THESIS

# COALITIONS FOR GREEN ENERGY: VIABILITY OF AGRIVOLTAIC SYSTEMS IN THE GLOBAL SOUTH

Submitted by

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# ABSTRACT

## COALITIONS FOR GREEN ENERGY: VIABILITY OF AGRIVOLTAIC SYSTEMS IN THE GLOBAL SOUTH

Agrivoltaic systems (AVS) offer an innovative approach to producing renewable energy and crops in the same field. This is vital for Global South countries, where food security and energy crisis are major concerns today. Using the Advocacy Coalition Framework, this study examines stakeholder perceptions of AVS adoption in Global South with a specific focus on Bangladesh. Data were collected from 223 respondents through face-to-face surveys. The study used multiple regression analysis to test the effects of perceived benefits, stakeholder participation, economic viability, financial support, and perceived barriers on AVS adoption. The findings show that stakeholders generally view AVS benefits positively. Perceived benefits had the strongest and statistically significant effect on AVS adoption. Stakeholder participation also showed a positive but weaker effect. Economic viability and financial support had positive but statistically insignificant effects. Perceived barriers had a negative effect on AVS adoption, with installation cost, lack of infrastructure, and technical knowledge as major concerns. The study highlights that stakeholders need clear benefits, practical proof, technical support, and reduced practical risks for AVS to become successful. The study also suggests pilot projects, training, reduced financial risk, and better infrastructure to support future AVS policy in similar Global South contexts.

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DEDICATION

*I dedicate this thesis to my late mother, who always dreamed of seeing me do something meaningful in life. Although she passed away before seeing this work completed, her love, prayers, and belief in me continue to guide me. I dedicate this thesis to her memory with my deepest love and gratitude.*

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# Chapter 1

# Introduction

Agrivoltaic is an innovative mechanism that utilizes solar photovoltaic (PV) panels for agronomic purposes. It presents a promising solution to the challenges of food insecurity and energy poverty (Dinesh & Pearce, 2016). As populations grow and climate change threatens agricultural productivity, countries face the urgent task of producing more food while reducing reliance on fossil fuels. The agrivoltaic systems (AVS) can provide the required solution to achieve these benefits as the same land can be used for energy generation and crop production (Coşgun, 2021; Dinesh & Pearce, 2016). It is more efficient for land use and meets food and energy needs. Evidence supports that it leads to lower greenhouse gas emissions, less heat stress on crops, and optimizes water use by 20 to 47% (Omer et al., 2025). AVS is extensively utilized in Global North to enhance land productivity and aid in renewable energy objectives. For example, it showed 90% land productivity in summer in Germany in 2018 by lowering heat stress (Trommsdorff et al., 2021). According to studies in the United States, water use efficiency increased significantly (328%) with the use of this innovative system (Hassanpour Adeh et al., 2018). Italy adopted AVS in vineyards, increasing grape yield by 277% and improving soil moisture (Magarelli et al., 2025). The various agrivoltaic projects on rice in Japan helped in renewable energy generation (Gonocruz et al., 2021). These examples show that AVS can improve food security and energy generation in areas that have high demand for agriculture and energy.

In the Global South, agriculture continues to be an important economic activity (Amekawa, 2009). Energy access is not dependable and is not often enough for rural development. AVS can therefore be a means to produce food and renewable energy at the same time in these regions. This could reduce dependence on fossil fuels, increase energy security, and enhance livelihoods. Agrivoltaics can also increase resilience due to better microclimatic effects (shading, moisture retention, etc.) and further improve crop performance in drought-hit regions (Poonia & Santra, 2022; Vidotto et al., 2024). While there is opportunity, there are also several barriers to the adoption of

AVS in global south. The implementation of technology can be hampered by high upfront costs, technical knowledge gap, land use conflict and poor policy support (Patel et al. 2024; Tomasi et al. 2025; Vidotto et al. 2024). Social class differentiation, limited funding accessibility, and doubt regarding long-term benefits can further act as barriers to agrivoltaics scaling in such contexts (Mohammad et al., 2024; Patel et al., 2024). These challenges highlight the need for comprehensive research that goes beyond technical feasibility and explores political, social, and institutional dimensions.

Stakeholder perceptions can induce the adoption and continued success of AVS (Moore et al., 2021). This happens because, at various stages, decision-making is influenced by farmers, policymakers, and others in the local community. Farmers' assessments of the economic benefit of crop yield increase or the additional income from energy generation is not enough for the adoption of AVS. They will also assess technical feasibility, compatibility with existing practices and risks like crop shading or land-use conflicts (Torma & Aschemann-Witzel, 2023; Wagner et al., 2024). Moreover, the way policymakers perceive the AVS informs how they design regulatory frameworks, incentives and other support mechanisms. For example, when they have a positive perception of AVS, policymakers will be more encouraged to create policies that enable the integration of renewable energy into agriculture. On the other hand, skepticism or uncertainty from policymakers may result in delays in regulation or perhaps lack of support for the AVS (Biró-Varga & Stremke, 2025; Torma & Aschemann-Witzel, 2023).

At the community level, acceptance of land-use changes and perceived fairness in the distribution of benefits are critical for obtaining social license to operate; communities are more likely to support innovative projects when they believe the initiatives are equitable, environmentally sustainable, and culturally appropriate (Hammami & Triki, 2016; Koch et al., 2011). Studies in global north and south contexts have shown that local knowledge, implementing agencies, food access, and perceived climate adaptation benefit further shape perceptions (Raj et al., 2022). This highlights the importance of engaging stakeholders early in project design. Overall, understanding these multi-level perceptions is essential for designing AVS projects that are not only technically and economically viable but also socially accepted and sustainable in the Global South, as neglecting stakeholder perspectives can significantly hinder adoption and reduce the long-term effectiveness of agrivoltaic interventions (De Falco et al., 2025; Torma & Aschemann-Witzel, 2023; Zahrawi & Aly, 2024).

However, despite the fact that agrivoltaic systems offer significant potential for addressing food security and energy nexus, their adoption in global south remains scarce (Mohammad et al., 2024; Patel et al., 2024). There is limited research focusing explicitly on stakeholder perceptions of agrivoltaic systems. Most studies to date have concentrated on technical performance, economic viability, or environmental impacts. This leaves a significant gap in understanding how local actors view AVS technology. It is vital to understand these perceptions, as stakeholders' engagement are crucial for the successful adoption and long-term sustainability of agrivoltaic systems. This study aims to bridge this gap by investigating stakeholder perceptions in global south and addressing the following research questions:

i) What are stakeholders' perceptions of integrating agrivoltaic systems in Global South?

ii) How do stakeholders perceive the potential benefits and challenges of agrivoltaic systems?

By examining these perceptions, this study intends to contribute to the broader discourse on sustainable agriculture and renewable energy adoption in global south. It will provide empirical evidence that can inform policymakers, practitioners, and investors about context-specific barriers and enablers. Ultimately, the research aims to support more effective, socially accepted, and sustainable implementation of AVS.

# Chapter 2

# Literature Review

Agrivoltaics have become an important part of the growing pressure on food and energy. Existing literature shows that agrivoltaics has grown into a serious field that connects numerous fields. For example, agronomy, engineering, economics, and policy. This literature show that it can improve land equivalent ratios, reduce water stress, create extra farm income, and support low-carbon rural development. Still, the results are highly dependent on local condition and system design (Chopdar et al., 2024; Widmer et al., 2024).

A large part of the global literature focuses on the technical aspects of AVS. Studies from dry and semi-arid regions show that partial shading from solar panels can improve local microclimates. It can lower evapotranspiration and in some cases improve crop productivity. Adeh et al. (2018) found that AVS improved soil moisture and water-use efficiency in water-stressed areas. Barron-Gafford et al. (2019) also found that AVS can create benefits across the food-energy-water nexus by reducing plant water stress and helping crops perform better under hot conditions. Trommsdorff et al. (2021) reached a similar conclusion in Germany. They study showed that well-designed AVS can keep agricultural production viable in the meantime producing energy. These findings are important for climate-deprived areas. They suggest that it is not just an energy technology but also a strategy of managing land. It has some core values of adaptation and mitigation. At the same time, the literature warns of being too much excited. Agrivoltaic outcomes basically vary by crop type, panel spacing, light conditions, and local climate (Widmer et al., 2024).

