing skills, was delivered in November 2022. We plan to arrange two plenary sessions for all researchers, policymakers, public servants, and industry stakeholders.

This capacity-building program covers RT-related theories and data analysis skills, which will equip robust research capacity in the long run. In the reporting period, the capabilities we have built include:

- Economic Growth and Rural Development: Basic Theory and Practice
- Measuring Rural Development and Transformation in Developing Countries
- Gender issues research: topics and empirical approach
- Panel data econometrics techniques, DID methods and IV approach
- Data management, modelling skills and academic research writing.

Sixty-two people have registered for all training sessions, and more would join for some sessions of interest. Among the participants, 31% are female, 53% are masters, 40% are PhD scholars, and 6% are undergraduate students. 35% are from government agencies, and 11% are from industry and international organisations. 60% are from our partners, and the rest are their associates.

Due to the Covid, all training sessions were online and open to any staff or students from the partners. In the end, we trained 83 people in total.

The partners' evaluation of the capacity-building program is very high.

- **100%** of participants rated the CB program between "**4-5**" stars of satisfaction, with an average rating of 4.36 out of 5 stars.
- **91%** of people answered **Yes** to this question: "Do you find the training helpful you to complete the project?"
- **91%** of people answered **Yes** to this question: "Do you think the training webinars increase your research capabilities or skills?"
- **100%** of people answered **Yes** to this question: Do you think the monthly workshops are a good way to increase your research capacity?
- **100%** of people answered **Yes** to this question: Did you increase your knowledge or have a more in-depth understanding of RT through the theoretical training workshops?
- **100%** of people answered **Yes** to this question: Do you think you have developed other abilities beyond research through the project? For example, expanding the network, increasing communication skills, reading/interpreting policy documents, etc..

Apart from the formal training, capacity building also includes workshops, mentoring, learning-by-doing research, short courses and student thesis research through the project activities.

The project supported Dong Wang to undertake a course of "Partnership Research for Agricultural and Natural Resource-Based Development", which was offered by ANU Fenner School to understand the nature, vision and requirements

of ACIAR project visions further and learn the theory of change and the methods of making impacts.

Our partners also use the project to support some students' thesis research. For example, Dr Pengfei Shi obtained his PhD through the project from CCAP, PKU and got a job offer from the Ministry of Agriculture and Rural Affairs, China. Dr Qiwang Huang (CCAP) completed his PhD thesis, and some chapters are connected with RT and trade research. The CCAP team has recruited and trained a couple of staff through the project, including two postdoctoral fellows, 4 PhD candidates and a couple of research assistants. For the complete list of students and early-career researchers produced by this project, please see Appendix 2.

MD Imran Omar (BAU) and Zhiyi Guo (CCAP) joined the project and linked their thesis with the RT topics. The IPB University connected seven Bachelor's theses with the project topics.

The project offers a chance to investigate yet-unexplored aspects of Pakistan's rural transformation and allows the improvement of knowledge and skills in the aforementioned field. As we move ahead, new information is being developed in areas like gender inclusivity, income equality, drivers of rural transformation, etc. This is not only building the capacity of new researchers but also creating enthusiasm among young researchers to learn about the role of institutions, policies, and investments in deriving the rural transformation process.

Dr. Fay Rola-Rubzen has been working with various country teams to develop econometric models to measure the impacts of gender inclusiveness on rural transformation. She has provided feedback and guidance on the modelling work and developing related papers. These meetings help build the team's capacity on the linkages between RT and gender and in measuring the gendered impacts of RT. This is important in building partners' knowledge of the key indicators and the data requirements for modelling the effects of gender inclusiveness on rural transformation.

The project provides a "learning-by-doing" environment that helps junior researchers learn fast and do well. We also find that remote or face-to-face mentoring activities are an excellent way to build capacity and help maintain a trusty relationship for a longer time. We would emphasise this approach more in the later stage of the project.

The project not only enhances the analytic skills of the incumbents involved in the projects but also helps to understand the drivers of rural transformation and its impact on poverty and income inequality. This information is helpful for policymakers to understand the role of rural transformation and to obtain profound knowledge of theory and methodology related to IPIs to promote rural transformation and gender inclusiveness development.

8.3 Community impacts – now and in 5 years

The research on the relationship between rural transformation and its outcomes, such as per capita income, poverty reduction, income inequality and gender balance, improves the understanding of this matter and is expected to influence the policy-making process to make sure that the benefit of the policy change is shared proportionately across members of the community.

8.3.1 Economic impacts

Examples of economic impacts to date are the following.

The project team communicated the preliminary findings of the research paper on – *rural transformation, income growth and poverty reduction in Bangladesh* – with high-level policymakers, the World Bank, and the FAO of the United Nations to provide backup support in preparing an investment project for the Bangladesh Ministry of Agriculture under the funding support from the World Bank and other donors. The Bangladesh team appreciated how RT1 and RT2 helped shape income growth and reduced poverty at the district level.

Through the research findings, Pakistan's government realised how essential it is to promote high-value crops. It is expected that more economic impacts will be recognised in Pakistan. Similarly, Pakistan's results demonstrate that formal credit availability to small landholders contributes to rural transformation. Currently, most small landholders in their country are excluded from this opportunity. Again, implementing our findings will enhance agricultural productivity, which is strongly linked with reducing poverty. These impacts are expected to be generated in the coming years as soon as the research work completed under the project is published.

The project has sorted out policy solutions and established the policy advisory board. This channel has made a significant impact and will continue impacting the policymakers on policy and investment decisions in the following years.

The long-run economic impacts generated by this project also include the policy suggestions we made in the following aspects:

- **Increased Agricultural Productivity:** Most rural areas in partner countries are agricultural-based. Hence, improved farming techniques, access to modern machinery, better seeds and irrigation methods, and moving toward high-value crops can increase agricultural productivity. This feeds the local population and can lead to surplus production for sale, contributing to the overall economy.

- **Diversification of the Economy:** Rural transformation will lead to diversification by moving from traditional grain crops to high-value crops, thus leading to a change in the structure of the local economy. This will contribute to improving the infrastructure and raising the education levels, leading to the emergence of new industries and businesses beyond agriculture. Such diversification will reduce the dependence on agriculture and make the economy more resilient.

- **Job Creation:** The emergence of new industries leads to the initiation of infrastructure development, agribusiness, and rural industries, which will create employment opportunities. This will help reduce unemployment rates in rural areas and curb urban migration, often driven by the search for employment opportunities.

- **Improved Infrastructure:** Investment in rural areas often involves developing roads, bridges, and electricity supply. This facilitates easier movement of goods and services and attracts more investments, leading to further economic growth.

- **Increased Access to Education and Healthcare:** Our project provides empirical evidence that education is one of the important drivers of rural

transformation. Hence, schools and healthcare facilities will be developed to achieve the rural transformation goal. Hence, achieving rural transformation will lead to a more educated workforce and a healthier population, vital for economic development.

- **Enhanced Agricultural Exports:** With increased productivity of high-value crops and access to markets through improved infrastructure, rural areas will become essential hubs for agricultural exports. This will bring foreign currency into the country and bolster the national economy.

- **Poverty Alleviation:** Creating jobs, improving education, and enhancing agricultural productivity through rural transformation will alleviate poverty in the country. Hence, when people have better access to stable employment and resources, they are less likely to live in poverty.

- **Environmental Sustainability:** Rural transformation also focuses on sustainable agricultural practices and environmental conservation. Hence, rural transformation will ensure long-term high productivity and preserve natural resources for future generations.

- **Increased Standard of Living:** Rural transformation results from multiple efforts and efficient use of resources where all the above factors play the role of mediators. Hence, rural transformation will improve the living standard in rural areas because access to education, healthcare, and economic opportunities leads to an improved quality of life for the residents.

However, it's important to note that the impact of rural transformation may vary across regions depending upon the stage of rural transformation. Successful rural transformation requires careful planning, adequate investment, and active participation of the local population and stakeholders.

8.3.2 Social impacts

The project team disseminated research findings to the Pakistan Punjab Economic Research Institute (PERI) through the webinar (where senior management of the extension department was also present). It convinced Pakistan policymakers that the country should focus more on high-value crops during agricultural diversification. Diversifying high-value crops will help increase the income of poor farmers and alleviate poverty. The Director-General of Extension was fully convinced and agreed with the idea. These impacts will be realised along with the project's progress when its findings convince policy advisors, researchers, and academicians that rural transformation can help mitigate poverty and bring prosperity.

The Indonesian policymakers and stakeholders improved their understanding of structural and rural transformations. The economic development of a country previously oriented toward agriculture is switching to non-agriculture to increase people's income. The agricultural labour force is declining each year in Indonesia. Even in 2020, non-farm workers in Indonesia were about 65 percent, dominated by the islands of Java, Bali, the province of East Kalimantan, and several provinces of the island of Sumatra. The Indonesian policy recommendation from this study led to informed policy making, promoting higher rural household income and reducing poverty through increasing non-farm employment and high-value agriculture.

The research impacts policy decision thinking in Bangladesh through the partners' advisory board meetings and other external communications.

The Chinese partner is also very active in delivering the project findings and impacting central and local governments through CCAP's policy platform and channels.

Based on the project findings, the Pakistan team proved that access to irrigation contributes to rural transformation as the country moves towards higher stages of rural transformation, implying that irrigation facility is linked with the process of rural transformation. Hence, society needs to use each drop of water more judiciously. The related policy suggestions can lead to improvement in the benefit of the whole community.

8.3.3 Environmental impacts

Environmental impacts refer to changes in natural resources, how natural resources are managed, and how the changed management affects the state of the natural resource (soil, water, air, and biodiversity). Rural transformation leads to sustainable use of resources, implying that the environmental impacts become more prominent as we move towards higher stages of rural transformation.

The research on the relationship between irrigation and RT in China informs the government to make more precise water management in agricultural production, particularly for some dry land areas that are moving to high-value crops. We have identified irrigation as a common factor for all participating countries.

In rural transformation, support through irrigation programs provides a positive environment, considering that the Indonesian government has also set several sustainable water resource management targets. These targets include increasing the national water resource capacity by approximately 2.3 billion m^3 and ensuring sustainable irrigation water supply from reservoirs covering about 355.8 thousand hectares. The government is also directing structural and non-structural strategies as efforts to enhance sustainable water management, involving strengthening the quantity, quality, continuity, and accessibility of water resources to improve the well-being of the community.

Regarding the impact on air quality, rural transformation in air quality management can enhance rural income through various means, such as reducing energy consumption, developing green open spaces, constructing sustainable housing, and implementing environmentally friendly public transportation systems.

The impact on biodiversity refers to the diversity of life on Earth, including species, genes, and ecosystems. Environmental impacts like habitat destruction, deforestation, pollution, and overexploitation of natural resources can lead to species loss and disruptions in ecosystems. This can have far-reaching consequences as biodiversity is crucial for ecosystem stability, resilience, and a wide range of ecosystem services. Rural transformation in biodiversity management can increase rural income through eco-tourism development, sustainable agriculture, and sustainable natural resources.

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8.4 Communication and dissemination activities

8.4.1 Coordination and engagement of international conference

- **2021 End-of-Year Conference**

The project held the first end-of-year conference on 29-30 November 2021, with post-conference training on 1 December 2021. The conference was named The First International Conference on Economic Transformation, Agriculture, and Rural Development (ICETRA) 2021, which was hosted by the Indonesia partner, the Faculty of Economics and Management, the IPB University. The conference was held in collaboration with the Indonesian Ministry of National Development Planning (Bappenas), ICASEPS Ministry of Agriculture, ACIAR, Australian National University, Peking University, Bank Indonesia Institute, Indonesia Economist Association (ISEI) and Indonesia Agricultural Economist Association (PERHEPI).

The conference invited distinguished speakers, which were: (i) Dr. Amalia Adaininggar Widyasanti, National Development Planning of the Republic of Indonesia, (ii) Dr. Clarita Ligaya, Bank Indonesia, (iii) Prof. Jikun Huang, Professor of Agricultural Economics, China Center for Agricultural Policy (CCAP), Peking University; (iv) Prof. Maximo Torero, Chief Economist FAO; (v) Prof. Christopher Findlay, Crawford School of Public Policy, Australian National University; (vi) Prof. Jill J. McCluskey Regent, Professor & Director, WSU School of Economic Sciences, Washington State University, (vii) Prof. Bustanul Arifin, Chair of Indonesian Agricultural Economist, Lampung University. With special remarks from (i) Prof. Dr Arif Satria, SP, MSi, Rector of IPB University; (ii) Dr. Ir. Kasdi Subagyono, M.Sc General Secretary of Ministry of Agriculture; (iii) Dr. Daniel Walker, Acting CEO Australian Centre for International Agricultural Research (ACIAR); and (iv) Prof Nunung Nuryartono, Dean of FEM IPB University.

The conference attracted 55 papers in total. ANU and all partner teams disseminated the 2021 research outputs during the conference.

- **Special symposium at the 66th Australian Agricultural and Resource Economics Society (AARES) 2022 Annual Conference**

From 7-11 February 2022, the ANU and CCAP team organised a special symposium on rural transformation at the AARES 2022 Annual Conference. We disseminated four research outputs in the symposium: the RT literature review, gender issues, the stages, speeds and outcomes of RT and the RT impacts on agricultural productivity.

- **The first International Conference on Agriculture, Natural Resources, and Rural Development (ICANaRD)" is on 27-28 July 2021.**

We disseminated three papers on the 1st ICANaRD in July 2021. The conference was organized by the Indonesian partner ICASEPS. The three papers are: (i) Three decades of rural transformation and its impacts on household income and poverty incidence in Indonesia; (ii) Rural and structural transformation and their impacts on household income and poverty reduction in East Java; (iii) The literature review of rural transformation in Asian developing countries: definition, measurement, and indicators.

- **Special symposium at the 67th Australian Agricultural and Resource Economics Society (AARES) 2023 Annual Conference**

Our project organised the special symposium and presented three papers at the Australasian Agricultural and Resource Economics Society (AARES) conference of 2023. These international presentations extended the reach of our project findings and had a broader and more dispersed scientific impact.