Beyond technical feasibility, many recent studies focus on social acceptance, institutional design, and stakeholder perceptions. This is important because agrivoltaics does not only change land use. It changes dynamics among farmers, energy developer, regulators, and rural communities. Torma and Aschemann-Witzel (2023) show that stakeholder views on agrivoltaics are shaped by perceived usefulness, fit with local values, fairness, and wider social meanings attached to land and innovation. Pascaris et al. (2023) make a similar argument; they show that AVS development sits at the meeting point of market concerns and broader sociopolitical acceptance. This means techno-economic viability alone is not enough. They also highlight the need for coordinated markets, cross-sector learning, and clear regulation if agrivoltaics is to move beyond small pilot projects (Pascaris et al., 2023). Research on farmers also supports this point. It shows that willingness to adopt AVS depends numerous factors. Such as expected usefulness, social norms, and farm-level benefits. At the same time, concerns about cost, management complexity, and institutional support can reduce adoption (Agir et al., 2023; Wagner et al., 2024a). Together, these studies show that agrivoltaic adoption is driven by social and political factors, just as technical.

This social and institutional side becomes even greater important in the Global South. In these regions, agrivoltaics is often discussed as a response to land pressure and climate stress. Yet the enabling conditions are often weaker. Recent studies note that Africa, South Asia, and other parts of the Global South are still underrepresented in agrivoltaic policy research. Even though the food-energy-climate nexus is especially severe there (Alves et al., 2025). In these contexts, the barriers go more than engineering. They include limited access to finance, unclear regulation, low technical capacity, and unequal power among stakeholders. Studies on renewable energy adoption in developing countries show similar problems. High upfront costs, weak institutional coordination, and poor policy implementation often slow the spread of low-carbon types of technologies (Luthra et al., 2015). Agrivoltaic studies also point in this direction (Alves et al., 2025; A. Pascaris et al., 2023). They show that expansion highly relies on strong business models that connect agriculture and energy rather than thinking them as separate entities. In the Global South, agrivoltaic viability should not be seen only as a profitability issue. Rather it is a governance issue that depends on coalition building among public, private, and community actors.

In Bangladesh, this issue is especially relevant. The country faces two types of challenges. It needs to expand energy access while protecting agricultural land. This also need to happen under severe climate problems. Studies on Bangladesh's energy transition identify major barriers such as financing constraints, weak institutional coordination, policy inconsistency, and low public awareness (Al-tabatabaie et al., 2022; Mahmud & Roy, 2021; Hossain et al., 2024). These barriers are more serious in rural areas. Here, agriculture remains central to livelihoods and solar technologies need to show clear economic and practical value to be accepted. Evidence from Bangladesh's solar irrigation sector is useful here. Sunny et al. (2022) found that solar irrigation in northern Bangladesh can improve 4.48 to 8.16% higher return on investment and reduce irrigation costs by 0.06 to 0.98%. However, wider adoption still depends on supportive policy and stakeholder-sensitive implementation. More recently, Al-Amin et al. (2024) provided one of the first Bangladesh-focused agrivoltaic studies. Their study showed that agrivoltaics has technical and economic promise for producing crops and electricity on the same land. Still, that work remains mostly techno-economic. It leaves open a wider social and political question of AVS adoption in the region.

Therefore, much of the current literature explains agrivoltaic viability through land-use efficiency, engineering optimization, or farm-level profitability. These are important, but they do not fully capture policy understanding in developing-country settings. New technologies often move forward when actors with similar beliefs coordinate around shared ideas of benefit and risk. This is where stakeholder perception becomes useful. In Bangladesh and similar Global South settings, farmers, government agencies, business, local communities, NGOs, and technical experts may not see agrivoltaics in the same way. Some may view it as a way for food security. Others may focus on profit, climate resilience, or land business. However, current agrivoltaic studies examine how this belief systems interact or how coalition formation affects policy process in a very limited manner, leading to a clear gap in the literature. Addressing this gap is necessary if agrivoltaics wants to move from a promising idea to a politically viable approach. This research contributes to our understanding of agrivoltaic adoption by asking: What are stakeholders' perceptions of integrating agrivoltaic systems in Global South? How do stakeholders perceive the potential benefits and challenges of agrivoltaic systems? Establishing stakeholder perceptions regarding adoption can help explain the political and governance conditions that impact on the viability of agrivoltaic systems. It also provides context-specific insight into how different actors' beliefs, interests, and concerns may influence policy adoption in Bangladesh and other Global South settings.

# Chapter 3

# Theoretical and Analytical Framework

To understand how AVS are adopted in the Global South, it is not enough to look only at the technical side. The process depends on different stakeholders who may have different ideas about its benefits and risks. These differences can influence whether policies actually move forward. A framework that can explain how these beliefs matter and how people come together based on similar views gives structure to our expectations regarding willingness to adopt agrivoltaics policy. The Advocacy Coalition Framework (ACF) is helpful here because it illustrates how stakeholders' beliefs can drive policy adoption or change over time, which is particularly essential for this study since it focuses on stakeholders' perception of AVS. Therefore, this study uses ACF as the theoretical framework to understand AVS adoption in the Global South context.

## 3.1 Advocacy Coalition Framework

This study is grounded in ACF proposed by Jenkins-Smith and Sabatier (1994). The ACF describes a policy change as a result of interactions between groups of actors with a given set of beliefs. Within the ACF, the belief system is particularly useful in this study. As indicated in Figure 3.1, ACF stresses that policy change occurs in policy subsystems where many actors form coalitions based on shared beliefs (Jenkins-Smith & Sabatier, 1994). The coalition works together to influence policy for a long time. Within this process, beliefs operate at different but connected levels that guide the actions and preferences of members. Deep core beliefs are the most fundamental. They mirror fundamental beliefs about the essence of humanity, normative values, and social justice. These beliefs tend to be deeply entrenched and are difficult to change even with new evidence or conditions. Policy core beliefs are more specific. The coalition supports various policy goals, strategies, solutions that they relate to. These beliefs shape how members define key problems and what types of actions they think are appropriate. Finally comes the secondary beliefs, which are flexible in nature and situation based. They include real choices concerning the implementation of policy, tools, and tactics. These beliefs can change relatively flexibly, when the information changes or the political situation changes (Sabatier & Weible, 2019). The coalition's deeper values and principles remain stable in spite of adjustments.

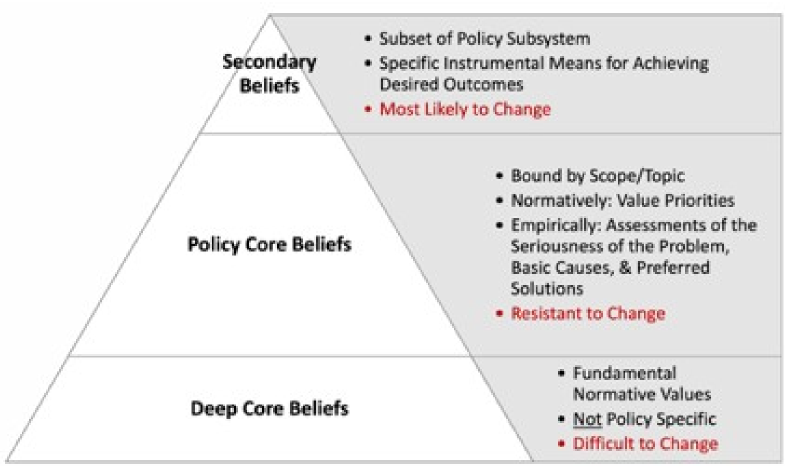


**Figure 3.1:** Belief levels – Policy Subsystem – Policy Change of Advocacy Coalition Framework.

The deployment of PV systems with agriculture in AVS is a new policy field in the Global South (Vorast, 2022). Gaining insight into the beliefs of this nascent subsystem is key to understanding how policies emerge and become more impactful. ACF has largely been applied in mature policy subsystems, where coalitions have formed, and beliefs have stabilized for long periods (Sabatier & Weible, 2019). However, Jenkins-Smith and Sabatier (1994) state that policy innovations may first materialize as subnational activity before expanding into nationwide programs. According to Tomasi et al. (2025), AVS also mainly regulates the subnational level. The application of ACF to this emerging policy arena offers scope to study the initial shape of coalition and their implications at the national level.

Core beliefs are fundamental values like technology, sustainable development, energy justice, and fundamental human-environment relations (Jenkins et al. 2016; O'Riordan 1995; Stern 2000). Policy core beliefs are specific in their focus on strategies for achieving desired outcomes. For example, should agrivoltaics prioritize energy generation, agricultural yield, or community resilience? Secondary beliefs may be flexible in nature, involving practical issues like perceived socio-cultural factors, benefits-barriers, and financial incentives. At the beginning stage of the agrivoltaic subsystem, belief systems of actors are developing. Farmers, policymakers, investors, and environmental advocates may view the AVS differently. Accordingly, the current study applies the ACF framework by investigating key policy core and secondary beliefs responsible for the formation of coalitions and shaping the AVS outcome in Bangladesh reflecting a wider Global South trend.