- **Special symposium at 11th meeting of Society of Agricultural Economists (ASAE) held in Tokyo (March 17-20, 2023)**

Our project organised the special symposium and presented three papers at the 11th meeting of the Society of Agricultural Economists (ASAE) held in Tokyo (March 17-20, 2023). These presentations made a significant impression on the attendees, leaving a strong and positive impact.

- **End-of-Project International Conference held in Beijing, China**

Based on the achievements from this project, the China Centre for Agricultural Policy (CCAP) at Peking University is privileged to host an international conference in Beijing on 6-8th December 2023. The Conference, entitled "Understanding the Drivers of Successful and Inclusive Rural Regional Transformation", will be held for two days, with a field trip arranged on the third day.

8.4.2 Communication with policymakers and experts

- **Bangladesh**

The Bangladesh team held the key informant interviews and advisory committee meetings in June and July 2021. The attendees included the stakeholders and policy advisors. The research team placed a policy recommendation on two main topics that are valuable to consider: (1) the path of RT in the major districts; (2) human resource quality and leadership styles of the local government to the speed and success of RT.

- **China**

The external communication and dissemination activities in China have been undertaken through Professor Jikun Huang's policy consultation channel and the CCAP policy platform. The policy dissemination activities to the higher-level policymakers are below.

➢ Jikun Huang was interviewed by CCTV13 on 6 January 2021.
➢ Jikun Huang, interviewed by people.cn, 9 March 2021.
➢ Jinxia Wang, interviewed by people.cn, 10 March 2021.
➢ Jikun Huang, interviewed by peoplefarm.cn, 23 April 2021
➢ Jikun Huang, interviewed by China News, 12 December 2021.
➢ Jikun Huang, interviewed by Xinhua Agency, 23 December 2021.
➢ Jikun Huang, interviewed by CCTV-17 on 24 December 2021, 20 March 2022, and 25 March 2022
➢ Jinxia Wang, interviewed by Beijing Review, 22 February 2022.
➢ Jikun Huang, interviewed by EEO.com.cn, 23 February 2022.
➢ Jikun Huang, interviewed by CRNEWS.net, 3 March 2022.
➢ Jikun Huang, interviewed by Business.sohu.com.cn, 12 May 2022
➢ Jikun Huang reported "Reforms and policies to transform China's food system" to the Ministry of Agriculture and Rural Affairs (26 April 2021), Beijing, China.
➢ Jikun Huang attended the international conference organised by the Scientific Group for UN Food Systems Summit 2021 (from January to March, several times), Online.
➢ CCAP members communicated with Zelin Jiang, the Chairman of the Chinese People's Political Consultative Conference (CPPCC) of Jilin Province, on 12 January 2021.
➢ Jikun Huang reported "The trend of agricultural labour force fluctuation and the guarantee mechanism of grain income" to the Leading Group for Rural Affairs of CPC Central Committee (29 September 2021), Beijing, China.
➢ Jikun Huang reported "Promoting the role of high-quality pilot free trade zones in agricultural development" to CPPCC National Committee Meeting (29 October 2021), Beijing, China.
➢ Jikun Huang reported "Policy suggestion on ensuring national food security and increasing farmers' income" at the CPPCC National Committee Meeting (19 November 2021) in Beijing, China.
➢ Jikun Huang delivered "Facilitating equity livelihood" to UN Food System Summit 2021.
➢ Jikun Huang delivered "Transforming Chinese food systems for both human and planetary" to UN Food System Summit 2021.
➢ Jikun Huang. (2021). "The trend of agricultural labor force fluctuation and the guarantee mechanism of grain income", report to Leading Group for Rural Affairs of CPC Central Committee (29 September), Beijing China

- Jikun Huang. (2021). "Promoting the role of high-quality pilot free trade zones in agricultural development", report to CPPCC National Committee Meeting (29 October), Beijing China
- Jikun Huang. (2021). "Policy suggestion on ensuring national food security and increasing farmers' income", report to CPPCC National Committee Meeting (19 November), Beijing China
- Jikun Huang (2021). "Facilitating equity livelihood" submitted to UN Food System Summit 2021
- Jikun Huang (2021). "Transforming Chinese food systems for both human and planetary", submitted to UN Food System Summit 2021
- Jikun Huang. (2021). "Improving agricultural total fact productivity: importance, urgency and policy implication", Organized by San-nong Forum in Tsinghua University (9 January), Beijing China.
- Jikun Huang. (2021). "China's food security and seed industry innovation", Organized by China Development Forum (20 March), Beijing China.
- Jikun Huang. (2021). "China's agricultural development: prospects and strategic priorities", Organized by Tsinghua University (23 April), Beijing China
- Jikun Huang. (2021). "Food security and agricultural development in China in the global context", Organized by Anhui Agricultural University (3 July), Hefei China
- Jikun Huang. (2021). "World's agricultural development and prospect", Organized by Crop Science Society of China (27 July), Beijing China.
- Jikun Huang. (2021). "Frontier and dynamic change of agricultural economy research", Organized by Annual Conference of Chinese Agricultural and Forestry Economics and Management (21 August), Online
- Jinxia Wang. (2021). "Forty years of irrigation in China, what next", Organized by International Conference of Agricultural Economist (25 August), Online
- Jikun Huang. (2021). "Facilitating inclusive ICT application and e-commerce development in rural China", Organized by International Conference of Agricultural Economist (29 August), Online
- Jinxia Wang. (2021). "Forty years of irrigation management reform in China" Organized by the 4th International Symposium on Natural Resources Management and Public Policy (22 October), Online.
- Jikun Huang. (2021). "China's food production and consumption: visions, challenges and ideas" Organized by China Food Economics and Management Forum (12 November), Nanchang China
- Jikun Huang. (2021). "Rural transformation in China: challenges and policies" Organized by International Conference on Economic Transformation, Agriculture and Rural Development (29 November), Online
- Jikun Huang. (2021). "Fostering China's agricultural and rural development with digital technologies: opportunities and challenges", Organized by Asian Society of Agricultural Economists (6 December), Online

- ➢ Jikun Huang. (2021). "Food security, characteristic agriculture and common prosperity: development thoughts and policy orientation", Organized by Guangdong Province (11 December), Online
- ➢ Jikun Huang. (2021). "China's agricultural development: vision, challenge and strategy", Organized by International Conference of Crop Scientists (16 December), Sanya China
- ➢ Yu Sheng. (2021). "Agricultural total fact productivity: theory and measurement", Organized by Survey Data Centre Jinan University (22 April), Guangzhou China.
- ➢ Jikun Huang. (2021). "Reforms and policies to transform China's food system", Organized by Ministry of Agriculture and Rural Affairs (26 April), Beijing China.
- ➢ Yu Sheng. (2021). "Investigating the impact of urbanization/industrialization process on off-farm employment in China", Organized by Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (10 May), Beijing China.
- ➢ Jinxia Wang. (2021), "Choice of water management strategies under the transformation of regional distribution of Chinese agricultural productivity", organized by Research Institute of Rural Revitalization, Huazhong Agricultural University, Wuhan China.
- ➢ 17-31 August 2021, CCAP attended International Conference of Agricultural Economists (ICAE), one of the sub-themes is about the ICT application and rural transformation.
- ➢ 6-8 December 2021, CCAP organized the 10th ASAE International Conference, within which a sub-theme is related to rural transformation.
- ➢ 17 December 2021, CCAP organized the 1st Green Agriculture, Ecological and Sustainable Rural Development International Conference, focusing on how to promote green agricultural development and sustainable rural development.
- ➢ Yu Sheng. (2023). "Information Technology and Biotechnology Revolutions and Its Impact on Agricultural Productivity in China: Opportunities and Challenges", Organized by Asian Society of Agricultural Economists (17 March), Tokyo Japan.
- ➢ Yu Sheng. (2023). "Capital Deepening, Technology Progress and Agricultural TFP Growth: Evidence from 17 OECD countries", Organized by OECD TFP and ENV Network Meeting (24 May), Paris France