## 3.2 Beliefs and Coalition Formation (BCF)

From an ACF perspective, stakeholders' beliefs may influence AVS adoption by influencing how they evaluate its benefits and feasibility. Research indicates that when stakeholders share similar views regarding the economic, environmental, and technological benefits, they are more likely to form coalitions that push for policy change (Elgin & Weible, 2013; Senaratne et al., 2023). Stakeholders' priorities come to align in the ACF system, and they get engaged in collaborative effort for facilitating policy development (Jenkins-Smith & Sabatier, 1994). Mutual benefits can help them get a consensus in shaping policy. When stakeholders achieve consensus alignment in a negotiated agreement, it establishes a strong sense of trust (Alfantoukh et al., 2018). It is vital for surmounting barriers to the acceptance of technologies like AVS. These influences can affect the success and failure of policy initiatives. As a result, it has been identified that how well the stakeholder beliefs align is important for the speed and effectiveness of policy adoption (Foley et al., 2016). Therefore, it can be hypothesized that:

- ***H1 - Beliefs and Coalition Formation:*** *Stakeholders with aligned policy core beliefs regarding the benefits of AVS are positively associated with support for agrivoltaic policy adoption.*

Furthermore, participation is another important factor in collaborative policymaking. The involvement of all stakeholders in policy development processes ensures contribution of all. It creates a greater opportunity for an inclusive and widely accepted policy framework to be created. According to Bell and Reed (2022), inclusive participation will legitimize the policy. At the same time improve its chances of long-term success in building understanding and trust. Stakeholder participation leads to better representation of diverse interest which can reduce conflict and promote consensus-building (Wang et al. 2021). As a result, participation is an essential mechanism through. Through this policy change or adoption can take place to form coalition, especially in difficult areas like agrivoltaics (Seay-Fleming et al., 2025). It is essential to take into account the needs, interest, and concerns of all AVS stakeholders. It can help create stronger coalition and collaboration in policy implementation. The development of sustainable agrivoltaic systems that enjoy wide support, and acceptance is possible with the right policy landscape that promotes inclusiveness and participation. Hence, the following is hypothesized:

- ***H2 - Participation:*** *Greater stakeholder participation in agrivoltaic policy making is positively associated with support for agrivoltaic policy adoption.*

## 3.3 Economic Viability (EV)

The widespread adoption of AVS depends largely on its economic viability (Chen et al., 2025). Within sustainable energy transitions, financial viability and cost-effectiveness are major determining factors in the adoption of technology and its long-term implementation (Billi et al., 2023). Lombardi and Berni (2021) investigated renewable energy systems and informed that farmers and policymakers need to consider operational costs and return on investment (ROI) when making the decision. Agrivoltaics can either be encouraged or discouraged due to these economic factors (Pascaris et al., 2020). Most business entrepreneurs mention perceived benefits like lower energy costs, greater productivity of land, and sales of that energy as their motivators (Cole et al., 2018; Edouard et al., 2023; Espinoza et al., 2024). With such wide potential benefits, it's not hard to imagine the acceptance of agrivoltaics. Nevertheless, it is still hard to find financial incentives in many areas, especially in the Global South (Schwerhoff & Sy, 2017). Implementing AVS in any developing country will be a big financial burden like Bangladesh. Bangladesh does not have enough facilities and funds to generate renewable energy. It has some additional difficulties in arranging funds for implementation of renewables (Hossain et al. 2024). According to Butts (2024), renewable energy supply in South Asia is less than 10% of global totals. Bangladesh, like several other countries, faces an annual financing gap of over $10 billion in the energy sector (ADB, 2025). Without any financial incentives, the uptake of AVS, in a widespread sense, is particularly constricted. Mohammad et al. (2024) found that high interest rates, technical cost, and absence of adequate financial incentives render the adoption rate of agrivoltaics significantly lower. The economic viability of agrivoltaics improves greatly with the broadening of government incentives for such projects. This is the essence of collaboration that can make things easy. There is considerable evidence from research on incentives like subsidies, tax breaks and low-interest loans that offer powerful prospects. These prospects are on the doorsteps of investors and consumers to lower upfront costs (Mormann, 2014; Rentschler & Bazilian, 2017; Wiser & Pickle, 1998). The provision of financial security allows for long-term investment in AVS. Such financial support can create a conducive environment for coalitions of different stakeholders and greater adoption of AVS. Therefore, it can be hypothesized that:

- ***H3 – Economic Viability:*** *Stakeholders who perceive agrivoltaic systems as economically viable (e.g., profitable, cost-effective) will be positively associated with support for agrivoltaic policy adoption.*
- ***H4 – Financial Support:*** *Stakeholders who perceive financial support for AVS positively will be positively associated with support for agrivoltaics policy.*

## 3.4 Perceived Barriers (PB)

In terms of AVS, the Global South is especially facing a number of hurdles to its successful adoption (Randle-Boggis et al., 2021). Barriers, including high upfront investment costs, lack of access to technical know-how, regulatory uncertainty, and so on, are often compounded due to economic and infrastructure issues (Mohammad et al., 2024). In the context of agrivoltaic implementation in this area, system integration and skilled labor-related technical hindrances are important roadblocks (Mahto et al., 2021). According to Cinderby et al. (2024), the regulatory and technical aspects in East Africa are some of the key touchpoints and barriers for agrivoltaics uptake. In the absence of action, these can lead to skepticism and a general reluctance to engage with technology on the part of stakeholders. Moreover, the lack of well-defined land-use regulations, zoning regulations, and the shortage of subsidies significantly contributes to the challenge of adopting agrivoltaic systems (Vorast, 2022). It highlights the need for adequate and consistent policy frameworks tailored to the realities of various regions. Perceived risks can also undermine confidence in the economic viability of agrivoltaics. For example, some stakeholders doubt that they will receive the ROI projected. Furthermore, others are concerned that land productivity could be negatively impacted (Gölz & Larisch, 2022; Ressar et al., 2021; Torma & Aschemann-Witzel, 2023). Specifically, the farmers' groups have a challenge in learning these new technologies and experiencing long-term benefits (Pascaris et al., 2020). Although public-private partnerships show promise in addressing infrastructure and financing gaps, they still face serious impediments to their wide-scale adoption, including limited infrastructure, a scarcity of skilled technical training and persistent regulatory uncertainty (GEF 2024). Targeted interventions could help address these challenges and overcome these barriers. As stakeholders -mainly from Global South- see fewer barriers in the future, the likeliness of adopting agrivoltaics increases. Therefore, it can be hypothesized.

- ***H5 – Perceived Barriers:*** *Perceived Barriers to the implementation of AVS will be negatively associated with support for agrivoltaics policy adoption.*

Figure 3.2 illustrates a detailed proposed analytical framework of the study. This empirical research investigates their expected effects. It is important to clarify that this study does not directly identify existing advocacy coalitions around AVS. ACF scholars generally examine policy subsystems over a long time period, often a decade or more (Sabatier & Weible, 2019). AVS is still a relatively new policy area in Bangladesh. Formal coalitions around agrivoltaic policy have not yet fully developed. Rather, the study examines stakeholders' beliefs and perceptions as early pre-conditions for possible future coalition formation. In this sense, the study uses the ACF to understand stakeholder belief about AVS viability pre-conditions in the global south. Therefore, this paper's framework should be understood as an analysis of the belief conditions that highlight the viability of future AVS policy adoption.

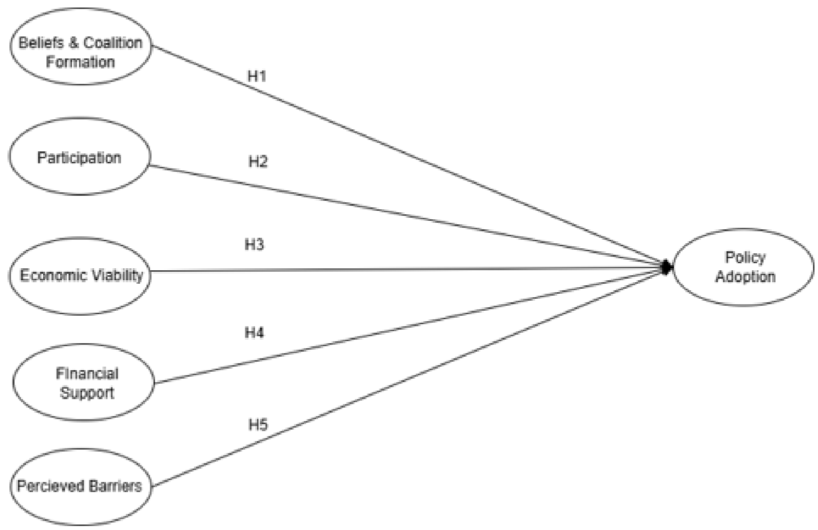


**Figure 3.2:** Analytical Framework of the Study

# Chapter 4

# Methodology

## 4.1 Study Area

This study was conducted in Sujanagar Upazila of Pabna district in Bangladesh (Figure 4.1). The area was selected because it is a strongly agriculture-based area. Most of the people living here are highly dependent on farming for their everyday life. Larges areas of open land are available and those are traditionally being used for crop production. This area is very much suitable for exploring land-based system like agrivoltaics.

Pabna district is known for producing major crops in Bangladesh. Such as rice, jute, and spices. Onion is one of the most important commercial crops in this region. In Pabna, onion cultivation covered about 82,341 acres with a total production of around 305,545 metric tons, which shows the strong use of land for agriculture (Islam et al., 2019). The Upazila consists 305,576 populations and number of Beel's (farming land) which is highly fertile and play as an agricultural nerve center of the county (Wikipedia, 2026). The instance of rigorous cultivation also shows us pressure on farming land at the same time.

From an AVS perspective, this area has an excellent potential. The availability of open land, high dependence on agriculture, and need for better resource use is highly relevant for testing such systems. At the same time, farmers face issues such as high input costs, limited technical knowledge, and lack of improved facilities (Islam et al., 2019). These conditions suggest that AVS could be useful if it can provide both energy and agricultural benefits within the same land.

## 4.2 Research Design

The research design provides the overall plan for collecting and analyzing data in a systematic way (Mitchell & Jolley, 1988). This study followed a face-to-face survey approach to understand stakeholder perceptions of AVS in the study area. A structured questionnaire was developed based

**Figure 4.1:** Geographic Area of the Study (Wikipedia, 2026).

on the theoretical framework and the objectives of the study. It was organized in a structured way to capture different dimensions of AVS adoption. The questionnaire consisted of three sections. The first section collected socio-demographic information (control variables) of the respondents. This includes gender, age, education, income, and occupation. The second section focused on the dependent variable, which is the perception of AVS adoption and its viability in the region. Respondents were asked about their interest in adoption, perceived importance, and willingness to recommend AVS. The third section examined different independent variables such as perceived benefits, stakeholder participation, economic factors, financial support, and perceived barriers to AVS adoption. A brief overview of the studied variables provided in Table 4.1.

All variables were measured using a Likert scale 1-5. The scale included five response options: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). This scale let respondents simply say how much they agreed or disagreed with each AVS statement. So it made their opinions easier to capture in a clear way. It also helped turn those views into numbers for the statistical analysis. The Likert scale is very common in perception studies (Joshi et al., 2015; Tanujaya et al., 2022). It works well when the goal is to understand how people feel about new technologies and policy ideas (Batterton & Hale, 2017). This is because the Likert scale convert personal opinions into measurable scores, to compare different views and test relationships.

**Table 4.1:** Summary of dependent, independent, and control variables used in the study.

| Variable Type | Variable | Items |
|---|---|---|
| Dependent | Agrivoltaic Adoption (AVA) | AVS viability (AVA1), sustainable development importance (AVA2), self-adoption interest (AVA3), recommendation others (AVA4) |
| Independent | Perceived Benefits (PB) | Food security (PB1), agricultural productivity (PB2), energy generation (PB3), job creation (PB4), environmental protection (PB5) |
| | Stakeholder Participation (SP) | Coalition building (SP1), inclusive policy (SP2), trust and collaboration (SP3) |
| | Economic Factors (EF) | Energy Cost Reduction (EF1), additional income (EF2), local economy (EF3) |
| | Financial Support (FS) | Government subsidies (FS1), low-interest loans (FS2), tax incentives (FS3) |
| | Perceived Barriers (BR) | Installation costs (BR1), Technical expertise (BR2), lack of infrastructure (BR3), Traditional farming conflict (BR4) |
| Control | Socio-demographic Variables | Gender, age, education, income, occupation |

## 4.3 Sampling and Data Collection

To collect the data, this study used measures that fit the research goal. The main aim was to understand how stakeholders perceive the viability of AVS in the study area. For that reason, purposive sampling was used (Gen & Wright, 2018; McCoy et al., 2017; Weible et al., 2023). This method helped select people who were connected to agriculture and energy and could give useful views on AVS. Purposive sampling is a non-probability method where the researcher chooses participants based on who is most likely to provide relevant information (Campbell et al., 2020).

It is often used when a study needs specific knowledge or experience rather than general opinions from the full population (Campbell et al., 2020). This method is useful in this study because it was important to focus on those who have some involvement in related areas.

To select the participants, this study used a suitable sampling technique. In large populations (>100,000), a sample of around 100 is often considered acceptable at a 95% confidence level with a precision level of ±10% (Singh & Masuku, 2014). Though collecting data from more people is always better, but time and financial limits made it difficult in this study. So, the final sample included 223 participants from a total population of 305,576. This gave a 95% confidence level and about 7% precision. To decide the required sample size, the study used following formula suggested by Yamane (1973).

$$n = \frac{N}{1 + N(e)^2} \tag{4.1}$$

Here, $e$ represents the precision level ($\sim 0.07$), $n$ is the size of the sample, and $N$ is the total number of population (305,576).

To start the data collection, the surveyor met possible respondents directly in the field. First, the respondents were greeted and the purpose of the study was explained in simple words. They were told that the study was about understanding people's views on AVS and whether it could be useful in the area. If anyone had questions, those were answered before the survey began. It was also clearly explained that taking part was fully voluntary, so they could stop at any time without any problem. The respondents were told that no personal identity information would be taken and their answers would stay confidential. After that, the questionnaire was completed through face-to-face interviews. This made things easier because respondents could understand the questions better, and the surveyor could explain anything that was unclear right away. Data were collected from December 25, 2025 to January 23, 2026.[1]

[1] This research was approved by the Colorado State University Institutional Review Board (IRB), Case No. #7558.

## 4.4 Data analysis and Reliability

Data analysis in this study followed several steps. First, socio-demographic variables were analyzed to understand the basic characteristics of the respondents. Frequencies and percentages were calculated for variables such as gender, age, education, income, and occupation. This helped to get an overall idea about the demographic pattern of the sample. Next, descriptive statistics of the main variables were performed. Measures such as mean, median, and standard deviation were used to understand the central tendency and variation of the data. This step helped to summarize how respondents perceive different aspects of AVS. It also gave an initial idea about the distribution of responses. After that, multiple regression analysis was conducted using the Ordinary Least Squares (OLS) method. For this purpose, the variables were first converted into composite scores by combining related items from the questionnaire. These composite variables were then treated as continuous variables in the regression model. Socio-demographic variables were used as control variables. The regression analysis was used to test the proposed hypotheses and examine the relationship between dependent and independent variables. Before running the regression, several assumptions were checked to ensure the validity of the model. These included normality of data using skewness and Q-Q plots and checking residuals to confirm that the model fits reasonably well.

To check the reliability and internal consistency of the dataset, Cronbach's alpha was calculated. In social science research, a Cronbach's alpha value above 0.60 (lowest 0.69 and highest 0.85 this study) is generally considered acceptable for reliability (Tavakol & Dennick, 2011). In this study, the values indicated a satisfactory level of consistency among the variables.

# Chapter 5

# Results

## 5.1 Socio-demographic Profile

Table 5.1 shows the socio-demographic characteristics of the 223 respondents. The sample was mostly male, with men making up 88.34% of the respondents, while women represented only a small share. This may be linked to the fact that in Bangladesh, much of the farming-related workforce is still dominated by men (Ahmed, 1992; Rahman et al., 2020).

**Table 5.1:** Socio-demographic Characteristics of Respondents (N = 223).

| Variable | Category | Frequency (n) | Percent (%) |
|---|---|---|---|
| Gender | Male | 197 | 88.34 |
| | Female | 26 | 11.66 |
| Age | 18–25 | 28 | 12.56 |
| | 26–40 | 113 | 50.67 |
| | 41–70 | 82 | 36.77 |
| Education | Illiterate | 38 | 17.04 |
| | Primary | 34 | 15.25 |
| | SSC | 40 | 17.94 |
| | HSC | 55 | 24.66 |
| | Undergraduate/Graduate | 56 | 25.11 |
| Income (BDT) | >10000 | 52 | 23.32 |
| | 10000–19999 | 53 | 23.77 |
| | 20000–29999 | 61 | 27.35 |
| | 30000–39999 | 35 | 15.70 |
| | <40000 | 22 | 9.87 |
| Occupation | Academic | 14 | 6.28 |
| | Business/Private | 36 | 16.14 |
| | Energy Professional | 53 | 23.77 |
| | Farmer | 93 | 41.70 |
| | Government Official | 12 | 5.38 |
| | NGO | 15 | 6.73 |

In terms of age, the largest group was 26–40 years, accounting for 50.67% of the sample. This means the respondents were mainly from the active working-age population. The 41–70 age group also formed a considerable part of the sample. The educational background of the respondents was mixed. A slightly larger portion had undergraduate/graduate and HSC-level education, although respondents with low or no formal education were also present. Around 17 percent of respondents appear to have any formal education. For income, most respondents were concentrated in the middle-income categories, especially BDT 20,000–29,999. Some were also in the BDT 10,000–19,999 and above BDT 10,000 categories.