- • **Indonesia**

The first Focused Group Discussion (FGD) was conducted on 24 March 2021, attended by 19 participants representing officials from the Ministry of Agriculture, Ministry of Development Planning (BAPPENAS), Coordinating Ministry for Economic Affairs, senior researchers of ICASEPS, and all team members. Participants appreciated ACIAR's initiatives to support the research project, which will provide input to the policy-making process of RT in Indonesia.

The first Advisory Committee (AC) meeting was conducted on April 7, 2021. The meeting was chaired by the Director of ICASEPS and attended by AC members and all research team members. The AC members fully support the analysis at the regional/provincial level to understand differences in the speed and success of RT and the corresponding drivers; AC members emphasised the importance of human resource quality and leadership styles of the local government to the speed and success of RT.

The second FGD with stakeholders to identify IPIs was held on 13 October 2021. The major comments were the following: (a) it is necessary to consider the path of RT in the food crop-based provinces and perennial crop-based provinces MoA mapping on major commodities by province; (b) the choice of the province also needs to consider variation in an agroecosystem (irrigated, dryland, swampy land) which also lead to commodity focus; (c) the importance of human resource quality and leadership styles of the local government to the speed and success of RT; (d) the higher share of high-value agriculture will be contributed to poverty reduction.

The second Advisory Committee (AC) Meeting was held on 20 December 2021. The AC meeting was chaired by Dr Sudi Mardianto (Director of ICASEPS) and attended by two AC members: Dr Arif Budimanta (Special Advisor to the President) and Dr Ketut Kariyasa (Director of Bureau of Planning, MoA). The main agenda of this meeting was a presentation by the Indonesian Team on the result of the analysis that had been done until December 2021, followed by comments and suggestions from the AC member. The AC member appreciated the results and suggested the following: a) the period of analysis to be shortened to 5 years period; b) the need to carefully assess the asymmetric nature of the food market in Indonesia; c) the widening wage gaps between agriculture and non-agriculture wages in the rural area; d) the importance of gender analysis in rural transformation; e) concern of the negative consequences on the food security target resulting from increased government's priority toward the production of high-value commodities.

Such meetings are called by the Indonesian team twice per year during the project period.

- **Pakistan**

The first advisory committee meeting was conducted on March 29, 2021. Members were briefed about the project objectives and current activities. Members took a keen interest in and highly appreciated ACIAR's initiative to conduct such a study. The advisory committee members raised several relevant questions, which initiated a productive discussion. Project team members responded to the questions and also explained the limitations of the project research area. The members of the advisory committee were satisfied and indicated their future thrust. The second advisory committee meeting was conducted on 4 November 2021. The concept of stage and speed of rural transformation was thoroughly discussed, along with the significance of IPIs in Pakistan. The findings of our research were also presented in the meeting.

Multiple visits to the Pakistan Bureau of Statistics PBS, the Provincial Bureau of Statistics and marketing departments, Pakistan Agriculture Research Council PARC, and the Ministry of Food Security and Research were made for data collection and compilation. Several individual meetings with high officials were also conducted to explain the objectives and benefits of the projects during the data collection procedure.

Dr Abedullah delivered an Invited Lecture on 28th April titled "Rural Transformation and its Outcomes in Pakistan" held by Nepal Institute for International Cooperation and Engagement (NIICE), suggesting that rural development with rural transformation is increasingly popular in the scientific community. Similarly, one of the working papers from the first year of the project has been presented at a conference by Ms Farah Naz organised by the Institute of Business Administration (IBA) Karachi, Pakistan, which is expected to attract the attendees to the work area of the project.

Multiple communication and dissemination activities have been held under the project during the last three years. These include the following:

- A meeting with the advisory council members was conducted on March 29, 2021. Members were briefed about the project objectives and current activities. Members took a keen interest in and highly appreciated ACIAR's initiative to conduct such a study. The advisory council members raised several relevant questions, which initiated a productive discussion. Project team members responded to the questions and also explained the limitations of the project research area. The members of the advisory committee were satisfied and indicated their future thrust.

- Multiple visits to the Pakistan Bureau of Statistics PBS, Provincial Bureau of Statistics and marketing departments, Zarai Tarqiati Bank Limited (ZTBL), Pakistan Agriculture Research Council PARC, and Ministry of Food Security and Research were made for data collection and compilation. Several individual meetings with high officials were also conducted to explain the objectives and benefits of the projects during the data collection procedure.

- An online training workshop was conducted by project team members on 22nd April 2021. The resource person for the workshop was Dr. Junaid Alam Memon, Assistant Professor, PIDE. The workshop was on "Boolean Operators-Optimize your scholarly literature search", which was attended by all the team members. The workshop aims to educate the participants about optimizing the search for scholarly literature in less amount of time. Practical examples and hands-on practice were part of it. It was a handy workshop as it facilitated the search strategy for the literature survey.

- We also disseminated our work by presenting it in a webinar entitled "Diversified Cropping System: Challenges and Opportunities", organized by the Punjab Economic Research Institute (PERI) on 2nd December 2021. The presentation is titled "Why Not Rural Transformation Rather Diversification-Constraints and Opportunities". The dissemination of research findings in the webinar (where senior management of the extension department was also present) convinced the country to not move only towards crop diversification. Rather, this diversification should be focused on high-value crops. Such diversification will not only help to increase the income of poor farmers but also lead to alleviating poverty. The Director General extension was fully convinced and agreed with the idea.

- The dissemination is not only held at the national level, but also the work is showcased internationally as Dr. Abedullah resourced an Invited lecture on 28th April 2022 with the title "Rural Transformation and its outcomes in

Pakistan" held by Nepal Institute for International Cooperation and Engagement (NIICE).

- A lecture was delivered to a potential audience by a project team member on 23rd February 2023. The lecture was on Adaptation, Modernization and Productivity; The Role of Agricultural Finance. The purpose of the lecture was to educate the audience regarding the importance of finance for the agriculture sector.
- Through international conference presentations in February and March 2023, the project findings have been widely disseminated to a larger audience, including the people from academics and policymakers.
- A one-day symposium on "Drivers of Rural Transformation, unveiling insights and findings" was organized at the University of Agriculture Faisalabad on October 19th, 2023, to better showcase the project output.

8.4.3 Fieldwork

During this reporting period, we conducted three fieldwork visits in Indonesia. Due to the travel restriction of the Covid, the fieldwork was run by our local partner ICASEPS, and there is no other fieldwork in the other countries.

The first fieldwork in East Java was in April 2021 with Farmer's group Gapoktan Pojokkulon. This fieldwork aimed to (1) observe the structure of the macro-economy in East Java Province and (2) understand the rural transformation of agriculture through agricultural machinery, population and employment in East Java Province. The results of the fieldwork showed that: (1) the economy of East Java Province is dominated by three main economic sectors, i.e. the agriculture sector, the manufacturing sector, and the trade/reparation sector; (2) the pattern of the rural transformation of agriculture in East Java Province is evident in the growth of the informal service sector (agriculture sector towards industry sector), while the structural transformation of the population and employment in this province is still in its earlier stages and the majority of employment remains in the primary sector.

The second fieldwork was in West Java, Bandung, Indonesia, from 26-29 October 2021. The fieldwork aimed to (1) observe the role of the agricultural sector in economic development in West Java; (2) understand the rural transformation of agriculture through agricultural machinery, population and employment in West Java Province; (3) identify the shifts in the agricultural sector in the economy in West Java. The results of the fieldwork showed that (1) the role of the agricultural sector in economic development in West Java is seen in the production and employment and its contribution to the formation of the GRDP. However, the development of economic growth in West Java has changed from year to year, including in the agricultural sector, where there is a shift in the share of output value, which causes a decrease in the contribution of the agricultural sector without causing a decline in the value of output from the sector; 2) the growth of the agricultural sector in West Java is positively influenced by national economic growth. Growth in the agricultural sector is relatively slow and has a competitive advantage. In addition, West Java's agricultural sector also specialises in location effects, especially for food crops, plantation crops, ornamental crops and horticulture subsectors.

In May 2022, ICASEPS teams conducted the third fieldwork visit at Semarang, Central Java Province, from May 17-20, 2022. During this fieldwork, ICASEPS also held a focus group discussion (FGD) as a communication and dissemination activity with the Research and Development Agency (Bappeda) of Central Java Province, the Department of *Agriculture and Plantation Central Java* Province, and Horticulture Farmers Mlatiharjo. The results of the fieldwork showed that the economic structure of Central Java was dominated by three sectors, which were manufacturing (34,82% of GRDP), agriculture, forestry, and fisheries (15,05%), as well as wholesale and retail trade and the repair of motor vehicles and motorcycles (13,39%). Central Java is vital to Indonesia's economy, contributing 8.7% to the national GDP. The total GDRP of the province reached USD 75,12 billion, with the most significant contributions originating from manufacturing (34,82% of GRDP), agriculture, forestry, and fisheries (15,05%) and wholesale and retail trade and the repair of vehicles (13,39%). It was also found that in Central Java Province, the agricultural sector was able to boost revenue and create employment.

8.4.4   Internal communication and others

We set a monthly workshop series to share research results and discuss the progress. In the project period, we conducted 32 monthly workshops. The inaugural workshop lasted three days; the rest were half a day every month. The ANU team called bilateral meetings with each partner on demand. During the project period, we held twice bilateral meetings with the Indonesian partners and once with each of the other partners. All the routine meetings and workshops were held online via Zoom. We set a bi-monthly newsletter series for sharing news and updating activities in participating countries. The project website was launched under the ANU Crawford School. All team leader and subject leaders are requested to submit a progress report to ANU every six months.

9 Conclusions and recommendations

This section briefly summarises the key learnings arising out of the project. In assessing the future needs, provide recommendations of what actions ACIAR could undertake to increase the likelihood of potential impacts, outlined above, materializing. This may include recommendations about follow-on projects.

9.1 Conclusions

The rural transformation (RT) project in Bangladesh, China, Indonesia, and Pakistan presents a compelling examination of the multifaceted processes underpinning rural development in these diverse contexts. Through a rigorous analysis of agricultural practices, labour force shifts, gender inclusiveness, food security, and sustainability, the study unveils the complex interplay of factors that drive or hinder RT. The findings underscore the pivotal role of Institutional and Policy Innovations (IPIs) in shaping the outcomes of RT, highlighting both commonalities and unique challenges faced by each country. It is observed that by raising the share of high-valued agriculture and the share of off-farm employment, rural per capita income could be enhanced, and poverty could go down. Also, the process of rural transformation may be driven by investment, policy, or institutions.

The need for a strategic shift towards high-value agriculture and the facilitation of rural labour migration to non-farm employment is underscored in China. The success of such transitions is contingent upon comprehensive urbanization and industrialization efforts alongside crucial reforms in the Hukou registration system. While economic disparities present a persistent challenge, the report identifies pathways for mitigating inequality alongside growth.

Indonesia's experience illustrates the variegated nature of income inequality and poverty reduction across its rural landscape. The study acknowledges the government's success in diminishing income disparity from 2015 to 2020 despite the rising challenges of rural income inequality due to the uneven accessibility to non-agricultural employment opportunities earlier. This calls for an enhanced focus on human resource quality and infrastructure development to foster equitable growth and improved rural welfare.

Pakistan's analysis reveals the RT pace is primarily driven by livestock and rural non-farm employment. Although these sectors have contributed positively to poverty alleviation, the impact on inequality remains mixed, emphasizing the need for equitable access to rural infrastructure to ensure inclusive growth.

Gender inclusiveness emerges as a critical component of RT, with the report detailing women's significant role in agricultural and non-agricultural sectors. Despite notable progress, gender disparities in income and access to resources persist, necessitating targeted efforts to empower women within the rural economy.

The relationship between RT, food security, and sustainability is explored, highlighting the positive impacts of RT on food security across the countries. The nuanced analysis of sustainability, particularly the study's findings on water scarcity in China, underscores the intricate balance between natural resource management and rural economic development.

Drawing lessons from Australia's agricultural sector reforms, the report advocates for the adoption of innovative approaches to agricultural research, development, and extension (RD&E). Such efforts are crucial for fostering sustainable practices, enhancing productivity, and ensuring the resilience of rural economies.

The impacts of rural transformation are profound, affecting economic growth, social equity, and environmental sustainability. Successful transformation has led to improved living standards in rural areas, reduced poverty rates, and enhanced food security. However, the transition also poses challenges, including urbanization pressures, loss of agricultural land, and social dislocation.

All of the project findings provide valuable guidance for policymakers and organizations. This project serves as a set of policy recommendations for a more prosperous future in partner countries' rural communities. The report highlights strategic approaches for accelerating rural transformation (RT) in Bangladesh, China, Indonesia, and Pakistan. These recommendations emphasize the importance of institutional innovations, policy support, and investments tailored to the unique contexts of each country to foster inclusive and sustainable rural development. The following subsection is a summary of the key policy recommendations:

In conclusion, the report emphasizes the need for a holistic and coordinated approach to RT that leverages institutional innovations, policy support, and strategic investments. By addressing the unique challenges and harnessing the opportunities within each country's context, policymakers, stakeholders, and development partners can significantly contribute to achieving sustainable and inclusive rural development. This collective endeavour will improve rural populations' livelihoods and contribute to the broader goals of poverty reduction, food security, and environmental sustainability.