A similar pattern appeared in occupation. Farmers were the largest group, followed by energy professionals and business sector workers. In terms of occupation, farmers constituted the largest occupational group, accounting for 93 respondents (41.70%). Energy professionals formed the second-largest category with 53 respondents (23.77%).

## 5.2 Descriptive Statistics

Table 5.2 presents the descriptive statistics of the main study variables and their corresponding items. Overall, the composite mean for *AVS Adoption (AVA)* was 3.66. Looking at the individual items, the highest means was found for *Sustainable Development (AVA2)* with a mean value of 4.55. Very interestingly, *Self-adoption Interest (AVA3)* and *Recommend Others (AVA4)* recorded lower mean values of 2.84 and 2.99, respectively. This suggests that while respondents generally viewed AVS as important for sustainable development, their personal willingness to adopt it or recommend it to others was comparatively lower. For *Perceived Benefits (PB)*, the composite mean was 3.99 and *Energy Generation (PB3)* had the highest mean at 4.35.

The mean of composite *Stakeholder Participation (SP)* was 3.77. It shows a generally positive perception of the role of stakeholder engagement in AVS policy development. Among its items, *Inclusive Policy (SP2)* received the highest mean score of 4.14. In terms of *Economic Factors (EF)*, the mean score was 3.88. Item *Additional Income (EF2)* had the highest mean of 3.98.

**Table 5.2:** Descriptive Statistics of Composite Variables and their Items.

| Variable | Obs. | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| AVS Adoption (AVA) | 223 | 3.66 | 0.74 | 1.50 | 5.00 |
| AVS Viability (AVA1) | 223 | 4.28 | 0.85 | 1 | 5 |
| Sustainable Development (AVA2) | 223 | 4.55 | 0.65 | 2 | 5 |
| Self-Adoption Interest (AVA3) | 223 | 2.84 | 1.24 | 1 | 5 |
| Recommend Others (AVA4) | 223 | 2.99 | 1.25 | 1 | 5 |
| Perceived Benefits (PB) | 223 | 3.99 | 0.79 | 1.60 | 5.00 |
| Food Security (PB1) | 223 | 3.93 | 0.98 | 1 | 5 |
| Agricultural Productivity (PB2) | 223 | 3.69 | 1.11 | 1 | 5 |
| Energy Generation (PB3) | 223 | 4.35 | 0.77 | 2 | 5 |
| Job Creation (PB4) | 223 | 3.75 | 1.04 | 1 | 5 |
| Environmental Protection (PB5) | 223 | 4.23 | 0.78 | 1 | 5 |
| Stakeholder Participation (SP) | 223 | 3.77 | 0.79 | 1.67 | 5.00 |
| Coalition Building (SP1) | 223 | 3.43 | 0.98 | 1 | 5 |
| Inclusive Policy (SP2) | 223 | 4.14 | 0.78 | 2 | 5 |
| Trust and Collaboration (SP3) | 223 | 3.74 | 0.96 | 1 | 5 |
| Economic Factors (EF) | 223 | 3.88 | 0.87 | 1.33 | 5.00 |
| Energy Cost Reduction (EF1) | 223 | 3.77 | 1.06 | 1 | 5 |
| Additional Income (EF2) | 223 | 3.98 | 0.99 | 1 | 5 |
| Local Economy (EF3) | 223 | 3.90 | 0.94 | 1 | 5 |
| Financial Support (FS) | 223 | 3.90 | 0.81 | 1.33 | 5.00 |
| Government Subsidies (FS1) | 223 | 3.97 | 0.97 | 1 | 5 |
| Low-Interest Loans (FS2) | 223 | 3.88 | 0.87 | 2 | 5 |
| Tax Incentives (FS3) | 223 | 3.84 | 0.95 | 1 | 5 |
| Perceived Barriers (BR) | 223 | 4.10 | 0.68 | 1.75 | 5.00 |
| Installation Cost (BR1) | 223 | 4.43 | 0.71 | 1 | 5 |
| Technical Expertise (BR2) | 223 | 4.17 | 0.83 | 2 | 5 |
| Lack of Infrastructure (BR3) | 223 | 4.30 | 0.77 | 2 | 5 |
| Traditional farming Conflict (BR4) | 223 | 3.50 | 1.05 | 1 | 5 |

Similarly, *Financial Support (FS)* produced a composite mean of 3.90 with *Government Subsidies* (FS1) recorded the highest mean at 3.97.

However, *Perceived Barriers (BR)* had the highest mean value (4.10) among all constructs. This indicates that respondents strongly acknowledged the presence of barriers to AVS adoption. Among these items, *Installation Cost (BR1)* showed the highest mean of 4.43. Taken together, the descriptive results suggest that respondents generally held positive views regarding the viability and benefits of AVS, at the same time, they also strongly recognized important implementation barriers.

**Table 5.3:** Mean Scores of AVS Adoption-Related Dependent Variables by Occupation.

| Occupation | N | AVA1 | AVA2 | AVA3 | AVA4 |
|---|---|---|---|---|---|
| Academic | 14 | 4.50 | 4.86 | 4.14 | 4.00 |
| Business/Private | 36 | 4.19 | 4.50 | 2.81 | 2.97 |
| Energy Professional | 53 | 4.43 | 4.66 | 3.23 | 3.28 |
| Farmer | 93 | 4.03 | 4.35 | 2.32 | 2.56 |
| Government Official | 12 | 4.83 | 4.83 | 3.25 | 3.67 |
| NGO | 15 | 4.80 | 5.00 | 3.20 | 3.20 |
| Total | 223 | 4.28 | 4.55 | 2.84 | 2.99 |

*Note:* AVA1 = AVS Viability; AVA2 = Sustainable Development; AVA3 = Self-Adoption Interest; AVA4 = Recommend Others. Values represent mean scores by occupation group.

Moreover, to examine the low mean value of adoption willingness and recommendation, we conducted an analysis of AVS adoption-related dependent variables by occupation. Table 5.3 shows an interesting gap between general support for AVS and personal willingness to adopt or recommend it. Across all occupation groups, respondents reported high mean scores for *AVS Viability* (4.28) and *Sustainable Development* (4.55). However, the mean scores for *Self-Adoption Interest* and *Recommend Others* were much lower. This pattern is especially visible among farmers, who had the lowest scores for *Self-Adoption Interest* (2.32) and *Recommending Others (2.56)*.

This finding suggests that respondents, particularly farmers, may support AVS in principle, but they remain hesitant when it comes to direct adoption.

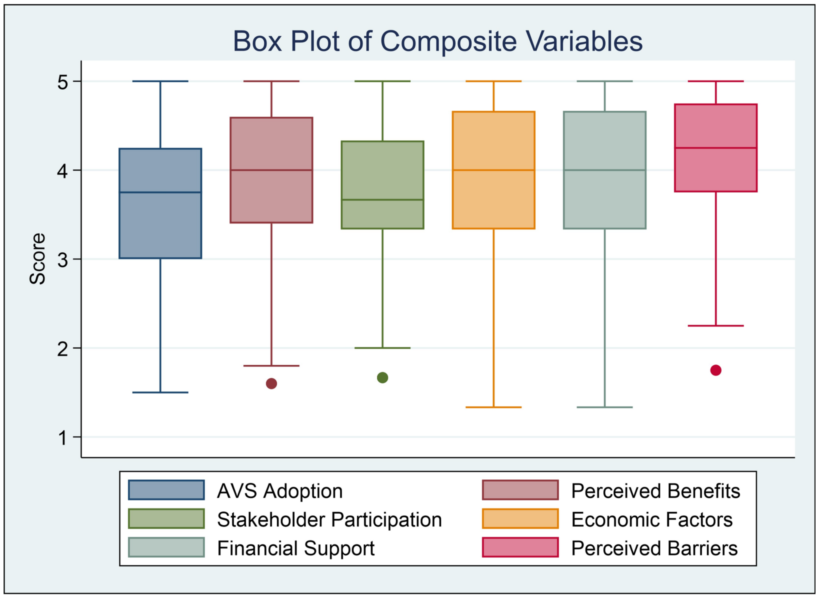


**Figure 5.1:** Boxplot depicting the distribution of composite variables

Figure 5.1 presents the distribution of the six composite variables used in the study. Most of the scores fall between 3 and 5, which shows that respondents mostly gave moderate to high responses across the variables. Among all the composites, *Perceived Barriers* has the highest median, which means respondents gave stronger responses to barriers than to the other dimensions. *Perceived Benefits, Economic Factors,* and *Financial Support* also have relatively high median values. In contrast, *AVS Adoption* and *Stakeholder Participation* are a little lower, though still above the midpoint of the scale. The figure also shows some difference in spread. *AVS Adoption* and *Economic Factors* are more widely spread, which means responses were more varied, while Perceived Barriers is more concentrated in the higher score range. A few lower outliers can also be seen in some variables. This means a small number of respondents reported lower scores than the rest. Overall, the box plot shows that respondents were generally positive across the composite variables.

## 5.3 Multiple Regression Analysis

To test the proposed hypotheses, this study employed multiple linear regression analysis using *AVS Adoption (AVA)* as the composite dependent variable. The analysis first estimated the standard OLS model to examine the direction and significance of the relationships between the predictors and *AVS Adoption (AVA)*. After that, diagnostic tests were conducted to assess heteroskedasticity. The Breusch–Pagan/Cook–Weisberg test indicated heteroskedasticity (p = 0.006), while White's test did not show a significant heteroskedasticity problem (p = 0.55). White's procedure is more general in detecting unspecified forms of heteroskedasticity while the Breusch–Pagan framework is more tied to a specific variance structure and is known to be sensitive to distributional assumptions (White, 1980). Since these two tests provided mixed evidence, a robust regression model was also estimated as a conservative check. Table 5 presents the hypothesis testing results from both the OLS and robust regression models.

**Table 5.4:** Hypothesis testing results from OLS and robust multiple regression models.

| Hypothesis | Predictor | Direction | Coefficient | p-value (OLS) | Decision (OLS) | p-value (Robust) | RSE | Decision (Robust) |
|---|---|---|---|---|---|---|---|---|
| H1 | PB | + | 0.196 | 0.003** | Supported | 0.006** | 0.071 | Supported |
| H2 | SP | + | 0.119 | 0.047* | Supported | 0.061† | 0.063 | Partially supported |
| H3 | EF | + | 0.053 | 0.368 | Not supported | 0.409 | 0.064 | Not supported |
| H4 | FS | + | 0.100 | 0.103 | Not supported | 0.076 | 0.056 | Not supported |
| H5 | BR | - | -0.168 | 0.047* | Supported | 0.061† | 0.089 | Partially supported |
| F value | | | | 5.02*** | | 7.28*** | | |
| $R^2$/Adj. $R^2$ | | | | 0.344 / 0.276 | | 0.344 / 0.276 | | |

*Note:* * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; †: $\sim$ 10% level; RSE: Robust Standard Error

As shown in Table 5.4, H1 was supported in both models. *Perceived Benefits (PB)* had a positive and statistically significant relationship with *AVS Adoption (AVA)*, with a coefficient of 0.196, and the p-values remained significant in both the OLS model (p = 0.003) and the robust model (p = 0.006). This means that stronger perceived benefits are associated with higher *AVS Adoption (AVA)*. H2 also showed a positive relationship with *AVS Adoption (AVA)*. In the OLS model, *Stakeholder Participation (SP)* was significant at the 5% level (p = 0.047), which supports the hypothesis. However, in the robust model, the p-value increased slightly to 0.061, so the hypothesis received only partial support there. H3 was not supported, as *Economic Factors (EF)* remained statistically insignificant in both the OLS ($p = 0.368$) and robust model ($p = 0.409$). In the same way, H4 was not supported because *Financial Support (FS)* had a positive coefficient but did not reach the 5% significance level in either specification, although the robust result was slightly closer to significance ($p = 0.076$). Finally, H5 was supported by the OLS model and partially ( 10% level) supported by the robust model. *Perceived Barriers (BR)* had a negative coefficient (-0.168), which matched the expected direction, and it was significant in the OLS model ($p = 0.047$), but only marginal in the robust model ($p = 0.061$).

Overall, the results show that *Perceived Benefits (PB)* is the most consistent predictor of *AVS Adoption (AVA)* across both model specifications. *Stakeholder Participation (SP)* and *Perceived Barriers (BR)* also appear relevant, although their significance becomes weaker once robust standard errors are applied. In contrast, *Economic Factors (EF)* and *Financial Support (FS)* do not provide enough statistical evidence to confirm the proposed hypotheses. The overall model remained statistically significant in both cases, with F-values of 5.02 and 7.28, respectively. The $R^2$ and adjusted $R^2$ values further show that the model explained 34.4% of the variation, with an adjusted explanatory power of 27.6%.

Overall, the regression analysis shows that beliefs and coalition formation had the strongest positive effect on policy adoption, which supports H1. Specifically, a one-unit increase in *Perceived Benefits (PB)* was associated with a 0.196-unit increase in AVS adoption, holding other variables constant. Participation also had a positive effect, so H2 received support in the OLS model, although the relationship became weaker in the robust model. A one-unit increase in Stakeholder Participation (SP) was associated with a 0.119-unit increase in AVS adoption. Economic viability showed only a small positive coefficient and remained statistically insignificant, meaning H3 was not supported. Financial support also had a positive but non-significant role, so H4 was not supported. In contrast, *Perceived Barriers (BR)* had a negative effect on policy adoption. This means that for every one-unit increase in *Perceived Barriers (BR)*, policy adoption decreased by

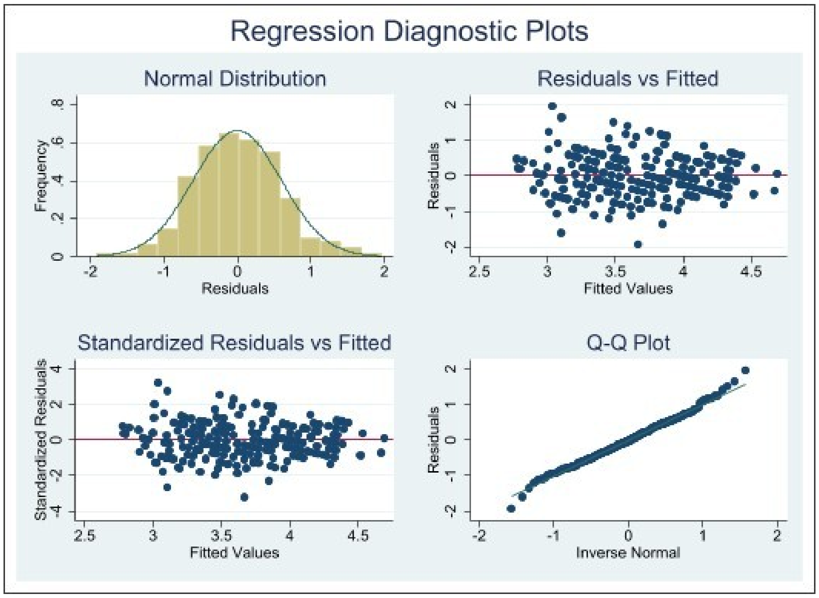


**Figure 5.2:** Model diagnostic plots: residuals distribution, residuals vs. fitted values, absolute standardized residuals, and QQ plot.

about 0.16 units. So, higher barriers reduced support for adoption, which supports H5 in the OLS model and gives partial support ( 10% level) in the robust model. Overall, the result makes it clear that coalition-related beliefs (perceived benefits) were the strongest driver of policy adoption. Perceived benefits were the strongest and most consistent predictor across both models. Stakeholder participation and perceived barriers were less stable, while economic factors and financial support were positive but not significant.

Figure 5.2 presents the regression diagnostic plot for the study model. Overall, the plots do not show any serious abnormality. The histogram of residuals appears roughly bell-shaped, and the Q-Q plot shows that most of the residuals lie close to the reference line, with only slight deviation at the lower and upper tails. The residuals versus fitted values plot and the standardized residuals versus fitted values plot also show that the points are generally scattered around the zero line without any strong systematic pattern or clear funnel shape. Although a few mild outliers can be observed, they do not appear severe enough to indicate a major problem. Taken together, these plots suggest that the regression model reasonably satisfies the assumptions of normality and linearity

# Chapter 6

# Discussion

This study investigated at how stakeholders perceive about AVS in the global south. It focused on five main issues: perceived benefits, stakeholder participation, economic factors, financial support, and perceived barriers. The following sections provide a detailed overview of major findings of the study by discussing each hypothesis.

## 6.1 H1: Beliefs and Coalition Formation

H1 hypothesized that stakeholders who perceive wider benefits of AVS would support AVS adoption. The result of this study strongly supports this hypothesis. Perceived benefits are found to have a significant relationship with AVS adoption. This means that when stakeholders see AVS as useful, they indicate willingness to adopt it. This finding fits well with the ACF. The ACF highlights that people support a policy when they share similar beliefs about the value of that policy (Jenkins-Smith & Sabatier, 1994). In this study, perceived benefits show those beliefs. This is in line with Torma and Aschemann-Witzel (2023), who found that stakeholders justify agrivoltaics based on its usefulness. Their study shows that people become very open to agrivoltaics when they think it can bring a big benefit. This finding also supports Pascaris et al. (2024), who argued that agrisolar can produce beneficial outcomes for solar development when it protects agricultural land and similarly shared value for different stakeholders' engagement.