9.2 Recommendations

9.2.1 Institutional innovations

Based on the institutional reform in the past four decades, we summarise the significant IPIs required for different stages of RT. It would provide a guide for policymakers to design better RT policies.

Table 6. Major IPIs by stage of rural transformation

Stage	Path of transformation	Additional IPIs in each stage and sequence
I	Primary on staple food production	Institutions (e.g., land), technology & extension, and irrigation
II	Agricultural diversification and rising high-value agriculture	Plus: Institutions and policies on market reform, and investment in R&D and technology, irrigation and road infrastructure
III	Farming and part time non-farm employment	Plus: Institutions and polices to support Township and Village Enterprises, and policies and investments on labour intensive industrialization in the urban economy.

IV	Increasing specialization on either farming or non-farm employment	Plus: Institutions for facilitating labour and land rental market development; more R&D investment
	Rapid mechanization and more non-farm employment	Plus: Institutions and policies to support mechanization and land consolidation, labour mobility and urbanization; new technology
V	High-value and sustainable agriculture and integrated urban-rural development	Plus: Institutions and policies to eliminate urban-rural division; policy support for and investment in sustainable agriculture; Rural Revitalization Development Strategy

9.2.2 Policy supports

In many developing countries, agricultural technology and extension innovations are the major driving forces of agricultural productivity growth and play a vital role in rural transformation. For example, China has developed several generations of hybrid rice and has significantly increased rice yield since the 1970s. Wheat yield has increased even more than rice yield due to modern varieties and inputs. With the rising production of rice and wheat to ensure the national food grain security, Other technology innovations in cash crops (e.g., Bt cotton) and livestock production (e.g., pig), fertilizer manufacture, agricultural mechanization, and information and communication are desired to foster rural transformation. Notably, most technologies farmers adopt have come from the public research and development (R&D) system.

The project raises many policy suggestions for partner countries. For example, marketization reform is important for all countries as it affects the rural transformation process. In general, farmers can diversify their livelihood in different ways, either by adjusting the production structure of agriculture, particularly from grain-based to more cash crops and other high-value agricultural products, or by participating in non-farm activities to improve the allocative efficiency of rural labourers. However, during such a process, some agricultural subsidy policies (e.g., direct grain subsidy) have little or no impact on agricultural production in China but have more impact in Indonesia. It may be due to the different stages that countries stay in the RT. On the other hand, the price invention policies (e.g., the minimum procurement prices for rice and wheat) also distort the allocation of agricultural inputs and lead to serious supply-side structural problems in agriculture, which is a common issue in many countries. Therefore, liberalization in agricultural markets can help them to import land-intensive products (e.g., soybeans, oil and sugar crops) and export labour-intensive commodities (e.g., fruits and vegetables), which have stimulated agricultural transformation.

9.2.3 Investment in infrastructure

Investing in agricultural production and market infrastructure has contributed to rapid rural transformation. As a series of recent studies documented, irrigation development in the past decades lays a solid foundation for rising agricultural productivity and transformation towards more high-value production in all countries. Increased non-farm employment has largely benefited from improved other infrastructure, such as transportation and telecommunication, with better integration of markets across regions as well as close linkage between small farms

and big markets. In the meantime, farmers have gained from more efficient use of infrastructure related to agriculture and rural areas. Some common policy recommendations are summarised below:

- Implement targeted institutional reforms to support the transition towards high-value agriculture and non-farm employment.

- Invest in rural infrastructure, such as irrigation systems, roads, and electricity, to facilitate economic growth and poverty alleviation.

- Foster regional cooperation and knowledge sharing to leverage collective experiences and best practices in rural development.

- Develop sustainable agricultural practices and diversify rural economies to enhance food security and environmental sustainability.

- Address water scarcity through efficient management practices and investments in water-saving technologies.

- Prioritize irrigation, foreign direct investment (FDI), and educational reforms as key drivers of RT.

9.2.4   Country-specific recommendations

Bangladesh:

- Implement policies that promote sustainable urban planning and development, including investing in infrastructure and services in rural areas.

- Invest in rural skills development through vocational training programs to equip the rural population with the necessary skills for employment in non-agricultural sectors.

- Strengthen credit disbursement mechanisms for farmers by enhancing microfinance programs and rural banking services.

- Implement policies that support agriculture, such as tax incentives, subsidies for inputs, and price support mechanisms.

China:

- Encourage the transition to high-value agriculture and enhance rural labour's shift to non-farm employment.

- Promote urbanization and industrialization while reforming Hukou registration to create more job opportunities.

- Address income disparity through appropriate institutional innovations, policy supports, and investments.

- Invest in irrigation farmland and high-standard farmland.

- Reduce the spousal education gap to decrease income inequality and support women's labour participation.

Indonesia:

- Prioritize improving human resources quality and developing public infrastructure to reduce income inequality and improve rural welfare.

- Address the increase in rural income inequality by making non-agricultural employment opportunities more accessible.

- Leverage irrigation, electricity, and modern market infrastructure to boost income generation and reduce poverty.

Pakistan:

- Focus on enhancing the share of livestock and rural non-farm employment to accelerate RT and reduce poverty.

- To support equitable growth, improve access to rural infrastructure, including roads, education, and market linkages.

- Foster women's inclusion in socio-economic opportunities to enhance the impact of RT on poverty and inequality.

- Invest in women's education, healthcare, and ownership of land and assets to promote a more inclusive RT.

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10.2 List of publications produced by the project

The table below includes the journal articles, book chapters and other published conference proceedings that have been published by the end of the date that the project gets concluded. It does not include the papers currently under review, policy briefs and other working papers. For the complete list of the project's outputs, please see the attached spreadsheet.

Publication Title or Journal Name	Article Title	Author/s	Primary country	Publication type
Journal of Integrative Agriculture	Are Gender Inclusiveness and Rural Transformation Interlinked: The Case of Bangladesh	Maria Fay Rola-Rubzen, Mohammad Jahangir Alam, Jon Marx Sarmiento, Ismat Ara Begum, Al Amin Al Abbasi and Subrata Saha	Bangladesh	Journal article (published)
Journal of Integrative Agriculture	Gender and Rural Transformation: A Systematic Literature Review. Accepted in the Journal of Integrative Agriculture	Maria Fay Rola-Rubzen, Hue T. Vuong, Claire Doll, Curtis Rollins, Jon Marx Sarmiento, Mohammad Jahangir Alam, Ismat Ara Begum	Australia	Journal article (published)
Journal of Integrative Agriculture	Developing Strategy to Alleviate Poverty with Rural Transformation in Pakistan: Stylized Facts from Panel Analysis	Abedullah A., Farooq, S., Naz, F.	Pakistan	Journal article (un-published)
Journal of Integrative Agriculture	Rural transformation, income growth and poverty reduction by province in China in the past four decades	Shi, P., Huang, J.	China	Journal article (published)
Journal of Integrative Agriculture	Regional rural transformation and its impacts on rural household income and poverty rate in Indonesia: 2000-2020	Sudaryanto Tahlim, Erwidodo, Dermoredjo Saktyanu Kristyantoadi , Purba Helena Juliani, Rachmawati Rika Reviza, Irawan Aldho Riski	Indonesia	Journal article (published)
Journal of Integrative Agriculture	Developing Strategy to Alleviate Poverty with Rural Transformation in Pakistan: Stylized Facts from Panel Analysis	Abedullah A., Farooq, S., Naz, F.	Pakistan	Journal article (published)