Within the latent variables, energy generation and environmental protection are found to have the highest value factors. It shows that stakeholders seem to value AVS because they are able to connect it with those environmental benefits. Studies show that agrivoltaics can increase renewable energy production while also reducing land pressure (Amaducci et al., 2018; De Falco et al., 2025; Wagner et al., 2024). AVS can produce electricity and crops from the same land, which can be useful for countries facing food and energy pressure. AVS can also support the food-energy-water link by improving crop conditions and generating solar energy (Barron-Gafford et al., 2019). H1 shows the most important findings of the study. Stakeholders support AVS and may be encouraged to form coalitions when they clearly see its shared benefits.

## 6.2 H2: Stakeholder Participation

Stakeholder participation was found to have a significant effect on the OLS model. However, in the robust model, the result became weaker (marginally significant). Participation is found to be important and although the evidence is not as strong as H1, this finding is still relevant. It highlights that different groups may not always think in the same way so participation can help these groups build trust and promote stakeholders' coalition formation. This finding matches Bell and Reed (2022), who argued that inclusive participation can enhance policy legitimacy. It is also comparable with Barki and Hartwick (1994), who showed that participation can reduce conflict and build agreement.

However, robust models highlight that participation alone is not helpful. Findings indicate that stakeholders need clear proof that AVS can work in their local area. It also matters who participates, under which consideration, institution, and who listens and implements (Conrad et al., 2011). So, the study suggests that policymakers should not use participation only as a formal meeting. It should be an inclusive and deliberative process of hearing different stakeholders' voices and including them in the policy making process when feasible.

## 6.3 H3: Economic Viability

From the hypothesis testing, economic factors had a positive coefficient, but it was not statistically significant. This result is interesting because literature mostly says economic issues are very important. Lombardi and Berni (2021) argued that farmers and policymakers care about cost and ROI. Pascaris et al. (2020) also argued that economic factors can affect agrivoltaic adoption.

However, this study found that economic factors did not strongly predict AVS adoption. One reason may be that AVS is still new in Bangladesh. Many stakeholders may not know the practical possibility of new technology. They are also used to traditional farming practices. Therefore, there may be a high tendency of resistance to change. One study suggests that excessive shading rate can reduce rice production while generating renewable energy (Gonocruz et al., 2021). Most farming land in Bangladesh highly depends on rice production. It requires strong sunlight (Shelley et al., 2016). Moreover, many farmers are older and unfamiliar with AVS, so they might see it as a risky change. One interesting finding from the adoption-related dependent variables was the low mean value for willingness to adopt AVS and recommend it to others, especially among the farmer group. This suggests that stakeholders may accept AVS as a promising idea, but farmers, who are directly connected to agricultural land use, are not yet fully ready to take the risk. This gap can help explain why economic factors were not statistically significant in the model. Another reason is that economic benefits may feel less clear than general benefits. For example, stakeholders may easily understand that AVS can produce solar energy, but they do not clearly know how much money they can make from it, so economic viability may become more important later after pilot projects, awareness campaigns, or real examples. Bangladesh launched its first structured AVS pilot project on 19th November 2025 (SREDA, 2025). This pilot project may help reduce this uncertainty.

## 6.4 H4: Financial Support

Financial support shows a positive output but it was not statistically significant. This finding is surprising. Many studies show that financial support is important for renewable energy. Mormann (2014), Rentschler and Bazilian (2017), and Wiser and Pickle (1998) all showed the importance of financial incentives. Noor et al. (2026) also found that high cost and lack of financial support can reduce agrivoltaic adoption.

However, the result of this study does not simply mean financial support is unimportant. In Bangladesh, farmers and local stakeholders could be worried about complicated rules and corruption. ADB's solar irrigation roadmap notes that subsidy levels need to be very high, such as 50% or 65%, to make solar irrigation pumps workable for many users. This shows that small incentives are not enough for marginal farmers (ADB, 2023). A study on solar irrigation in Bangladesh also found that farmers need strong financial help, but they also need training, capacity building, and technical support at the same time (Mitra et al., 2021). Another reason could be debt risk. Many farmers already face income loss because of climate shocks (Ahmed, 2024). In 2024, floods destroyed around 1.1 million metric tons of rice in Bangladesh (Paul, 2024). This kind of shock makes farmers cautious about taking new loans for an unfamiliar technology like AVS. For many farmers, a loan feels like another risk. Studies on microcredit in Bangladesh also show that loan systems can create pressure when repayment schedules do not match farmers' income cycles and high interest (Islam et al., 2018).

## 6.5 H5: Perceived Barriers

H5 hypothesized that perceived barriers reduce support for AVS adoption. The result supports this hypothesis in the OLS model and marginally supports it in the robust model. Specifically, the descriptive results showed that perceived barriers had the highest mean among all variables, implying that respondents strongly agreed that AVS faces serious barriers in the study. They were specifically concerned about installation cost, lack of infrastructure, and technical knowledge.

This result is comparable to existing literature. Bosman et al. (2024), Pascaris et al. (2020), and Vorast (2022) all showed that high cost, weak policy support, and infrastructure problems create barriers to AVS adoption. Cinderby et al. (2024) also found similar technical and regulatory problems in East Africa. Torma and Aschemann-Witzel (2023) also argued that people may hesitate to accept AVS if they worry about cost and complexity with farming practices.

In the Global South context, many rural people depend on land for their livelihood. Consequently, it's easy for them to be concerned about anything that changes land use. If policymakers do not support them clearly, they can hesitate to support AVS. Infrastructure is another big issue. AVS does not only need solar panels. It also needs strong grid connection, storage facilities, and regular maintenance. Weak roads and transport systems can also make installation and maintenance harder. Lack of infrastructure can make AVS look risky.

# Chapter 7

# Conclusion and Policy Recommendations

This study uses the ACF to understand how stakeholder beliefs influence AVS adoption. The findings show that stakeholders generally look at AVS in a positive way, but with some nuance. They connect AVS with sustainable development, energy generation, and environmental protection. The findings of this study highlight that perceived benefits had a significant effect on AVS adoption. This means stakeholders are supportive when they clearly see the usefulness of AVS. This supports the ACF argument that shared beliefs can help create policy support and possible coalition formation. Stakeholder participation also had a positive effect. The findings on economic viability and financial support were mixed. Both had positive coefficients, but they were not statistically significant. The result highlights that stakeholders do not yet fully understand the real cost and risk of AVS. Since AVS is still new in Bangladesh, many people may support the general idea but still hesitate for risky adoption. Perceived barriers were found to have a negative effect on AVS adoption. This finding is very important because barriers had the highest mean among all variables. Some specific challenges discovered were cost, infrastructure, and technical knowledge. Based on these findings, this study offers the following recommendations.

i. Government should expand local pilot projects and demonstration farms to show real evidence of AVS.

ii. Policy actors should educate and train farmers on AVS so they can communicate economic and social benefits.

iii. Stakeholder participation should be real and continuous, where they can influence decisions in a collaborative way.

iv. Financial support should reduce farmers' risk on loan debt, and profit loss.

v. Promote training, capacity building, and technical assistance through international collaboration.

vi. The government should create clear land-use, ownership, and benefit-sharing rules to protect stakeholders.

vii. Improvement of rural infrastructure.

viii. Promotion of local monitoring, community security, and clear responsibility for protecting AVS.

This study contains some limitations. First, the study was conducted only in Sujanagar Upazila of Pabna district, Bangladesh. The findings may not fully represent all areas of Global South. Other regions may have different farming systems and stakeholder views. Second, the study used data from 223 respondents. This sample was useful for understanding stakeholder perceptions in the study area, but a larger sample could have produced stronger statistical evidence. Third, AVS is still very new in Bangladesh. Many respondents may not have direct experience with this technology. Their answers may reflect early impressions rather than practical experience. Future studies should include larger samples, more comparative study areas of other Global South contexts, and methods such as interviews or focus groups to understand stakeholder perceptions more deeply.

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# Appendix A

# Recruitment Form

My name is Md Ashraful Islam, and I am a graduate student at Colorado State University, USA. I would like to invite you to participate in my research study to understand stakeholders' perceptions of the viability of agrivoltaic systems (AVS) in Bangladesh and their potential benefits and challenges. You may participate if:

1. You are 18 years or older.
2. Work in areas relevant to AVS
3. Have some familiarity with agriculture or AVS and
4. Are willing and able to provide informed consent.

As a participant, you will be asked to complete a survey consisting of questions about your background and opinions on AVS. The survey will take approximately 10–20 minutes to complete.

There are no anticipated risks beyond those encountered in everyday life. Your participation is voluntary, and you will not receive any compensation for participating. Your responses will be kept confidential. Only summary data will be used in research reports, and no information that could identify you personally will be shared. Your decision to participate or not will not affect your relationship with daily life, your workplace, or any other organization.