Journal of Integrative Agriculture	A review of rural transformation studies: Definition, measurement, and indicators	Dong Wang, Chunlai Chen, Christopher Findlay	Australia	Journal article (published)
Journal of Integrative Agriculture	Accelerating Rural Transformation in Asian Developing Countries	Jikun Huang, Dong Wang, Christopher Findlay, Chunlai Chen	Australia	Journal article (published)
China Agricultural Economic Review	Regional rural and structural transformations and farmer's income in the past four decades in China	Huang, J., Shi, P.	China	Journal article (published)
Bulletin of National Natural Science Foundation of China	Pathway, consequences and driving forces of rapid and inclusive rural transformation	Huang, J., Shi, P.	China	Journal article (published)
World Development	Impact of urban growth on rural transformation through off-farm employment in China	Sheng, Y., Zhao, Y., Zhang, Q., Dong, W., Huang, J.	China	Journal article (published)
Chinese Rural Economy	The changing trend of irrigation investment in Northern China since the "8th Five-Year Plan" and the determinants affecting increased investment decisions at the village level	Wang, Z., Wang, J., Chen, H., Guan, B., Deng, H.	China	Journal article (published)
	Facilitating agricultural transformation in China and Southeast Asia	Huang, J.	China	Book
Chinese Economic Transformation: Views from Young Economists	Off-farm employment in rural China and the hukou system	Y. Zhao, M. Chen and Y. Sheng	China	Book Chapter
Strategic Study of CAE	Trends of global agriculture and prospects of China's agriculture toward 2050	Huang J, Xie W, Sheng Y, Wang X, Wang J, Liu C, Hou L	China	Journal article (published)

Science and Innovations for Food Systems Transformation	Transforming Chinese food systems for both human and planetary health	Fan, S., Huang, J., Zhang, F., Zhao, W., Song, H., Nie, F., ... & Cong, W.	China	Book
China Agricultural Economic Review	Dual carbon goals and the impact on future agricultural development in China: a general equilibrium analysis	Wei, W., Cui, Q., & Sheng, Y	China	Journal article (published)
IOP Conference Series: Earth and Environmental Science	The role of women's participation in regional development in Java, Indonesia	Rika Reviza Rachmawati , Helena Juliani Purba , Aldho Rizki Irawan , Tahlim Sudaryanto, Erwidodo , Saktyanu Kristyantoadi Dermoredjo , and M. Fay RolaRubzen	Indonesia	international proceeding
IOP Conf. Series: Earth and Environmental Science	Rural and structural transformation and their impacts on household in East Java	Erwidodo, S K Dermoredjo, E S Yusuf, H J Purba, R R Rachmawati, and T Sudaryanto	Indonesia	international proceeding
IOP Conf. Series: Earth and Environmental Science	Three decades of agricultural and rural transformation in Indonesia	T Sudaryanto , H J Purba , R R Rachmawati , Erwidodo , S K Dermoredjo , E S Yusuf , N Nuryantono , S H Pasaribu , S Amalia , and M Amin	Indonesia	international proceeding
Paper submitted to E3S (Scopus Index Publisher)	The Dynamics of Rural Transformation, Household Income, and Poverty Reduction: A Case Study in North Sumatra at the International Conference on Agriculture and Rural Development	Rika Reviza Rachmawati, Helena Juliani Purba, Tahlim Sudaryanto, Erwidodo, Saktyanu Kristyantoadi Dermoredjo, Aldho Riski Irawan	Indonesia	Conference /workshop paper
Journal of Rural Studies	The effect of rural transformation on income and poverty in Indonesia	Prof. Nunung Nuryartono; Syamsul Hidayat Pasribu, PhD; Muhamad Amin Rifai; Syarifah Amaliah; Triana Anggraenie; Lilis Hoeriyah	Indonesia	Journal article (published)

Book-IPB Press	Indonesian Rural Economic Transformation 20 Years Post-Reformation	Prof. Nunung Nuryartono; Syamsul Hidayat Pasribu, PhD; Muhamad Amin Rifai; Syarifah Amaliah; Triana Anggraenie; Lilis Hoeriyah et al	Indonesia	Book
Applied Economics	Foreign direct investment, off-farm employment and rural labour income: evidence from China	Cong Hu, Chunlai Chen, Christopher Findlay & Yan Wu	Australia	Journal article (published)

11 Appendixes

11.1 Appendix 1: Research team

Name	Country	Institute	Role
Christopher Findlay	Australia	ANU	key team member
Chunlai Chen	Australia	ANU	Project leader
Fay Rola-Rubzen	Australia	UWA	Subject leader
Dong Wang	Australia	ANU	Post-doc Fellow
Al Amin Al Abbasi	Bangladesh	BAU	Key member
Ismat Ara Begum	Bangladesh	BAU	Key member
Mohammad Jahangir Alam	Bangladesh	BAU	Country leader
Rezaul Karim Talukder	Bangladesh	BAU	Member
Md Imran Omar	Bangladesh	BAU	Member
Subrata Saha	Bangladesh	BAU	Key member
Huayong Zhi	China	CCAP	Senior research assistant
Jikun Huang	China	CCAP	Country leader
Jinxia Wang	China	CCAP	Subject leader
Lanlan Su	China	CCAP	Post-doc
Pengfei Shi	China	CCAP	Key member
Qiwang Huang	China	CCAP	PhD candidate
Yang Xu	China	CCAP	Student
Tiantian Zhou	China	CCAP	Student
Kaixing Huang	China	CCAP	Key member
Xingshuo Liu	China	CCAP	Student
Zhiyi Guo	China	CCAP	PhD candidate
Yu Sheng	China	CCAP	Key member
Eddy Yusuf, S.E	Indonesia	ICASEPS	Member
Erwidodo	Indonesia	ICASEPS	Key member
Helena J.Purba	Indonesia	ICASEPS	Key member
Rika Reviza R, M.Sc	Indonesia	ICASEPS	Key member
Saktyanu Kristyantoadi	Indonesia	Indonesia	Key member
Aldho Rizky Irawam	Indonesia	Indonesia	Member
Tahlim Sudaryanto	Indonesia	ICASEPS	Country leader
Muhamad Amin Rifai	Indonesia	IPB	Member
Nunung Nuryartono	Indonesia	IPB	Team leader
Samaliah	Indonesia	IPB	Member
Syamsul Hidayat Passaribu	Indonesia	IPB	Co-leader
Triana Anggraenie	Indonesia	IPB	Member
Abid Hussain	Pakistan	PARC	Team leader

Ghulam Sadiq Afridi	Pakistan	PARC	Member
Hassnain Shah	Pakistan	PARC	Member
Muhammad Azeem Khan	Pakistan	PARC	Key member
Muhammad Ishaq	Pakistan	PARC	Member
Abedullah	Pakistan	PIDE	Country leader
Farah Naz	Pakistan	PIDE	PhD Fellow
Shenaz Khattak	Pakistan	PIDE	PhD Fellow
Shujaat Farooq	Pakistan	PIDE	Key member
Ishaq Muhammad	Pakistan	PKU	PhD candidate

11.2 Appendix 2: Students and early career researchers produced by the project

ID	Student name	Education level	Supervisors name	University name	Country	Start year	Completion year
1	Xiaohong Liu	PhD	Jikun Huang	Peking University	China	2017	2023
2	Xiaohong Liu	PhD	Jikun Huang	Peking University	China	2017	2023
3	Zhiyi Guo	PhD	Jinxia Wang	Peking University	China	2023	2027
4	Tiantian ZHOU	PhD	Yu sheng	Peking university	China	2018	2024
5	Moyu Chen	PhD	Yu Sheng	Peking University	China	2020	2024
6	Qiwang Huang	PhD	Jikun Huang	Peking University	China	2018	2023
7	Jiajia Zhao	Postdoc	Jikun Huang	Peking University	China	2021	2023
8	Liu Xinyu	Postdoc	Jikun Huang	Peking University	China	2023	2023
9	Pengfei Shi	PhD	Jikun Huang	University of Chinese Academy of Sciences	China	2016	2022
10	Farah Naz	PhD	Dr. Abedullah and Dr. Shujaat Farooq	Pakistan Institute of Development Economics	Pakistan	2019	on-going
11	Shahid Shabir	PhD	Dr. Shujaat Farooq	Pakistan Institute of Development Economics	Pakistan	2019	2024

12	Rido Rahmat Lionar	Undergraduate	Dr. Syamsul Hidayat Pasaribu, S.E, M.Si	The IPB University	Indonesia	2021	2021
13	Annisa Listya Ningrum	Undergraduate	Prof. Dr. Ir. R. Nunung Nuryartono M.Si. and Muhamad Amin Rifai M.Si	The IPB University	Indonesia	2017	2021
14	Friska Nova Ramadianita	Undergraduate	Prof. Dr. Ir. R. Nunung Nuryartono, M.Si	The IPB University	Indonesia	2018	2022
15	Fani Umrotul Khikmawati	Undergraduate	Prof. Dr. Ir. R. Nunung Nuryartono, M. Si and Muhamad Amin Rifai, S.E, M. Si	The IPB University	Indonesia	2017	2021
16	Afra Arsybald Hudoyo	Undergraduate	Prof. Dr. Nunung Nuryartono, S.E, M.Si	The IPB University	Indonesia	2021	2021
17	Md. Imran Omar	PhD	Prof. Dr. Mohammad Jahangir Alam	Bangladesh Agricultural University	Bangladesh	2022	2025
18	Subrata Saha	PhD	Prof. Dr. Mohammad Jahangir Alam	Bangladesh Agricultural University	Bangladesh	2021	Ongoing
19	Al Amin Al Abbasi	PhD	Prof. Dr. Mohammad Jahangir Alam	Bangladesh Agricultural University	Bangladesh	2021	Ongoing
20	Dong Wang	Postdoc	Chunlai Chen	Australian National University	China	2021	2024

11.3 Appendix 2: Response to the reviewers' suggestions

Reviewers' suggestions	Response
Policy Interventions:	
1. Final report to specify how policy engagement was done to disseminate project results.	The policy engagements were done in several ways: • The project generated an advisory board in partner countries, and the board meeting was held at least twice per year to disseminate the project results and collect comments from policymakers. • The project delivers three policy briefs to partner countries, including one on gender issues. • The project disseminated results through international conferences and two journal special issues. • The project engaged with policymakers through other activities such as mass media interviews, consulting jobs, etc. The revision includes those points in Section 6 and Section 8.4.
2. Revise policy suggestions to be more precise, identifying necessary changes in institutions, public policies, and investment strategies to spur targeted RT outcomes (Please see **Annex 2**), and consider both intended and unintended consequences of policy interventions (Please see **Annex 3**).	We rewrite the policy suggestions in Section 9.2. In this part, we precisely outline some general suggestions that may apply to all partner countries in terms of institutional innovations, policy support, and investment in infrastructures. Also, we outline country-specific recommendations that indicate particular focus or priorities that need attention from different countries. Overall, the project concludes that IPIs are important factors that can not only promote but also accelerate RT. We encourage the governments of partner countries to apply those recommendations to make changes.

3. Acknowledge the regional and context-specific nature of the results and policy suggestions due to heterogeneity across countries and regions and modelling limitations due to the use of secondary data.	Yes, some specific IPIs may not apply equally across regions within a country. Even though the national level trends could be the same, the stages and speeds may be different across regions. This project uses the secondary regional-level panel data to reveal the general patterns at the national level. At the same time, we also investigate some particular regions that have distinctions, though it is limited by data source availability. We suggest ACIAR consider future projects on more disaggregate level data.
Impact Pathway:	
4. Present a clear impact pathway for the intended RT outcomes. This can be done at the country level (Please see **Annex 4**).	The impact pathway is presented in Section 5.2, particularly in Figure 2 and Table 1. More detailed impacts made by the project are discussed in Section 8.
5. Briefly discuss how the RT outcomes contribute towards the attainment of relevant UN sustainable development goals, such as no poverty, zero hunger and gender equality (i.e., SDG 1, 2 and 5).	The discussions are presented in Subsections 7.2.1, 7.2.2, and 7.2.3. The project addresses these issues through an investigation of the relationship between RT and income growth, poverty reduction, income inequality and gender balance. In sum, we see RT as an effective pathway to achieve SDG 1, 2, and 5 so that the partner countries can focus on accelerating RT by spurring IPIs.
Identification of IPIs:	
6. Clarify the analytical approach to define the significance of various IPIs.	We identify the significance of various IPIs through three main steps – the first round was based on country teams' experiences and local experts' advice; then, we put all potential IPIs together advising the whole team so different countries can share their views on it; in the last step, each country team selected three main IPIs to study.
7. Consider both the demand and supply sides of the rural economy, assess	This project is more supply-side concentrated because the RT processes – either featured by the production shifting from low-value to high-value agriculture or by the labour force migrating from farming to non-farm employment – are both supply-

unintended consequences, and promote sustainability.	side drivers. However, we also touched on the demand-side issues under the missing service subject. The land and environmental issues may give rise to some unintended consequences, and we see climate change as a pressing issue on natural systems. Those factors would need to be explored more in future work.
8. Include policies addressing inclusiveness, like the ageing population, and youth engagement in agriculture.	This project delivers excellent outcomes on gender issues. We see the same approach can be applied to aging, youth and other similar issues in the future work.
Synthesising and Disseminating Results:	
9. Clarify accessibility of datasets for researchers and other users outside the project.	ANU team keeps the datasets. Requested by our partners and data providers, the datasets are not appropriate to open to the public and any access to the data source was under permission by the project and country team leaders. We recommend ACIAR to consider who should be in charge of the dataset after the project.
10. Commended for efforts to ensure sustainability, urged to continue collaboration, and submit policy briefs.	We encourage the partners to get together again for AARES 2025 conference and suggest ACIAR continue to sponsor a special session for RT. ANU team and ACIAR may advise Jikun Huang and other team leaders for a future work plan, say, some issues on sustainability, digital topics, private sector issues, etc..