If you would like to participate in this research study, please complete the survey provided.

Do you have any questions now? If you have questions later, please contact me at +1 970-412-2796 or ashraful.islam@colostate.edu.

If you have any adverse effects or concern about the research, please contact the primary investigator Dr. Kristin Olofsson at Kristin.Olofsson@colostate.edu or the Office of Graduate Studies at Colorado State University at +1 970-491-6817 or gradschool@colostate.edu. This research is approved by the Colorado State University Institutional Review Board under protocol number #7558.

# Appendix B

# Research Participation Informed Consent

**Study Title:** Coalitions for Green Energy: Viability of Agrivoltaic Systems in the Global South

**Principal Investigator (PI):** Dr. Kristin Olofsson

**Co-Principal Investigator (Co-PI):** Md Ashraful Islam

College of Liberal Arts, Colorado State University, Fort Collins, Colorado-80521, USA.

## Key Information About This Research

The key information that follows can help you learn more about this research project. It can also help you decide whether or not to participate. Please read the entire consent form or have someone read it with you. If there is anything that you do not understand, please talk to the researcher to have your questions answered before you agree to participate.

## Study Purpose

The purpose of this research is to understand stakeholders' perceptions of the viability, benefits, and challenges of agrivoltaic systems (AVS) in Bangladesh. This research is part of the partial fulfilment of graduate program at Colorado State University, USA. This survey is being sent to approximately 300 people in Bangladesh from a diverse range of sectors and interests. I will identify participants using purposive sampling, which means I will collect data from people who have knowledge and experience in areas related to AVS, such as agriculture, energy, academia, NGOs, and other relevant sectors. My goal is to gather detailed information from these individuals about their perspectives on the benefits, challenges, and potential adoption of AVS in Bangladesh.

## Description and Time Commitment

If you agree to participate in this research, you will complete a survey. Participation will take approximately 10–20 minutes. The survey will ask questions about your basic socio-demographic background, experiences, and opinions related to agriculture, renewable energy, and AVS. Your responses will help the researcher understand how AVS can be adopted and supported in Bangladesh.

## Eligibility

To participate in this research, you must be:

i) 18 years or older. ii) Work in areas relevant to AVS. iii) Have some familiarity with agriculture or AVS and iv) Are willing and able to provide informed consent.

## Participation is Voluntary

Your participation is voluntary. You can decide whether to participate or not participate. You may withdraw at any time. You may skip any question you do not wish to answer or decline any activity you do not wish to participate in. If you do not want to be in this study or choose to withdraw from the study at any point, your decision will not affect your daily life or workplace.

To withdraw, you can email the researcher, Md Ashraful Islam, at ashraful.islam@colostate.edu, or inform the surveyor in person at any point during the survey. If you withdraw your participation, any data already collected from you may be retained to maintain the integrity of the study or may be discarded upon your request. Once the data have been aggregated and analyzed, it may not be possible for the research team to remove your responses from the anonymous dataset.

## Risks and Benefits

We do not anticipate any risks from participating in this research beyond those encountered in daily life. The survey questions are non-invasive and do not collect sensitive personal information. Only your gender, age, income, and occupation will be collected for socio-demographic information. You may feel minor discomfort reflecting on your experiences or opinions, but no physical, social, or economic risks are expected.

We do not anticipate any direct benefits from participating. However, the expected indirect benefits of participating in this research include contributing to a better understanding of how AVS can be successfully implemented in Bangladesh with a broader context of global south. Information from this study may help improve policies, stakeholder engagement, and adoption of AVS in the future. You will not receive any compensation for participating in this study.

## Privacy, Confidentiality, Data Security, and Sharing

All research data will be stored securely in compliance with Colorado State University standards. All responses will be kept anonymous, confidential, and used solely for academic research purposes. Your personal identity will not be disclosed in any reports or publications. Only authorized members of the research team, including the PI and Co-PI, will have access to information, if collected. In some cases, university personnel, research sponsors, or government officials may need to review the research records to ensure the study is conducted safely and appropriately.

No guarantees can be made regarding the interception of data sent via the Internet; however, we anticipate that your participation in this survey presents no greater risk than everyday use of the Internet. Identifiable research records will be retained for at least three years after the study ends. After this period, all identifiers and associated files will be securely destroyed. All electronic data will be stored on password-protected computers, and physical documents will be kept in a locked cabinet. Only aggregated and de-identified data may be shared in research reports, publications, or presentations.

## If You Have Questions

Please contact, Md Ashraful Islam, at ashraful.islam@colostate.edu or +1970-412-2796 with any questions. The faculty advisor overseeing this research is Dr. Kristin Olofsson from the College of Liberal Arts and can be contacted at Kristin.Olofsson@colostate.edu.

## Statement of Consent

I understand what this research study is about, and my questions so far have been answered. I consent to take part in the study and to have my responses used in this research. I understand that I will receive a copy of this document for my records and that the researchers will keep a copy as part of the study record.

Legal Name: ______________________________

Participant Signature: ______________________________

Date of Signature: ______________________________

This research has been reviewed and approved by the Colorado State University Institutional Review Board (IRB). An IRB is a committee that protects the rights of people who participate in research. You may contact the IRB by phone at +1970-491-1553 or Email at CSU_IRB@colostate.edu.

# Appendix C

# Questionnaire Survey

**Coalitions for Green Energy: Viability of Agrivoltaic Systems in the Global South**

Please tik the appropriate choice (✓)

## 1. Socio-demographic information of the respondents.

| Gender | | Age groups | | Education Level | | Income Level (BDT) |
|---|---|---|---|---|---|---|
| Male | ☐ | 18–25 | ☐ | Illiterate | ☐ | >10000 ☐ |
| Female | ☐ | 26–40 | ☐ | Primary | ☐ | 10000–19999 ☐ |
| Other | ☐ | 41–70 | ☐ | SSC | ☐ | 20000–29999 ☐ |
| | | | | HSC | ☐ | 30000–39999 ☐ |
| | | | | <Undergraduate | ☐ | <40000 ☐ |

**Occupation** ☐ Farmer ☐ Government official ☐ Energy Professional ☐ NGOs

☐ Academic ☐ Business/Private ☐ Other: ________________

**2. AVS is a process of using solar panels on farmland to produce renewable energy while also growing crops. To what extent do you agree or disagree with the following statements about the AVS in your region? (DV)**

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| AVS is highly viable to the region | ☐ | ☐ | ☐ | ☐ | ☐ |
| I consider AVS adoption important for sustainable development | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am interested to adopt AVS | ☐ | ☐ | ☐ | ☐ | ☐ |
| I recommend others to adopt AVS | ☐ | ☐ | ☐ | ☐ | ☐ |

## 3. What is your perception regarding the following potential benefits of AVS?

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Improved food security | ☐ | ☐ | ☐ | ☐ | ☐ |
| Increase in agricultural productivity | ☐ | ☐ | ☐ | ☐ | ☐ |
| Renewable energy generation | ☐ | ☐ | ☐ | ☐ | ☐ |
| Job creation | ☐ | ☐ | ☐ | ☐ | ☐ |
| Reduce environmental degradation | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other: | ☐ | ☐ | ☐ | ☐ | ☐ |

## 4. To what extent do you agree or disagree with the following about stakeholder participation in AVS policy development?

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Increase coalition-building | ☐ | ☐ | ☐ | ☐ | ☐ |
| Promote inclusive policy outcomes | ☐ | ☐ | ☐ | ☐ | ☐ |
| Enhance trust and collaboration | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

## 5. To what extent do you agree or disagree with the following about economic factors in AVS adoption?

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Reduces energy costs | ☐ | ☐ | ☐ | ☐ | ☐ |
| Additional income through energy sales | ☐ | ☐ | ☐ | ☐ | ☐ |
| Boost local economy | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

## 6. To what extent do you agree or disagree with the following regarding financial interventions for AVS?

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Government subsidies encourage adoption | ☐ | ☐ | ☐ | ☐ | ☐ |
| Low-interest loans make AVS financially feasible. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Tax incentives support AVS investment. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

## 7. To what extent do you agree or disagree that ______ is important to adoption of AVS?

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Public awareness | ☐ | ☐ | ☐ | ☐ | ☐ |
| Citizen engagement | ☐ | ☐ | ☐ | ☐ | ☐ |
| Clear regulations | ☐ | ☐ | ☐ | ☐ | ☐ |
| Strong government support | ☐ | ☐ | ☐ | ☐ | ☐ |
| Technical expertise | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

## 8. Indicate your level of agreement or disagreement with the following barriers to AVS adoption?

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| High installation costs. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Lack of technical expertise. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Lack of Infrastructure | ☐ | ☐ | ☐ | ☐ | ☐ |
| Conflicts with traditional farming practices. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

## 9. Please provide additional information if you want: