Assessing Prospects for Environmental Management Using Information About Social Capital Characteristics: A Case Study From Shrimp Farming Communities in the Sundarbans Region of India

by

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Abstract

The Indian Sundarbans, a UNESCO World Heritage site, forms the world's largest tidal mangrove ecosystem. Traditional low intensity shrimp farming is present, but the Indian Government sees potential for its intensification and views shrimp aquaculture as a vehicle for rural coastal poverty eradication. However, intensive shrimp aquaculture has come under fire from environmental groups for its harmful environmental and social impacts. A previous study, which explored stakeholder preferences for aquaculture development recommended less intensive shrimp aquaculture practices than the intensive approach under consideration. One attractive option not explored in the initial study is group shrimp aquaculture. Group shrimp aquaculture relies on the ability and willingness of participants to act collectively, which is influenced by the social capital they possess. Principal Component and Hierarchical Cluster Analyses are used to analyze social capital in the communities by creating distinct clusters based on social capital characteristics. A regression analysis is conducted to determine if social capital affects attitudes towards more group shrimp farms on leased or common land. The research concludes that households, which possess bonding and bridging social capital, are more suitable for group shrimp aquaculture development than those, which possess limited social capital.

Keywords: Social capital; collective action; shrimp aquaculture; group aquaculture; India; the Sundarbans

Dedication

To my parents for supporting me on all my adventures!

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Glossary

AIC	Akaike Information Criterion
ANOVA	Analysis of Variances
CAA	Coastal Aquaculture Authority
CPR	Common Pool Resource
DFID	United Kingdom Department for International Development
FAO	Food and Agricultural Organization
HCA	Hierarchical Cluster Analysis
IUCN	International Union for Conservation of Nature
KMO	Kaiser-Meyer-Olkin
MPEDA	Marine Products Export Development Authority
NACA	Network of Aquaculture Centres in Asia-Pacific
NGO	Non Governmental Organization
OECD	Organization for Economic Co-operation and Development
PASW	Predictive Analytics SoftWare
PCA	Principal Component Analysis
Rs.	Indian Rupees
SHARP	Shastri Applied Policy Research Project
SOCAT	Social Capital Assessment Tool
UN	The United Nations
UNDP	The United Nations Development Programme
UNESCO	The United Nations Educational Scientific and Cultural Organization
WCED	The World Commission of Environment and Development

Chapter 1: Introduction

Governments in lesser-developed countries have adopted numerous strategies to address poverty in rural areas, however poverty stubbornly persists, and in some cases has even been exacerbated by the government strategies (Kim, 1997). It is increasingly acknowledged that rural poverty stems from a complex, and not fully understood relationship among socioeconomic, political, and natural factors (Bird & Shepherd, 2003; Hulme & Sherpherd, 2003). The world's rural poor are mainly reliant on agriculture (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2008), therefore increasing the incomes, and improving the livelihoods of rural small holders has become the cornerstone of pro poor development strategies. Development organizations such as the Food and Agriculture Organization (FAO) have prioritized strengthening the economic position of small holders by providing policy advice to governments and non-governmental organizations (NGOs) (Baas & Rouse, 1997).

Aquaculture, in particular has great potential to play a role in stimulating economic development in poor rural regions. The development of aquaculture has been described as a 'blue revolution' (Irz, Stevenson, Tanoy, Villarante, & Morissens, 2007; Costa-Pierce, 2002; Bardach, 1997; Coull, 1993). Akin to the green revolution, which was once hailed as a solution to world hunger, the blue revolution promises to improve the livelihoods of the poor in developing countries (Stonich & Bailey, 2000; Bashirullah, Mahmood, & Matin, 1989). Unfortunately, poor small holders have been effectively excluded from the benefits of the blue revolution because they are unable to engage in aquaculture due to numerous resource constraints, and diseconomies of scale. To overcome these barriers, one approach has been to encourage group aquaculture[1].

[1] For the purpose of my study group aquaculture refers to all forms of cooperative and community managed aquaculture production including community management of aquaculture farms.

Group aquaculture approaches focus on risk sharing, the pooling of capital, farmland and farm labour, and group training in aquaculture methods. Smallholder farmers, by organizing into groups, are able to gain an advantage of scale in accessing services and markets, which are otherwise limited to large commercial farmers (Umesh et al., 2010; Stringfellow, Coulter, Lucey, McKone, & Hussain, 1997; Hoff, Braverman, & Stiglitz, 1993).

1.1 Problem Statement

The extent to which aquaculture can help alleviate poverty and stimulate development has become a major debate among policy makers, NGO's, and governments worldwide. The commercial cultivation of high-value species such as shrimp, destined for export markets in developed nations, is particularly controversial. The development of the commercial shrimp industry has led to questions about the ecological impacts (Tisdell, 2003; Hein, 2002); mangrove destruction (Paez-Osuna, 2001); the ability to improve nutrition and provide food security (Stonich & Bailey, 2000; Primavera, 1997); and the equity of its development (Patil & Krishnan, 1998; Primavera, 1997; Vivekanandan, Muralidharan, & Rao, 1997; Coull, 1993).

The controversy surrounding the shrimp aquaculture industry has motivated research into different management and development options. A previous study by Philcox, Knowler, and Haider (2010) analyzed the preferences of communities living in the Sundarbans region of West Bengal for aquaculture development. The findings indicated the communities' favoured sustainable shrimp aquaculture development. The sustainable development approach favoured by the communities included greater community participation in the shrimp farming industry, and importantly included cooperative or group ownership and management of shrimp farms. A group shrimp farming approach relies on the willingness and ability of people to act collectively, and a key determinant of collective action is social capital (Wood, 2003). As such, social capital may affect attitudes towards acting collectively and cooperating in shrimp aquaculture. Therefore it is important to first identify, and group households based on their social capital characteristics in order to determine if they are suitable for group shrimp aquaculture.

1.2 Research Objectives

The main objective of my research is to assess the prospects for sustainable shrimp aquaculture development in the Sundarbans region by using social capital information to identify suitable households for group aquaculture development.

My research will address the following questions:

i. Does social capital vary among households in the Sundarbans?
ii. Does social capital affect attitudes towards group shrimp farms on leased or common land?
iii. Based on social capital characteristics which households are suitable for group shrimp aquaculture development?

To answer these questions, the research objectives are as follows:

i. Does social capital vary among households in the Sundarbans?

I will assess whether social capital varies among the households in the Sundarbans region. I expect that households will exhibit different dimensions of social capital. A certain type of social capital will be associated with households that rarely travel outside their village, while a different type of social capital will be expected to be more abundant among wealthier households that have the financial means to travel outside the village.

ii. Does social capital affect attitudes towards group shrimp farms on leased or common land?

I will explore how social capital affects attitudes towards group shrimp farming among the household groups by analyzing how they respond to questions about more group shrimp farms on leased or common land.

iii. Based on social capital characteristics which households are suitable for group shrimp aquaculture development?

Based on the different types of social capital found in the community I will identify the households suitable for group shrimp aquaculture development. Some households will exhibit social capital features, and possess demographic characteristics that make them better suited for group shrimp aquaculture than others.

1.3 Case Study: Shrimp Farming in West Bengal[2]

Small-scale shrimp cultivation in rotation with rice paddy farming has been traditionally practiced in the Indian State of West Bengal for centuries (FAO, 1999). The majority of shrimp farms in West Bengal use traditional low intensity methods of shrimp production. West Bengal has 405,000 hectares of relatively underexploited land ideal for large-scale intensive commercial shrimp aquaculture (Philcox, 2006). An opportunity exists to intensify shrimp production in the state, however intensive shrimp production in India has been criticized for causing negative environmental and social impacts (Bhat & Bhatta, 2004; Bhattacharya & Sarkar, 2003). The development of commercial shrimp aquaculture in West Bengal using intensive methods may result in environmental degradation, and further aggravate the poverty in rural coastal areas that the Indian government is trying to eliminate under the coastal economic development platform (Knowler et al., 2009). The question facing policymakers in the region is how best to develop the shrimp industry in a manner that will benefit rural coastal communities, and not have a detrimental effect on the fragile Sundarbans ecosystem, which is a UNESCO world heritage site.

1.4 Scope of Research

My research focuses on group shrimp aquaculture development in the Sundarbans region by investigating the social capital characteristics of the communities in the district of 24 Parganas South. The purpose is to determine if social capital affects attitudes towards group shrimp farms. Social capital is a multifaceted concept, and analyses of social capital have confirmed it exists at the individual, community, and national level (Dasgupta & Serageldin, 2000; Portes, 1998; Putnam, 1995; Coleman, 1988). For the purpose of my research it is necessary to approach social capital analysis from a micro level. A micro level

[2] The Indian State of West Bengal has been officially renamed as Paschim Banga. However the State will be referred to as West Bengal in this study because the survey data was collected before the name change.

approach considers collective action at the community level and addresses the tendency of people to cooperate by way of pooling resources to achieve desired outcomes (Franke, 2005). I will analyze social capital at the household level in the two villages surveyed in the study area.

1.5 Organization of Study

In Chapter 2, I provide background on the study site including details on livelihood activities and the legal framework surrounding shrimp aquaculture in India. In Chapter 3, I review the existing literature on the links between poverty, resource degradation, sustainable development, sustainable aquaculture, collective action and social capital theory. In Chapter 4, I provide an overview of conceptual frameworks used in the collective action and social capital literature. I then outline the methodology employed in my study. I present the results of the statistical analyses in Chapter 5. Chapter 6 provides a discussion of the results, and integrates the findings with attitudes towards group shrimp aquaculture. In Chapter 7, I conclude the study by discussing the implications of my research and providing recommendations for group shrimp aquaculture development.

Chapter: 2 Background

In this chapter I present the characteristics of the study area and describe the various income generating activities and livelihoods. I will present the institutional and legal framework that governs the shrimp aquaculture industry in India, and describe the nature of shrimp aquaculture in the district of 24 Parganas South.

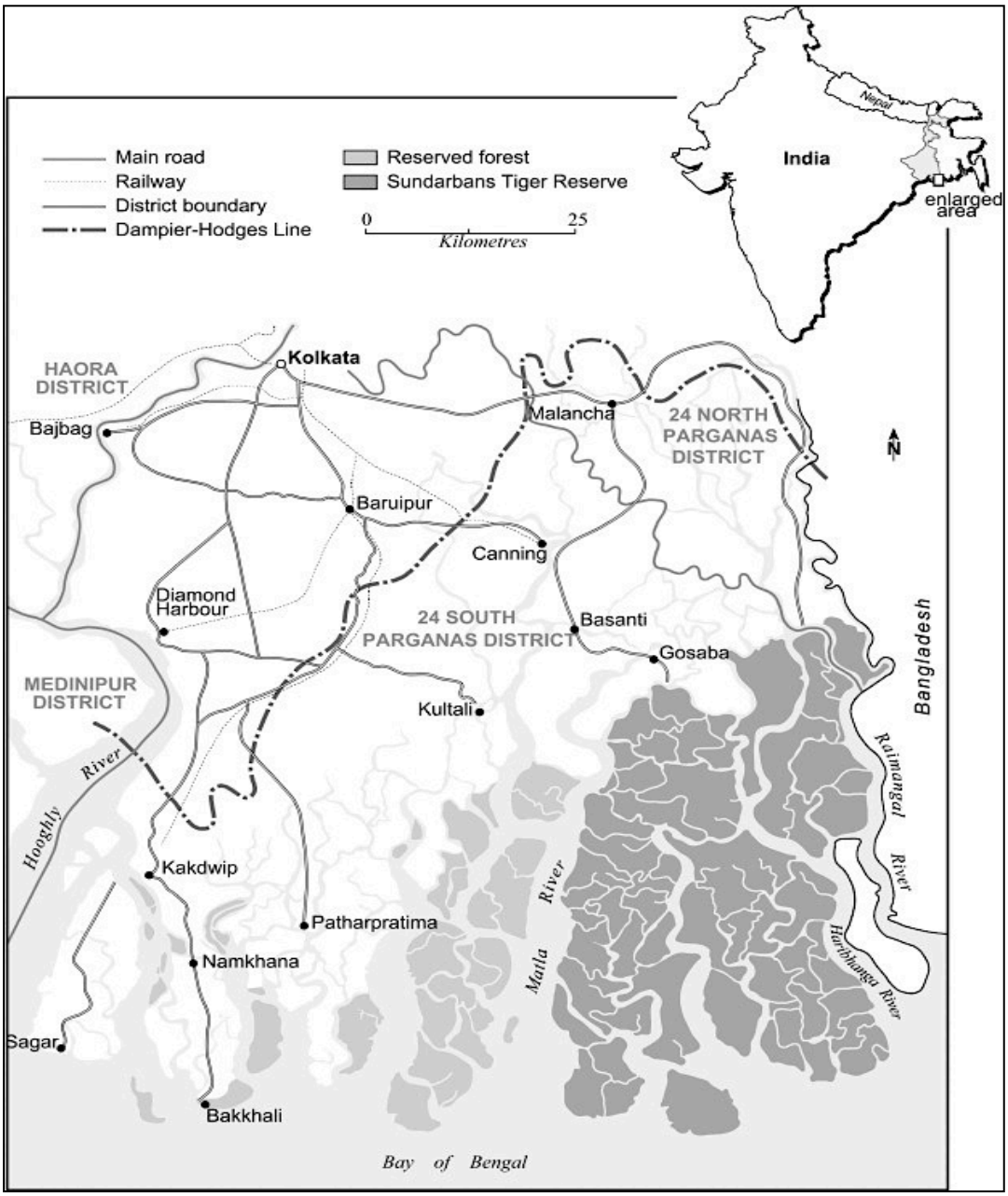
2.1 Description of Study Area

The Sundarbans region is located in the State of West Bengal in the districts of 24 Parganas South and 24 Parganas North. The Sundarbans is the world's largest tidal mangrove ecosystem, and has been designated a UNESCO World Heritage Site. The forest management area consists of 4,260 km^2 of reserved forest; of which 2600 km^2 is managed by the Sundarbans Tiger Reserve, and the remaining 1660 km^2 is managed by 24 Parganas South Forest Division. In addition to the forest-managed areas, there is 5,400 km^2 of inhabited non-forest area, which is known as the Sundarbans region (Philcox et al., 2010). The population of West Bengal is 91.3 million, and the district of 24 Parganas has a population of 8.1 million (Government of India, 2011).

The district of 24 Parganas South is located in the southern portion of West Bengal (Figure 1). It stretches from the Kolkata metropolitan area to riverine villages in the mouth of the Bay of Bengal, and covers an area of 8,165.05 km^2. The urban areas of the district are plagued by problems associated with a high population density and insufficient infrastructure, while rural areas suffer from a complete lack of infrastructure. The geographic location and topography of the district has hindered the development of transport and communication links, resulting in limited economic development (Government of India, 2011). The district is particularly prone to devastation from cyclones, which leads to the loss of crops, property and human life. Respondents for the study were surveyed in Namkhana Block (an administrative division), with 128 households selected from the village of Chondinpiri North, and 168 from the village of Debnagar. The majority of respondents

(90.5%) were born in the district of 24 Parganas South, and the remaining 9.1% of respondents were born in the neighbouring district of Paschim Medinipur. Households lived in the district an average of 2.20 generations.

Figure 1. Map showing the District of 24 Parganas South



Source: Knowler et al. (2009)

2.2 Survey Data

The survey data used in my study was collected in an earlier project, which was a collaborative research project with researchers in India and funded under the Shastri Indo-Canadian SHARP program. A random and targeted household survey was used to collect quantitative data from respondents[3]. The random sample contained 296 households, while the targeted sample contained 100 households made up of 52 fry collector households and 48 shrimp farmer households. For the purpose of my research I will use the random sample of 296 households for all empirical analyses[4]. The random sample survey was administered in two villages in Namkhana Block: Chondinpiri North and Debnagar. According to Philcox (2006) the two villages in Namkhana Block were selected based on the following criteria:

i. Representation of different livelihood activities within the population,
ii. Suitability for shrimp aquaculture development,
iii. Presence of the conversion of agricultural to shrimp pond area,
iv. Access to brackish water,
v. Presence of extension services and assistance for shrimp aquaculture.

2.3 Livelihoods and Resources

Like many rural smallholders in developing countries, households in Chondinpiri North and Debnagar engage in several livelihood activities that may be composed of year-round or seasonal agriculture, aquaculture, fishing, formal sector employment, remittances, trading, leasing of land, or use of natural or common property resources such as mangrove forests.

[3] Two groups of samples: a random sample (296 households) and two separate samples targeted and shrimp fry collectors, and shrimp farmers to ensure sufficient representation of all stakeholder groups

[4] In Section 2.4.1, I will aggregate the shrimp farmers in the random sample with the targeted sample shrimp farmers to compare shrimp farmers to respondents interested in shrimp farming

The following information refers to May 2005, when the data was collected. Households in the two villages owned an average of 0.77 bighas[5] of cultivated irrigated agricultural land, and 2.17 bighas of cultivated non-irrigated agricultural land. Leasing in and leasing out agricultural land was not uncommon, and households leased out an average of 0.32 bighas. Households also owned polyculture and shrimp ponds. The mean pond area owned was relatively small, only measuring 0.75 bighas. The mean leased in pond area was larger, measuring 1.17 bighas. Agriculture was the most important livelihood activity in the district, 83.1% of households cultivated rice, and 91.9% owned livestock. Rice, betel leaves[6] and vegetables were the main crops cultivated, rice and vegetables were cultivated for both subsistence and income purposes, while betel leaves were cultivated for sale. The average total income generated from betel production was 27294.17 Rupees (Rs), and the average total income from the sale of rice was 6182.35 Rs, followed by vegetables (5909.32 Rs). Income from other agricultural produce was 1350.61 Rs. Animal husbandry was practiced, and livestock reared included cattle, sheep, goats and poultry. Households owned an average of 2.63 heads of cattle (Appendix B). The ownership of cattle is considered an important source of capital because income can be earned through the sale of dairy products, and cattle are also a source financial security (Ramkumar, Rao, & Waldie, 2004).

The majority of households practiced polyculture farming (37.8%) or general farm labour (34.8%) as a primary activity. The dominant secondary livelihood activity was also polyculture farming (21.3%), followed by shop merchant and general wage labourer both representing 7.4%. Households also practiced additional livelihood activities such as artisanal fishing, and industrial fishing. A smaller number practiced shrimp farming as a primary activity (5 households out of 296) and shrimp fry collection (35 households out of 296) (Appendix C). Mangroves are an important resource for rural communities and provide a wide range of wood products such as: timber, firewood, charcoal, and non-wood products including thatch, honey, fodder, and medicine (FAO, 1994). Despite the economic

[5] One bigha is 3283 m^2

[6] The scientific name of betel vine is *Piper betel L*. It belongs to the family the Black Pepper family (Gunther, 1952).

importance of mangroves, only 17.9% of households in the study area had used mangrove forests in the past, and of the 17.9%, the majority, (84.6%) used mangroves for solely subsistence purposes, 7.7% for income generation, and 7.7% for both income generation and subsistence.

2.4 Structure of Shrimp Aquaculture

Shrimp aquaculture in West Bengal is influenced by developments at the national level. For example, the Ministry of Agriculture of the Government of India through the Division of Fisheries is responsible for planning, and monitoring fisheries and aquaculture development in all of the 28 Indian States and 6 Union Territories. Fisheries departments operate on the state level, with fisheries executive officers at the district level and fisheries extension officers at the block level. Several key pieces of legislation are relevant to aquaculture at the federal level including: the *Indian Fisheries Act* (1897), which penalizes the killing of fish by poisoning water and by using explosives, and the *Environment Protection Act* (1986) that is concerned with all environment related issues; the *Water Act* (1974), and the *Wild Life Protection Act* (1972). Essentially, all this legislation must be read together to gain a full picture of the rules that are applicable to aquaculture (FAO, 2005).

In 1996, in response to the negative effects of commercial shrimp aquaculture on coastal environments, the Supreme Court of India banned non-traditional shrimp aquaculture in India's coastal zones. No shrimp ponds were to be constructed within 500 meters of the high tide mark, applicable for all seas, estuaries, creeks, rivers and backwaters. However, some Indian policymakers would like to use commercial shrimp aquaculture to drive economic development in coastal communities (Philcox et al., 2010). The Government aims to increase the area under cultivation and intensify production through the introduction of commercial shrimp aquaculture techniques, and new technologies (Government of India, 2007). The Government of India's Planning Commission's 11th Five Year Plan (2007 – 2012) states that, "brackish water aquaculture plays a vital role in the export of marine products, and cultured shrimps contributes 45% of the total shrimp exported and accounts for 60% of foreign exchange earnings from aquaculture" (p.122). In 2005, the Coastal Aquaculture Authority (CAA) was created by the *Coastal Authority Act* to promote the development of shrimp aquaculture. The mandate of

the CAA effectively voids the moratorium on shrimp aquaculture development, and opens the door for the expansion of commercial shrimp aquaculture in the Sundarbans region (Philcox, 2006).

2.4.1 Shrimp Aquaculture in 24 Parganas South

Shrimp farmers in 24 Parganas South have traditionally practiced low intensity shrimp rotation culture with rice paddy farming in bheries, which are impounded shallow bodies of water (Philcox et al., 2010; Gupta, Chowdhury, & Som, 2006). The rotation of shrimp and rice has provided smallholder farmers with a diversified source of food utilizing environmentally benign techniques. “Shrimp was an inexpensive source of protein, enriching the local diet ” (Primavera, 1998 as cited in Philcox et al., 2010, p.123). During the 1980’s methods of shrimp culture were intensified in the districts of 24 Parganas North and 24 Parganas South. The intensification of shrimp aquaculture saw production increase from 12,500 tonnes from the period 1990 to 1991, to 23,445 tonnes from the period 1995 to 1996. The production during 1999 to 2000 dropped to 19,960 tonnes due to environmental problems, and an outbreak of shrimp diseases (Upadhayay, 2001).

Shrimp Farmers

The targeted sample (N=100) includes 48 shrimp farmer households, while the random sample (N=296) includes 38. Criteria for "shrimp farmer" classification vary between the two samples; households from the targeted sample self-identified as shrimp farmers and households from the random sample were classified as such only if they met at least one of the following criteria:

i. Indicated that were involved in shrimp farming as a primary, secondary or tertiary livelihood activity,
ii. Owned a shrimp pond,
iii. Earned an income from shrimp farming in the last 12 months.

The interest in shrimp farming was gauged by asking non-shrimp farming households in the random sample “how likely is it that their household will convert agricultural land and or polyculture area to shrimp pond area for the purpose of shrimp farming in the next 5 years.” In total 160 households were very unlikely to convert, while 53 households were

either “more likely than unlikely”, or “very likely” to convert their agricultural land to shrimp pond area for the purpose of shrimp farming (Table 1). I called this group “interested in shrimp farming.”

Table 1. Likelihood of converting agricultural land and or polyculture pond area to shrimp ponds for the purpose of shrimp farming in the next 5 years

Likelihood of converting	Frequency	Percentage
Very unlikely	160	68.7
More unlikely than likely	20	8.6
More likely than unlikely	31	13.3
Very likely	22	9.4

Note: 25 non-responses.

Many households interested in shrimp farming are attracted by the higher profits associated with cultivating shrimp. When the survey data was collected only 1 out of 48 shrimp farmers in the targeted sample, and 6 out of 38 shrimp farmers in the random sample generated any income from shrimp farming in last the last 12 months. This finding is significant, because despite no income being generated by the majority of shrimp farmers the activity is still considered to be profitable.

The association of profit with shrimp farming is understandable when the wealth indicators of shrimp farmers and households that are interested in shrimp farming are compared. I combined the 48 shrimp farmers from the targeted sample with the 38 shrimp farmers from the random sample, resulting in a total of 86 shrimp farmers. I then compared the combined total of 86 shrimp farmers to the 53 households in the random sample that were interested in shrimp farming. The difference between the two groups in terms of access to wealth in the form of land, and income is significant. It provides a plausible explanation for why households interested in shrimp farming cited profits as the main reason for wanting to convert their land to shrimp pond area in the next 5 years. The difference in general wealth indicators also highlights that access to capital in various forms is crucial for households interested in shrimp farming (Table 2).

Table 2. Comparing demographic characteristics of shrimp farmers and households interested in converting land to shrimp ponds

Demographic variables	Shrimp Farmers/ Interested in shrimp farming	N	Mean	SD	t	P
Household wealth index	Shrimp farmers	86	0.35	0.17	3.81	**0.000**
	Interested in shrimp farming	53	0.24	0.15		
Total income in Rupees	Shrimp farmers	86	60284.59	53165.57	4.22	**0.000**
	Interested in shrimp farming	53	30233.02	30730.03		
Number of years of schooling	Shrimp farmers	86	8.60	3.20	3.17	**0.002**
	Interested in shrimp farming	53	6.66	3.97		
Total land owned in bighas	Shrimp farmers	86	6.15	4.29	3.40	**0.001**
	Interested in shrimp farming	53	3.77	3.47		
Distance from brackish water in meters	Shrimp farmers	86	189.71	238.22	-2.34	**0.022**
	Interested in shrimp farming	53	358.50	490.31		

Shrimp farmers were wealthier than households interested in converting their land to shrimp pond area in the next 5 years. The difference in the mean wealth index[7] of shrimp farmers was significant (M=0.35, SD= 0.17) and those interested in shrimp farming (M=0.24, SD= 0.15), t= 3.81, P=0.000. Owning more land allows households to cultivate rice and vegetables for subsistence purposes and practice shrimp farming. Cattle are considered a source of financial security and status. Having a large family is considered an asset on smallholdings because of the availability of trusted farm labor.

The total income of shrimp farmers and those interested in shrimp farming was significantly different. Shrimp farmers had an income of (M=60284.59 Rs, SD=53165.57 Rs) compared to respondents who were interested in converting their land to shrimp pond area (M=30233.02 Rs, SD= 30730.03 Rs), t= 4.22, P=0.000.

[7] Wealth index = (no. of adults (over 15 years of age) + owned land (bighas) + no. of cattle) 1 highest score. The ranges for the three categories “High Wealth”, “Medium Wealth”, and “Low Wealth” are: Low 0 < 0.137; 0.137 < Medium < 0.240; High ≥ 0.2404.

Shrimp farmers were more educated than those interested in shrimp farming; they had more years of formal schooling (M=8.60, SD= 3.2) than households interested in shrimp farming (M=6.66, SD= 3.97), t= 3.17, P= 0.002. The amount of land owned, measured in bighas[8] was significantly different. Shrimp farmers owned (M=6.15 bighas, SD= 4.29 bighas), while households interested in shrimp farming owned (M=3.77 bighas, SD= 3.47 bighas), t= 3.40, P=0.001. Shrimp farmers were also closer to a source of brackish water (M=189.71 m, SD= 238.22 m), while those interested in shrimp farming were further away (M= 358.5 m, SD= 490.31 m, t= -2.34, P=0.022).

To identify the most important barriers preventing households from converting their agricultural land to shrimp ponds, shrimp farmers and non-shrimp farmers in the random sample who were "more unlikely" and "very unlikely" to convert agricultural land were asked to rank the most important reasons for not converting (Table 3).

Table 3. Ranking reasons for not converting agricultural land/polyculture pond area to shrimp ponds in the next 5 years among households more unlikely and very unlikely to convert agricultural land

Reason	N	Ranking mean [a]	SD
Other (unspecified)	37	1.70	0.81
Financial risk	146	1.86	0.96
Lack of household funds/credit	158	1.89	1.22
Lack of access to brackish water	75	2.72	1.54
Lack of technical knowledge	75	3.13	1.23
Not interested	58	3.36	1.93
Risk of disease	86	3.43	1.44
Government regulations	25	5.76	1.13

[a] Ranking based on 1 as the most important rank and 8 as the least important rank.

Lack of household funds and financial risk were the most commonly cited reasons for not converting land to shrimp pond area, (158) and (146), and had a ranking mean of 1.89 and 1.86 respectively. One hundred and thirty eight respondents ranked these two reasons for not converting their agricultural land or polyculture pond area to shrimp ponds as most important. Group shrimp farming can potentially address these two constraints because a

group approach allows for financial resources to be pooled together, and the financial risk is shared among many people. The 138 households could be well suited for a group shrimp farming approach; therefore it is necessary to determine what factors influence their attitudes towards more group shrimp farms on leased or common land.

Shrimp Fry Collectors

Thirty-five households in the study area engaged in shrimp fry collection. They generated a livelihood by supplying shrimp farms with wild shrimp seed from mangrove areas. Shrimp fry collection is considered a job of last resort because of the low pay and numerous health problems caused by extended exposure to brackish water. Marginalized women and children are disproportionally responsible for shrimp fry collection (Philcox et al., 2010; Crow & Sultana, 2002). Since collectors depend on the mangroves for their livelihood and have more frequent interactions with mangroves than non-fry collectors, they are more likely to notice changes in the mangrove system. The majority of households (85.7%) who practiced fry collection noticed a decrease in the abundance of shrimp fry. Many households (24 out of 35) blamed the decrease in abundance of shrimp fry on off shore trawlers, and some blamed the decrease in abundance on the increase in the number of shrimp fry collectors (11 out of 35 households). None of the households mentioned the loss of mangrove forests as a reason for the decrease in abundance of shrimp fry.

2.4.2 Shrimp Aquaculture Methods

As mentioned in Section 1.3, the State of West Bengal has potential for large-scale commercial shrimp aquaculture development. Despite attempts to intensify shrimp production in the 1980's, traditional farming methods are still predominant in the district of 24 Parganas South. The nature of shrimp aquaculture in the district of 24 Parganas South is different from shrimp farming that occurs in other parts of the world or even in other parts of India. Gupta et al. (2006) identified the following characteristics of shrimp aquaculture in the district:

i. "Less intensive shrimp farm development,
ii. "Smaller role for outside capital investment,
iii. "Relatively little encroachment of shrimp farms towards mangroves, and
iv. "Larger number of fry collectors" (p.7).

Given these characteristics of shrimp aquaculture in the district, the shrimp farming system can be considered traditional or improved traditional (Appendix E). The traditional system of shrimp culture is tide fed; the salinity of the pond is variable according to the monsoon regime; the shrimp seed is stocked from adjacent canals by auto stocking; feeding is done using natural food; water intake and drainage is controlled by sluice gates, depending on the tidal effects (Gupta et al., 2006).

Chapter 3: Literature Review

The literature review highlights the link between poverty and resource degradation that has led to the emergence of sustainable development, a concept that has been applied to various sectors including aquaculture. The sustainable aquaculture approach is then presented as an alternative to unsustainable aquaculture. Different methods of sustainable aquaculture are reviewed, with an emphasis placed on group aquaculture. The role that collective action and social capital play in the development of sustainable approaches is explored, highlighting the gap in research on the relationship between social capital theory and group aquaculture development.

3.1 Poverty and Resource Degradation

"In the last few decades the state of global resources has either not improved or worsened; and environmental degradation has been significant" (UN conference on Environment and Development, 1992; World Summit on Sustainable Development, 2002 as cited in Nyangena, 2008, p.745).

Poverty reduction and environmental protection have been at the heart of development research over the last decades. The literature has drawn attention to the intensely debated relationship between poverty and the environment. It is necessary to provide an overview of the central ideas and assumptions about the relationship between the poor and the environment that has served as the dominant paradigm within the development field. Two distinct schools of thought have emerged in the environment and development literature. The predominant school of thought asserts environmental degradation is caused by chronic poverty, and to address environmental issues, the problem of poverty needs to be solved. The other school of thought argues holding poverty responsible for environmental degradation is inappropriate and too simplistic because of a multitude of interlinking and interacting factors (Duraiappah, 1998).

The development literature has traditionally singled out the poor for being responsible for environmental degradation. The literature highlights the vicious cycle of poverty and degradation; this cycle is described as Malthusian by Reardon and Vosti (1995), "whereby poor peasants, forced by population increase, exploit land out of necessity to feed themselves, thus the land is degraded even more, resulting in further impoverishment" (see Dasgupta & Maler, 1994; Pearce & Warford, 1993; Mink, 1993 as cited in Reardon & Vosti, 1995, p.1495). "In many marginal rural areas, growing numbers of poor people inevitably have to degrade the environment a little more each day just to make ends meet" (Gow, 1992, p. 50). This sentiment has been echoed in many international fora such as the World Commission on Environment and Development, responsible for the seminal Brundtland report, which states:

> Poverty itself pollutes the environment, creating environmental stress in a different way. Those who are poor and hungry will often destroy their immediate environment in order to survive: They will cut down forests; their livestock will overgraze grasslands; they will overuse marginal land; and in growing numbers they will crowd into congested cities (Symptoms and causes, para. 1).

The World Bank's 1992 World Development Report has echoed the view established by the Brundtland report and states, "poor families who have to meet short term needs mine the natural capital by excessive cutting of trees for firewood and failure to replace soil nutrients" (Niringiye, Wambugu, Karugia, & Wanga, 2010, p. 82).

The other school of thought considers the dominant paradigm of poverty and environmental degradation as a rudimentary conceptualization of a complex relationship (Leach & Mearns, 1995; Broad, 1994). It is argued that the relationship between poverty and environmental degradation is not deterministic, but rather depends on a multitude of interwoven factors. Studies have identified demographic, cultural, and institutional factors as important parts of the overall equation of poverty and environmental degradation; identifying direct causality links between the two is problematic (Broad, 1994). The link between poverty and environmental degradation proposed by the Brundtland report, the World Bank and other development organizations fails to recognize that levels of poverty, influence the nature of interaction between people and the environment. However, varying levels of poverty have different effects on environmental degradation. Annis (1992) disaggregated poverty into the "extremely poor" and the "merely poor", the extremely poor being landless or rootless overharvest their resources to survive. In contrast the "merely poor" are peasants

with secure land tenure who sustainably manage their resources for future generations. In addition, research by Forsyth, Leach and Scoones (1998) found that degradation also results from natural forces, and cannot be solely attributed to human activities.

Local technology has been developed to counter and control degradation. For example, communities have implemented land use strategies to stabilize vegetation cover and diversified income-generating activities to reduce degradation. “As the cost of land relative to labor increased, people often changed their methods of managing plants and animals and made land improvements to offset initial declines in productivity resulting from more intensive land use” (Scherr, 2009, p.481). Research conducted in the Philippines by Board (1994) found many of the poor are future oriented and concerned that environmental degradation will deprive future generations of a livelihood. The finding is significant because it demonstrates that the poor are not simply interested in short term maximization, degrading their resources to survive, nor are they architects of their own poverty; on the contrary, the poor exhibit sustainable attitudes and behaviors which are relevant to the development of sustainable aquaculture approaches like group shrimp farming.

3.2 Sustainable Development

‘‘*The earth provides every human being’s need, but not every human being’s greed!’’ (Gandhi*)

The traditional literature on poverty and the state of the environment has been challenged by evidence of a complex relationship between poverty and environment degradation. Thus, the focus has shifted from blaming the poor for environmental degradation to finding solutions for poverty and environmental problems, particularly centered on the concept of sustainable development. Not one definition of sustainable development has been agreed upon, “most definitions conceptualize the fundamental idea in terms of a tension between the goals of economic development and environmental protection ” (Geisinger, 1999, p.65). The first important use of the term “sustainable development” can be traced back to 1980 (International Union for Conservation of Nature et al*.,* 1980). A few years later the World Commission on Environment and Development (WCED) produced the Brundtland Report that defines sustainable development as “meeting the needs of the present without compromising the ability of future generations to meet their

needs" (WCED, 1987, p. 43). Even though this definition is extremely anthropocentric, as stressed by Hopwood, Mellor and O'Brien (2005), it was one of the first acknowledgements that human existence is embedded within and deeply dependent on the environment (Giddings, Hopwood, & O'Brien, 2002).

The sustainable livelihoods concept emerged as a result of mounting evidence that poverty does not always result in environmental degradation. The poor exhibit sustainable behaviour and employ different mechanisms to cope with environmental degradation. Mechanisms used by the poor to cope with environmental pressures can have different outcomes, they can either lead to more poverty, by decreasing consumption, or they can offset poverty by overexploiting common pool resources, which can lead to further environmental degradation (Scherr, 2000). The poor can also employ strategies that enhance their natural resource holdings, such as responsible environmental management (Scherr, 2000). The different strategies employed by the poor to overcome environmental pressures suggest they have access to assets other than financial resources. The concept of sustainable livelihoods recognizes the various assets the poor possess. Sustainable livelihoods are defined as "the capabilities, assets including both material and social resources and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the resource base" (Scoones, 1998, p.5).

3.3 Sustainable Aquaculture Development

The link between poverty and environmental degradation is particularly pertinent to the developing world because agricultural practices have the largest effect on the environment. Agriculture accounts for most of the land use, and concurrently agriculture is the primary livelihood of the poor (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2008; Malik, 1999). Feeding the growing populations of developing countries will require an intensification of food production systems, which will challenge the aspirations of environmental protection and goals of rural poverty reduction (Pinstrup-Andersen, Pandya-Lorch, & Rosegrant, 1997). In response to concerns about the environmental degradation associated with agriculture, calls have been made for more sustainable methods of production, especially in aquaculture

where the idea of sustainable aquaculture has emerged as a direct result of the criticisms of commercial aquaculture discussed in Chapter 1.

Like the overarching concept of sustainable development, sustainable aquaculture development does not have one universal definition. “While sustainable aquaculture is a noble, farsighted universal goal there seems to be universal confusion as to what it is, let alone how to attain it or to recognize it” (Boyd & Schmittou, 1999, p. 61). The literature presents a number of interpretations and definitions of sustainability as it applies to aquaculture. Frankic and Hershner (2003) propose a broad list to evaluate the sustainability of an aquaculture enterprise:

> i) Consideration should be given to the continuity of supply, and quality of inputs; ii) the social, environmental and economic costs of providing the inputs, iii) the long-term continuity of production; iv) financial viability; v) social impact and equity, vi) environmental impact and, vii) the efficiency of conversion of resources into useful product (p.523).

Other researchers such as Costa-Pierce (2002), Edwards (1998), Edwards and Demaine (1997), Grove and Edwards (1993), Kautsky and Folke (1992) present the idea of ecological aquaculture, which they define as an:

> Alternative model of aquaculture research and development that brings the technical aspects of ecological principles and ecosystems thinking to aquaculture, and incorporates – at the outset – principles of natural and social ecology, planning for community development, and concerns for the wider social, economic, and environmental contexts of aquaculture (p.343).

Costa- Pierce (2002) goes on further to outline six characteristics of ecological aquaculture: i) it preserves the natural ecosystem; ii) it practices trophic level efficiency; iii) it manages nutrients ensuring no discharge of substances harmful to the ecosystem; iv) it uses native species iv) it encourages local community development through its operations in the community; and vi) it is a global partner and shares information.

Similar to ecological aquaculture discussed above, Soto et al. (2008) conceptualize the idea of an ecosystem-based approach to aquaculture, which they define as a “strategic approach to development and management of the sector aiming to integrate aquaculture within the wider ecosystem such that it promotes sustainability of interlined social ecological systems” (p.17).

3.3.1 Alternative Aquaculture Methods

Alternative aquaculture methods that are sustainable have been proposed to address the negative environmental and social impacts from conventional aquaculture. Various new and century old alternatives have been researched, and developed. Integrated methods of aquaculture, such as polyculture were developed in China 4000 years ago, and adopted in Hawaii 1500 years ago (FAO, 2000; Costa-Pierce, 1987 as cited in Frankic, 2003). Other alternatives include, the previously discussed ecological aquaculture, organic aquaculture, and closed and low discharge systems (White, O'Neill, & Tzankova, 2004), and group and community managed aquaculture (Radheshyam, 2001; Hugues-Dit-Ciles, 2000; Srinath et al., 2000).

Integrated polyculture methods are well established in the aquaculture literature, and are considered a sustainable aquaculture practice (Halwell, 2008; Costa-Pearce, 2002). Polyculture aquaculture is the cultivation of diverse organisms in the same system. Each organism has a specific niche and using distinct resources within the farming system (Stickney, 2000). Output from one subsystem becomes an input for another subsystem, improving efficiency of aquaculture production (Edwards, Pullin, & Gartner, 1988). Examples in the literature of integrated systems include a combination of rice and fish, which has been practiced in China for millennia (Fernando, 2002). In Europe, waterfowl and crayfish have been cultured together in freshwater ponds (Maki, 1982 as cited in Neori et al., 2004). In Canada, salmon, mussels, and seaweed, have been successfully cultivated in the same system (Chopin et al., 2008).

Organic aquaculture is another form of aquaculture that is considered sustainable. "Organic aquaculture manages food production as an integrated system that is an organism whose individual parts mesh into one production system, all parts of the operations are integrated, such as the nutrient inputs, animals, environment, and wastes being produced" (Kapuscinski & Brister, 2000 as cited in White et al., 2004, p.9). Organic aquaculture increases production by promoting good water quality management and effectively managing stocking densities.

The last form of sustainable aquaculture to be discussed is group aquaculture. Farming techniques for sustainable group aquaculture aim to overcome the financial barriers to adopting aquaculture faced by small holders and marginalized populations. These systems utilize locally available pond inputs, and investment is in the form of land, water and

labor. Group aquaculture provides an opportunity for the less wealthy to participate in aquaculture development since costs and risks are shared (Philcox et al., 2010). The following section of the literature review takes a detailed look at the group farming approach and its application to aquaculture, which is of specific interest to my study.

3.3.2 The Group Approach

Farmers' organizations are among the most common forms of collective action; the group farming approach has especially garnered the interest of researchers, development organizations and governments (Hilhorst & Wennink, 2010). Emerging research is not focused on the controversial collective farms of the communist era, but on the potential of group farming to meet human needs by solving economic, agricultural, and natural resources management problems (Wong, 1979).

Group farming is defined broadly as a group of people working together in farm production. Group farming entails coordinated farming operations, cooperation in farm tasks, and collective management by farmers to promote agricultural development (Hali, 1998; Oxby, 1983; West 1983; Bartholomaeus & Powell, 1979; Gasson, 1977). For the purpose of my research, group farming is the informal or formal association of individuals coming together to form a group, pooling resources, and labour in order to pursue economic as well as non-economic ends related to shrimp aquaculture, for the benefit of all its members.

In their report on the successes in emerging African agriculture, Gabre-Madhin and Haggblade (2004) identified farmers' organizations as playing a vital role in encouraging collective technology development, and natural resource management. In addition, farmer organizations provide important platforms for capacity building, and innovation in rural and agricultural settings (Bingen, Serrano, & Howard, 2003). Policy makers consider group farming to be a vehicle for poverty reduction in rural areas by improving the livelihoods and agricultural performance of poor smallholders.

3.4 Group Farming for Sustainable Aquaculture

The group farming approach has been successfully applied to the development of aquaculture in Kerala, India. Srinath et al. (2000) embarked on a project to determine the effectiveness of a group shrimp farming approach to achieve sustainable aquaculture. A pilot study was implemented to gauge farmers' perceptions of group farming. Demonstration farms were used to exhibit methods of field preparation, seed selection, and monitoring farm conditions. The attainment of group farming objectives, participatory features of the program, and the likely impact of group farming on the local community were measured using farmers' ratings on expectations and attainment of objectives. Groups that implemented recommended practices reported a two to six fold increase in yields and a 20% reduction in farming costs.

Elsewhere in India, the Marine Products Export Development Authority (MPEDA) and the Network of Aquaculture of Centers in Asia Pacific (NACA) implemented the development of better management practices for responsible shrimp farming through a group approach. Farmers in the State of Andhra Pradesh were organized into seven groups called aqua clubs to collectively solve shrimp management problems. The aim of the aqua clubs was to support the development of sustainable aquaculture by providing the most marginalized members in the aquaculture sector with information on technologies, and sustainable use of resources (Umesh et al., 2010). The positive impacts from the group farming approach include reduced disease incidence, reduced chemical and antibiotic use, improved profits, and increased environmental awareness.

The promotion of farmers groups is not without its critics. Questions are raised about whether farmers groups can achieve development objectives, and increase the incomes of the most marginalized members of society (Karami & Rezaei-Moghaddam, 2005). Thorp, Stewart and Heyer (2005) suggest that the very poor or "merely poor" are not likely to succeed in groups, while the chronically poor or "extremely poor" are excluded from group formation all together because they are unable to contribute to groups due to a lack of assets, education, and social status. The wealthier sectors of rural society do not participate in group formation because group membership offers limited economic benefits when compared to the costs of participating (Mercer, 2002; Weinberger & Jutting, 2001).

The literature provides numerous examples of failed group farming endeavours. Bolivian and Peruvian rural organizations inadvertently exclude the poor because of membership fees. The same organizations fail to become financially sustainable and depend on subsidies and financing from NGO's (Bebbington, 1996). In Kenya, women tree planting groups underperform, lack longevity and eventually fail (Hambly, 2000 cited in Place et. al, 2004). The examples of groups failing to achieve development goals and improve the livelihoods of the poorest members of society illustrates that farmers groups alone are not a panacea to rural poverty, and are not always effective due to the aforementioned reasons. An understanding of the conditions necessary for farmers' groups to be successfully established and maintained is required.

Several themes emerge from the discussion of group farming that are embodied in theories of collective action and social capital. Group farming can be considered a form of collective action. "Collective action often leads to creation of peoples organizations, commonly referred to as groups which bring together individuals with common problems and aspirations and who cannot, as individuals, meet certain goals as effectively, if at all" (Ouma & Awudu, 2009, p.4). To understand the conditions under which successful group farming occurs it is important to investigate the mechanism and rationale behind collective action, and central to the theory of collective action is the concept of social capital.

3.5 Collective Action

Civilizations have a long history of collectively managing natural resources, for example, herdsmen have managed common pastures and fishing communities have managed and controlled their fisheries collectively (Pretty & Ward, 2001). "Collective action can be defined as the coordinated behaviour of groups, or as voluntary action by a group to pursue shared objectives for technology adoption, and to ensure resource use is efficient, equitable and sustainable" (Meizen-Dick et al., 2002; Vermillion, 2001 as cited in Markelova et al., 2009, p.2). By combining their capital, labor and other resources, group members can access resources or perform activities, which if attempted individually, would impose a significant degree of risk (Ouma & Awudu, 2009). Research in collective group management has explored fields ranging from: microfinance institutions, forest management, irrigation to group farming (Hiatt & Woodworth, 2006; Pretty & Ward, 2001; Franzel, 1999; Morduch,

1999). Collective action has allowed farmers to benefit from agricultural innovations, which leads to an increase in financial and human capital, and makes the development process more sustainable (Parthasarathy & Chopde, 2000).

Natural resource management research has documented the benefits of collective action, for example, a study by Gebremedhin et al. (2004) found collective action for grazing land management in Ethiopia was a common practice, and resulted in the sustainable management of the grazing lands. In Sri Lanka group irrigation management schemes were found to produce above average yields in a time of drought, and cooperation was witnessed between Singhalese and Tamil farmers in a country that was being torn apart by ethnic conflict (Uphoff & Wijayarantna, 2002). As a result, social capital is prominent in many aspects of agriculture, and rural development in lower income countries due to its perceived positive effects on development and opportunities for poor small holders who lack access to financial, human or natural capital (Meinzen-Dick, DiGregorio, & McCarthy, 2004).

3.6 Social Capital Theory

The relationship between collective action and social capital is well documented in the development literature. The relationship has been described as deterministic, and social capital is considered a precursor for people to act collectively (Meinzen-Dick et al., 2004). “One of the most important preconditions to successful collective action is the existence of social relationships that allow individuals to overcome the transaction costs associated with cooperation” (Wood, 2003, p.23). The relationship between social capital and collective action is a result of social capital providing networks between people, which allows for collective action to emerge (Adger, 2003). The Organization for Economic Co-operation and Development (2001) defines social capital as social networks together with shared norms, values, and understanding that facilitate co-operation within or among groups. Ramos-Pinto (2006) explored the relationship between social capital and collective action, and concludes that social capital facilitates collective action. Social capital also increases the likelihood of collective action,”for example, close interactions or networks can make cooperation more likely” (Ouma & Awudu, 2009, p.5).

The literature identifies three main branches of social capital research: “i) social capital as a socially accessed resource; ii) social capital as a cognitive resource; iii) and social capital as networks that facilitate collective action” (Ramos-Pinto, 2004, p.3). The theory of social capital was first described by Bourdieu (1986); given a theoretical framework by Coleman (1988) and brought into the mainstream literature by Putnam (Ramos-Pinto, 2004; Pretty & Ward, 2001). These three seminal bodies of work define and describe the operation of social capital differently, but despite the differences they are all concerned with the effects of social relationships.

The first contemporary definition of social capital is traced back to the early work of Pierre Bourdieu, who recognized the value of social capital in explaining certain social phenomena. Bourdieu (1986) describes the concept as “the aggregate of the actual or potential resources, which are linked to possession of a durable network of institutionalized relationships of mutual acquaintance or recognition” (p.248). Bourdieu views social capital as a social resource that can be harnessed, whereby individuals can employ their networks and connections to fulfill personal ambitions, a view supported by Lin (2001) who postulates that individuals invest in social relationships to access social capital resources. Thus, social capital can be an individual as opposed to a collective resource. As a result, people can possess a greater amount of social capital than others if they have a greater density of networks (Welzel, Inglehart, & Deutsch, 2005; Ramos-Pinto, 2004). In Bourdieu’s view, these networks that people possess are used by the powerful and wealthy to exclude marginalized members of society (Myers, 2004). The views expressed by Bourdieu (1986) and Myers (2004) are relevant to the discussion of group aquaculture formation in the Sundarbans region, where society is stratified according to wealth and caste.

Putnam (1995; 1993) considers social capital as a cognitive resource and conceptualizes the concept as a public good (Myers, 2004; Ramos-Pinto, 2004). Putnam (1993) uses the connection between networks and wider benefits to society through the medium of cognitive attributes in his work. Trust in particular appears in Putnam’s concept of social capital as an element that facilitates cooperation among individuals engaged in networks (Ramos-Pinto, 2004). Cognitive social capital is derived from mental processes, and as such cognitive social capital assets are not observable (Uphoff, 1999). Cultural features such as shared norms, values, and beliefs define cognitive social capital (Krishna & Uphoff, 2002; Uphoff, 1999). The view that social capital is primarily a cultural characteristic that can facilitate collective action is supported by the work of Fukuyama (2001) who argues,

“the norms that constitute social capital can range from a form of reciprocity between two friends all the way up to complex and elaborately articulated doctrines like Christianity or Confucianism” (p.7). Shared norms provide the foundation for traditional culture such as tribes that can promote cooperation among individuals. Conversely, these traditional norms may be resistant to change; for example, the traditional hierarchical caste system of a country like India can be an obstacle to development (Fukuyama, 2001). Traditional norms may hinder development because they create groups with a narrow radius of trust, therefore reducing the ability of members of the group to take advantage of economic opportunities beyond the immediate group (Fukuyama, 2001).

Knack and Keefer (1997) also support the idea that trust is important for economically prosperous societies, and social capital is best defined by norms of civic cooperation. The researchers conducted a comparative analysis using economic growth as the dependent variable and created a social capital index composed of countries’ responses to a questionnaire on social trust, and the level of internalized civic norms. The results provided evidence of the importance of trust and civic cooperation to economic activity. The presence of local organizations, trust and civic cooperation within a community is viewed as an indicator of the presence of social capital. As previously stated by Knack and Keefer (1997), and Fukuyama (2001) trust and civic cooperation are essential for economic development, and therefore large amounts of cognitive social capital are considered beneficial for communities. However, evidence has demonstrated that the presence of a large number of community organizations, and civic groups, does not necessarily translate to socioeconomic prosperity. Communities may have a stock of social capital but may still suffer from poverty and resource degradation. Bodin and Crona (2008) highlight the failure of Kenyan fishing communities to protect, and effectively manage their declining fish stocks despite exhibiting high levels of cognitive social capital.

The branch of research that views social capital as networks that facilitate collective action focuses on individuals’ connectedness, and the ability of those connections to act as resources that can encourage cooperation (Ramos-Pinto, 2004). Coleman (1988) defines social capital as “a variety of different entities having two characteristics in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors whether persons or corporate actors within the structure” (p. S98). “Coleman was interested in the collective benefits of interpersonal connections. He considered networks and ties also as a collective resource that enables people to engage in joint actions for common goals”

(Ostrom & Ahn, 2003; Ostrom, 1994; as cited in Welzel, Inglehart, & Deutsch, 2005, p. 124). The ability of networks and connections to facilitate collective action features prominently in research conducted by the World Bank on the economies and societies of developing countries. The research has primarily focused on the effect of social capital on pro poor livelihood intervention projects (Ramos-Pinto, 2004). In a World Bank project to improve drinking water in Indonesia through a community-based approach, Isham and Kahkonen (1999) found that villages with stocks of social capital resulting from village groups and associations actively participated in the design of development projects. Bebbington (1996) found that the livelihoods of agricultural cooperative members were greatly improved as a result of the social capital they had built through extensive networks with NGO's, highlighting the importance of networks in development outcomes (cited in Richards & Roberts, 1998). Research has demonstrated that the networks inherent in social capital can facilitate collective action and influence development outcomes.

3.6.1 Bonding and Bridging Social Capital

The social capital literature broadly identifies two distinct forms of social capital, bonding and bridging social capital. "These two aspects are useful for examining the networks within, between and beyond communities" (De Silva et al., 2007; Pretty & Ward, 2001, as cited in Sawatsky, 2008, p.7). Bonding capital is the relations between family members, friends and colleagues who are demographically similar (Sabatini, 2005; Szreter & Woolcock, 2004), which in certain instances can lead to negative externalities; Woolcock and Narayan (2000) consider social capital to be a double edged sword; high levels of bonding social capital can provide benefits through social ties such as job referrals, and financial assistance, but may impose costs because the same social ties and loyalty can isolate members from economic opportunities outside their community. The level of bonding social capital can be balanced with bridging social capital to avoid the pursuit of narrow interests that may have negative social and economic consequences.

Bridging social capital refers to more distant relations between organizations or people who are demographically dissimilar (Sabatini, 2005; Szreter & Woolcock, 2004). "The combinations of both bonding and bridging social capital elements are said to contribute to the emergence of different types of social capital outcomes" (De Silva et al., 2007 as cited in Sawatsky, p.3). "Bridging and bonding social capital can reinforce each other, and give rise to effective community actions or entrepreneurial social infrastructure" (Flora & Flora, 2004,

p.532).

A third concept of social capital is gaining ground in the literature called linking social capital[9]. Linking social capital is similar to bridging capital in some respects, and it is considered a subset of the latter (Szreter & Woolcock, 2004) "Linking social capital is norms of respect and networks of trusting relationships between people who are interacting across explicit, formal, or institutionalized power or authority gradients in society" (Blakely & Ivory, 2006, p.1).

The reviewed literature demonstrates that social capital is a multifaceted concept that operates on multiple levels of society (Kennelly, O'Shea, & Garvey, 2003; Dasgupta & Serageldin, 2000). The concept exists at the individual, community and even national level (Coleman, 1998; Portes, 1998; Putman, 1995). Even though social capital is defined on "different levels and for different purposes, at the heart of all these definitions lie relations" (Narayan & Cassidy, 2001; Portes, 1998 as cited in Dahal & Adhikari, 2008, p.3). Social capital's effect on collective action and cooperation provides an opportunity to understand the social relationships that allow individuals to act collectively, to cooperate and form groups.

3.6.2 Measurement of Social Capital

Many theories of social capital assume it is quantifiable. However, measurement has been imperfect because the concept has been ill defined, "often the measurement of social capital has implied the definition" (Owen & Videras, 2006, p.1). The definition of social capital varies across studies, which increases its elusiveness and further complicates its measurement (Durlauf, 2002). The World Bank's Social Capital Thematic Group attempted to standardize the measurement of social capital by creating a survey tool to gather social capital data called the Social Capital Assessment Tool, also known as the SOCAT. The tool captures structural and cognitive social capital characteristics at the household, community

[9] For the purpose of my study I focus on the community and household consider level, and thus consider only bonding and bridging capital in the analysis. However, the importance of linking capital is acknowledged in this study.

and organizational levels. The detailed collection of information can link social capital with poverty and household welfare outcomes (World Bank, 2010). Four main features: trust, reciprocity, common rules and norms, and networks serve as the basis for empirical research on social capital (Grootaert & Narayan, 2004; Pretty & Smith, 2004; Svendsen & Svendsen, 2004).

The impact social capital can have on development outcomes, and poverty alleviation cannot be denied, and social capital has been called the missing link in development outcomes (Grootaert, 1997). Despite emerging research on the relationship between social capital and natural resource management issues, the complex relationship is still not fully understood. Few empirical studies exist on social capital and group aquaculture. Studies have considered the effect of social capital on common pool resources like nature based tourism in Mexico (see Sawatsky, 2008), or on the ability of social capital to influence community based wildlife managed outcomes in Nepal (see Wood, Knowler, & Gurung, 2008). Group shrimp aquaculture does not constitute a common pool resource, and as such, my research addresses a gap in the literature.

Chapter 4: Methodology

This chapter provides an overview of the methodology I will employ in my research. I begin by discussing two analytical frameworks, which incorporate social capital, and have been applied in the field of resource management. Both of these frameworks have been employed in a wide range of studies, exploring prospects for community management of natural resources, and identifying opportunities for aquaculture development. I then provide a brief overview of the social capital survey questions I will be analyzing; followed by a discussion of the quantitative methods I will use to analyze them. Lastly, I will elaborate on the statistical procedures used in the analysis.

4.1 Analytical Frameworks Incorporating Social Capital

Social capital is used to explain development outcomes by incorporating the concept into analytical frameworks that address natural resource management dilemmas, most notably Edward and Stein's (1999) framework, used to analyze common property problems, and the United Kingdom's Department for International Development (DFID) sustainable livelihood framework.

Edward and Stein's (1999) model has been applied to studies ranging from, community based tourism, and community based wildlife management, to the participation of women in collective management institutions (see Sawatsky, 2008; Meinzen-Dick, Pandolfelli, & Dohrn, 2007; Wood, 2003). The framework is used to analyze the effect of contextual factors on multiple use common property situations. Contextual factors are defined as "dynamic forces constituted in the user groups' social, cultural, economic, political, technological and institutional environment" (Edwards & Steins, 1999, p.207). The framework utilizes three categories of characteristics to analyze CPR situations: physical or technological characteristics of the resource system, decision-making rules governing use of the resource system, and characteristics of the community. This set of characteristics combine and interact to result in action strategies of resource users, patterns of interaction;

individuals make choices from sets of different possible strategies in relation to common property resources and to one another, and finally outcomes of collective resource problems. The community characteristics category considers social capital theory by examining the communities' capability to engage in collective management and the ability of members to work together to achieve a collective outcome (Wood et al., 2008).

The sustainable livelihood framework has been at the heart of many rural development projects initiated by governments and international organizations, such as the United Kingdom Department for International Development (DFID), and United Nations Development Program (UNDP) (Xue, 2006). The sustainable livelihood framework approaches livelihoods by considering poverty from a holistic perspective. It places the assets of the poor within a vulnerability context and assesses the effect of external policies on livelihood outcomes (Allison & Horemans, 2006; Majale, 2002). A livelihood is sustainable when it can cope with and recover from stresses and shocks, while maintaining or enhancing its capabilities and assets, both now and in the future, without undermining the natural resource base (Chambers & Conway, 1992).

The framework considers asset categories, livelihood strategies, livelihood outcomes, transformation processes and the vulnerability context. In order to thrive; individuals need access to capital assets, which are grouped under the following categories: human capital, natural capital, physical capital, financial capital, and social capital. Households can use their assets to create strategies, which result in various livelihood outcomes, ranging from poverty reduction, and livelihood adaptation, to natural resource base sustainability (Scoones, 1998). "Transformation processes affect assets, livelihood strategies, and outcomes, and are defined as the institutions, policies, and societal norms that characterize the environment in which households are located" (Scoones, 1998 as cited in Xue, 2006, p.23). The vulnerability context refers to events outside people's control, and includes changes in population, resources, and economic indicators, or shocks such as natural disasters, conflict, or lack of resource availability (Allison & Horemans, 2006; Adato & Meinzen-Dick, 2002).

The CPR framework and the sustainable livelihood framework incorporate social capital within their respective structures, however neither framework irrefutably acknowledges the importance of social capital in defining the natural resource management and sustainable livelihood outcomes. Social capital is rudimentarily applied to natural resource management and rural developed programs, for example the mere existence of

basic social relations among community members is taken as an indicator of social capital. Additionally social impacts are analyzed incorrectly under the semblance of social capital characteristics and social capital assets. Unlike the other capital assets, social capital is rarely empirically explored (see Ahmed, Troell, Allison, & Muir, 2010; Ahmed, Allison & Muir, 2008). For the purpose of my research project I will only be focusing on the social capital characteristics of the community. In doing so, I recognize the importance of social relations in influencing prospects for group shrimp aquaculture development. The social capital endowments of the community will not be analyzed in isolation but will be nested within the cultural and economic context of the region.

4.2 Social Capital Questions

The household survey contained a total of eight social capital related questions representing proxy indicators of social capital identified in the literature: reciprocity and exchanges, relations of trust, and connectedness in networks and groups (Pretty & Ward, 2001; Onyx & Bullen, 2000). The fourth indicator of social capital, common rules and norms, is inherent in the other proxy indicators.

Reciprocity and exchanges

Reciprocity and exchanges is a common theme in the social capital literature, and is described as short-term altruism through the exchange of goods and knowledge of equal value. Reciprocity can also serve long term self interests because a continuing relationship of exchange will eventually be repaid (Taylor, 1982 cited in Bullen & Onyx, 2000; Coleman, 1998; Putnam, 1993). To assess reciprocity and exchanges I considered the number of voluntary community, groups and societies in which respondents regularly participate. Other studies have used a similar question as an indicator of reciprocity (see Wood, 2003).

Relations of trust

Relations of trust reduce the transaction costs associated with cooperation. Many studies use trust as a proxy for social capital (Wood et al., 2008; Owen & Videras, 2006; Woolcock & Narayan, 2006). Similarly I will assess trust in the community by investigating two questions asking respondents whether they feel like most people within the village can

be trusted, and whether they feel most people encountered outside the village can be trusted.

Connectedness in networks and groups

Connectedness in networks and groups is used to measure the last component of social capital. Common indicators are of connectedness in networks and groups include informal and formal memberships, attending village events, and religious festivals (Grootaert & Van Bastelaer, 2002; Knack & Keefer, 1997). I will use the number of informal village events attended in the last 12 months to measure the connections within the community, and the number of religious festivals outside the village attended in the last 12 months to measure the connections beyond the village community. The difference in connections within the village and connections outside the village highlight two types of social capital, bonding and bridging social capital.

Bonding and bridging social capital

As previously discussed bonding social capital is between family members, close friends and neighbours; it is inward looking and generates a narrow radius of trust. Bonding social capital variables include: the number of voluntary community groups in which respondents volunteer their time, the number of informal village events attended, trust in people in the village, and participation in new community projects in the village. Bridging social capital refers to the relationship between more distant associates or cooperative relations among people who are demographically dissimilar; it creates a wider radius of trust that can be generalized to the wider community (De Silva et al., 2007; Woolcock & Narayan, 2000; Gittel & Videl, 1998). Bridging social capital variables include the number of religious festivals attended outside the village, and whether the respondent trusts people outside the village (Table 4).

Table 4. SHARP project household survey questions used in the analysis representing proxy indicators of bonding and bridging social capital (Philcox, 2006; reproduced in Appendix A)

Social capital variables	Response	Indicator [a]	Type of social capital [b]
Most communities have a number of clubs or societies. How many voluntary community groups, clubs or societies do you regularly participate in?	Numeric	Reciprocity	Bonding
rAre you on a management committee for any of these groups?	Yes/ No	Common rules and norms	Bonding
How many informal events have you attended in the last 12 months?	Numeric	Networks	Bonding
Do you feel most people within the village can be trusted?	Almost no-one, A few people , Most people, Almost everyone	Trust	Bonding
Have you attended any religious festivals in the last 12 months that required you to travel outside the village	Yes - How many have you attended, No	Networks	Bridging
When you travel outside the village, do you feel most people you encounter can be trusted?	Almost no-one, A few people, Most people, Almost everyone	Trust	Bridging
Generally, do you participate in new community projects that are initiated in your village?	Never, Rarely, Sometimes, Usually, Always	Networks	Bonding

[a] Pretty and Ward (2001)
[b] Onyx and Bullen (2000)

4.3 Statistical Analysis

4.3.1 Statistical Analysis of Social Capital

Social capital has been analyzed using different methods. Wang et al. (2008) used ordered regression to test the relationship between social capital and the self reported health status of rural populations. Ellison, Steinfield and Lampe (2007) used factor analysis to investigate the relationship between popular online social networks and the formation and maintenance of social capital. Narayan and Cassidy (2001) attempted to provide researchers with a set of statistically validated survey questions for analyzing social capital by conducting a study in Ghana and Uganda, also utilizing factor analyses. Owen and Videras (2006) used a Latent Class Approach to analyze social capital from a general social survey. The latent class model classified individuals into distinct types of social capital using both memberships and indicators of trust and fairness.

I used a Principal Component Analysis (PCA) to analyze the social capital questions in my study. A PCA avoids co-dependence effects among social capital variables, and has the ability to identify the main components of social capital from responses to a set of social capital related questions. The goal of PCA is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much of the variation present in the data set. “This is achieved by transforming to a new set of variables, the principal components which are uncorrelated, and which are ordered so that the first few retain most of the variation present in all of the original variables” (Joliffe, 2005, p.1). I used PASW 18.0 Statistical software to conduct the analysis.

Wood et al. (2008) used a Principal Component Analysis to assess social capital to study prospects for community-based management of musk deer in Sagarmatha National Park, Nepal. The factor scores from the PCA were then used to conduct Hierarchical Cluster Analysis to group households with distinct social capital characteristics. The cluster analysis employed by Wood et al. (2008) is an example of how a PCA may be used in conjunction with other statistical methods.

4.3.2 Principal Component Analysis of Social Capital Variables

The PCA was conducted on the random sample of 296 households.[10] I selected seven of the eight social capital variables questions to include in the PCA. One question had to be dropped from the analysis because it was not applicable to many of the respondents and was therefore left unanswered. The social capital variables were standardized to obtain Z-scores, which are a measure of the distance of one observation from the mean. Standardization is recommended when variables have been measured in different units or on different scales to remove the arbitrary effects caused by different units of measurement. I ran a PCA on the seven selected social capital variables to determine if and how social capital varied among respondents. I used the Varimax method of orthogonal rotation; this method is a very popular orthogonal rotation for PCA because of the ease of interpretation. After a Varimax rotation each original variable is associated with a small number of factors, and each factor represents a small number of variables (Abdi, 2003). The Varimax rotation works by maximizing the sum of the variances of the squared coefficients with each eigenvector while the rotated axes remain orthogonal (StatSoft, 2011). The Kaiser criterion was employed to decide how many factors to retain. The Kaiser criterion only allows for factors with Eigen values of at least 1.0 to be retained (StatSoft, 2011). To determine the appropriateness of factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy test was used; the test measures the appropriateness of the correlation matrix (Norusis, 1985 as cited in Crane, Busby, & Larson, 1991). High values close to 1.0 indicate that factor analysis may be useful and values less than 0.5 indicate otherwise. The variables were saved as regression factor scores to be used in a Hierarchical Cluster Analysis (HCA).

[10] Five missing values were replaced with the mean when conducting the Principal Component Analysis.

4.3.3 Hierarchical Cluster Analysis

I used the factor scores obtained from the PCA to split the respondents into distinct clusters using a Hierarchical Cluster Analysis (HCA) and Ward's method with a Squared Euclidian distance measure. “Cluster analysis is a statistical method for classification of data, and unlike other statistical methods of classification, such as discriminant analysis, clustering does not make prior assumptions within a population” (Punj & Stewart, 1983, p.135). Hierarchical clustering provides hierarchical classification of data that is not done in a single step, but rather in a series of successive partitions. Clusters may range from one single cluster containing all individuals to *n* clusters, each containing a single individual. Once the agglomerative algorithm has placed two individuals into the same group they cannot subsequently appear in different groups. Ward’s method uses an analysis of variance approach to gauge the distances between clusters, minimizing the sum of squares of any two clusters formed at each step. The Ward's method is considered efficient, and tends to create small sized clusters (StatSoft, 2011). “Squared Euclidean distance analysis removes the signs of the variables and places greater emphasis on objects further apart, thus increasing the effect of outliers” (Garson, 2007 as cited in Sawatsky, 2008, p.32).

The agglomerative hierarchical method ultimately reduces the data to a single cluster; the most appropriate number of clusters needs to be determined by the researcher. I used a dendogram to determine the most appropriate number of clusters. I validated the number of clusters I had selected by referring to the agglomeration schedule and I looked for a point in the schedule was there was an abrupt and significant jump in the proximity coefficient from the previous value.

4.3.4 Regression Analysis

In the second part of my analysis I used a regression analysis to determine which variables influenced attitudes towards group shrimp farming on leased or common land. A regression analysis helps to understand the relationship among the dependent variable of interest and various independent or explanatory variables, which are hypothesized to influence the dependent variable. Regression analysis has been used in several studies involving social capital (see Holtgrave & Crosby, 2004; Glaeser, Laibson, & Sacerdote, 2002; Kawachi, Kennedy, Lochner, & Prothrow-Stith, 1997).

I conducted two sets of regression analyses. The first set of models were estimated at the community level and considered the entire random sample of 296 responses[11]. The second set of regression analyses took a more targeted approach—I estimated a separate set of models on the 138 households who ranked lack of household funds/credit and financial risk as most important for not converting their land to shrimp pond area for the purpose of shrimp farming. The regression analysis of the sub sample explores how the social capital characteristics of the households that do not plan to convert their agricultural land or polyculture pond area to shrimp pond area because of the constraints identified in Section 2.4.1, influence attitudes towards group shrimp aquaculture. The econometric software package LIMDEP 9.0 was used for all regression analyses.

I hypothesized that the dependent variable would be influenced by demographic characteristics, such as income, wealth, household size, education level, gender, village, and age, and by social capital characteristics. I incorporated social capital into the regression models as individual social capital variables, as principal component scores from the PCA on social capital variables, and as clusters that were obtained from the HCA. The motivation for including social capital information in three different forms was to determine which form would yield the best results in an empirical analysis of social capital data.

I used a binary probit model to determine the independent variables that influence a respondent's attitude towards more group shrimp farms on leased or common land. Several adjustments had to be made to the data to make them suitable for the binary probit model. The dependent variable that was initially coded on a 6-point likert scale was recoded to a dichotomous choice to facilitate the binary probit analysis[12]. Strongly agree and agree were aggregated into agree, and neutral, don't know, disagree and strongly disagree were aggregated into does not agree[13]. In the case of more group shrimp farms on leased or

[11] Five missing values had to be deleted from the data set to conduct a regression analysis resulting in a sample of 291 for the community level analysis, and 136 for the subsample analysis.

[12] Additional segmentations were attempted such as village of residence, and livelihood activity, however the model coefficients were not significant. An ordered probit analysis was attempted but could not be estimated due to a small sample size resulting in low variability in the dependent variable.

[13] The models were also estimated with the neutral category excluded, and aggregated with agree and strongly agree. The resulting models were not statistically significant.

common land, the response was either (Y=1) agrees, or (Y=0) does not agree. Therefore the binary probit model has only two possible outcomes “0” or “1 “ (see Greene, 2011; Maddala & Lahiri, 2009; Gujarati, 2008). I assumed that agreeing depends on an unobservable or latent variable y^*_i which is determined by explanatory variables.

The latent regression is specified as $y^* = \beta' x + \varepsilon$.

$$y_i = \begin{cases} 1 & if\ y_i^* > 0 \\ 0 & otherwise \end{cases}$$

y^* = An unobserved agreement with group shrimp farms

x = A vector of independent variables that may influence agreeing with more group shrimp farms

β = A vector of parameters reflecting the relationship between agreement with more group shrimp farms and variables in x.

ε = An independently and identically distributed error term with mean 0 and variance 1.

I used maximum likelihood estimation to estimate the probit models. The McFadden Pseudo R^2 value, and the likelihood ratio test were used to determine the goodness of fit and overall significance of the model. I used the Akaike Information Criterion (AIC) to compare and select the best model. The measure is useful when comparing models with a different number of parameters, and provides a simple, effective and objective means for selecting an estimated best approximating model (Burnham & Anderson, 1998). In addition, the AIC is advantageous in comparing different models because it penalizes over-parameterization unlike other methods such as R^2 which increases in size the more parameters are included in the model (Greene, 2011). Smaller AIC values indicate a better fit of the model to the data. I used P- values to determine if the estimated coefficients of the independent variables were statistically significant, considering significance levels of 1%, 5%, and 10%. The size and signs of the estimated coefficients were used to understand how the independent variables influenced the dependent variable. The marginal effects of the independent variables on the probability of agreeing or disagreeing with more group shrimp farms were also considered. Marginal effects for a dummy variable can be interpreted as the change in the predicted probability with and without the dummy variable equal to one (Greene, 2002). The marginal effects were evaluated at the computed variable means in the data set.

Model 1 Social Capital Variables

Model 1, the social capital variables model included explanatory social capital and demographic variables from the household survey. The variable (VGROUP) is the number of voluntary community groups the respondent regularly participates in; (MAN) is whether the respondent is on the management or organization committee of a group; (EVENTS) is the number of informal village events attended; (FEST) is the number of religious festivals attended outside the village; (TRUSTV) and (TRUSTO) represent relations of trust inside and outside of the village; and (PART) is how often the respondent participates in new community projects initiated in the village. The demographic variables in the model are represented by (VILL), whether the respondent is from Debnagar or Chondinpiri North; (GENDER), is the gender of the respondent; (SCHOOL) is the number of years of formal schooling received; (WEALTH1), and (WEALTH3) represent low and high household wealth index categories. Finally (INC1) and (INC3) are low-income category and high-income category, medium income (INC2) was used as a reference case (Table 5). Model 1 was tested under the following specifications:

$$\text{SFCOM2 (Dependent variable)} = \beta_0 + \beta_1\,(\text{VGROUP}) + \beta_2\,(\text{MAN}) + \beta_3\,(\text{EVENTS}) + \beta_4\,(\text{FEST}) + \beta_5\,(\text{TRUSTV}) + \beta_6\,(\text{TRUSTO}) + \beta_7\,(\text{PART}) + \beta_8\,(\text{VILL}) + \beta_9\,(\text{GENDER}) + \beta_{10}\,(\text{SCHOOL}) + \beta_{11}\,(\text{WEALTH1}) + \beta_{12}\,(\text{WEALTH3}) + \beta_{13}\,(\text{INC1}) + \beta_{14}\,(\text{INC3}). \quad [4.1]$$

Model 2 Principal Components

Model 2 is an adaptation of the above model, and replaces single variables with three social capital factor scores, (FAC1) which represents community aspects, (FAC2) is relations of trust, and (FAC3) is networks and connections. These factor scores were calculated from a Principal Component Analysis of seven social capital variables. The model included all the same demographic variables specified in Model 1 above, and was tested under the following specifications:

$$\text{SFCOM2 (Dependent variable)} = \beta_0 + \beta_1\,(\text{FAC1}) + \beta_2\,(\text{FAC2}) + \beta_3\,(\text{FAC3}) + \beta_4\,(\text{VILL}) + \beta_5\,(\text{GENDER}) + \beta_6\,(\text{SCHOOL}) + \beta_7\,(\text{WEALTH1}) + \beta_8\,(\text{WEALTH3}) + \beta_9\,(\text{INC1}) + \beta_{10}\,(\text{INC3}). \quad [4.2]$$

Model 3 Cluster Membership

The last model can be considered an extension of both Model 1 and 2. The model extended the analysis by incorporating social capital in the form of clusters created by the hierarchical clustering of social capital principal component scores. The clusters each

represented different combinations of social capital. Only Cluster A and Cluster B were included in the model to avoid multicollinearity, Cluster C was used as a reference case. The demographic variables in Model 3 are identical to the demographic variables in the previous two models, and it was tested under the following specifications:

$$\text{SFCOM2 (Dependent variable)} = \beta 0 + \beta 1\ (\text{CLUA}) + \beta 2\ (\text{CLUB}) + \beta 3\ (\text{VILL}) + \beta 4\ (\text{GENDER}) + \beta 5\ (\text{SCHOOL}) + \beta 6\ (\text{WEALTH1}) + \beta 7\ (\text{WEALTH3}) + \beta 8\ (\text{INC1}) + \beta 9\ (\text{INC3}). \quad [4.3]$$

Table 5. Description of variables used for binary probit models

Variable code	Variable form	Definition	Expected sign
SFCOM2	Binary	Do you think there should be more community managed shrimp farms	n/a
		1 = Agree	
		0 = Otherwise	
Independent variables			
VGROUP	Continuous	Number of voluntary groups respondents participates	+
MAN	Binary	Management/organization of groups	+
EVENTS	Continuous	Number of informal village events attended	+
FEST	Continuous	Participation in new community groups	+
TRUSTV*	Binary	Trust in people in the village	+
		1= Most people	
		0= Otherwise	
TRUSTO*	Binary	Trust of people outside the village	+
		1= Most people	
		0= Otherwise	
PART*	Binary	Participation in new community projects initiated in the village	+
		1 = Yes	
		0 = Otherwise	
FAC1	Continuous	Principal component score	+
FAC2	Continuous	Principal component score	
FAC3	Continuous	Principal component score	+
CLUA	Binary	Member of Cluster A	+
		1 = Yes	
		0 = Otherwise	
CLUB	Binary	Member of Cluster B	+
		1 = Yes	
		0 = Otherwise	
CLUC*	Binary	Member of Cluster C	+
		1 = Yes	
		0 = Otherwise	

Table 5. Continued

VILL	Binary	1 = Debnagar 0 = Otherwise	+
GENDER	Binary	1 = Male 0 = Otherwise	+
SCHOOL	Continuous	Number of years of formal schooling completed	+
TOTLAND	Continuous	Total amount of land owned	+
LIVEST	Continuous	Total number of livestock owned	-
WEALTH1	Binary	1 = Low household wealth index category 0 = Otherwise	-
WEALTH2*	Binary	1 = Medium household wealth index category 0 = Otherwise	-
WEALTH3	Binary	1 = High household wealth index category 0 = Otherwise	+
INC1	Binary	1 = Low income category 0 = Otherwise	–
INC2*	Binary	1 = Medium income category 0 = Otherwise	–
INC3	Binary	1 = High income category 0 = Otherwise	+
* Variable was dropped from the model to avoid multicollinearity in the model * TRUSTO, TRUSTV, PART Variables recoded to a binary choice			

Chapter: 5 Results

In Chapter 5 I first present the results of the Principal Component Analysis and Hierarchical Cluster Analysis. The variation of social capital among clusters is examined to develop a typology of the clusters. Then, I discuss the binary probit models used to identify factors influencing level of agreement with more group shrimp farms on leased or common land.

5.1 Principal Components

I ran the Principal Component Analysis on the random sample of 296 respondents. All but one of the social capital questions were included in the analysis, I omitted *"overall, how would you rate the performance of the groups in which you participate*" because the question was not applicable to the respondents who did not participate in any groups, thus resulting in many non-responses. I conducted the Kaiser-Meyer-Olkin Measure of Sampling Adequacy to determine whether the data was appropriate for a factor analysis, the test resulted in a KMO value of 0.64 which was above the 0.50 threshold that indicates a PCA is appropriate.

Three components emerged from the PCA accounting for 65.1% of the variance. Component 1, which I named community aspects was defined by participation in voluntary community groups, clubs and societies; involvement in management or organizing committee for voluntary groups; and participation in new community projects that are initiated in the village. Component 1 explained 20.6% of the variance, and accounted for the reciprocity and exchanges dimension of social capital. Reciprocity and exchanges is demonstrated by involvement in voluntary groups and volunteering time to help with the management of the voluntary groups. The second component, called “trust” was defined by relations of trust both in and outside the village, and represented another dimension of social capital. Component 2 explained 19.9% of the variance. Component 3 was defined by

attendance of informal events village events and attendance of religious festivals outside the village, representing the connectedness and networks aspect of social capital. Component 3 explained 19.6% of the variance, and was labelled “networks” (Table 6).

Table 6. Eigenvalues from the Principal Component Analysis (PCA) on 7 social capital variables

Components	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.134	30.48	30.48	2.134	30.48	30.48	1.794	25.63	25.63
2	1.314	18.78	49.26	1.314	18.78	49.26	1.393	19.90	45.52
3	1.110	15.86	65.12	1.110	15.86	65.12	1.372	19.60	65.12
4	0.828	11.83	76.95						
5	0.593	8.48	85.43						
6	0.570	8.14	93.57						
7	0.450	6.43	100.00						

Table 7. Factor scores for the rotated component analysis of social capital variables

Social capital variables	Component 1	Component 2	Component 3
Number of voluntary community groups, clubs or society respondent regularly participates in	**0.797**	0.010	0.219
Is respondent involved in management/organization	**0.786**	0.115	0.115
Participation in new community projects	**0.644**	0.079	-0.056
Trust in people in the village	0.185	**0.808**	-0.036
Trust in people outside the village	-0.006	**0.840**	0.078
Number of informal village events	0.297	-0.068	**0.760**
Number of religious festivals outside village	-0.059	0.103	**0.850**

5.2 Hierarchical Clusters

I used the factor scores generated in the PCA to create clusters by conducting a Hierarchical Cluster Analysis using Ward's method and a Squared Euclidian distance measure. I selected a three-cluster model based on the dendogram generated in the output. The agglomeration schedule confirmed a three-cluster solution because of a distinct jump in coefficients between stage 292 that had a coefficient of 430.6, and stage 293 that had a coefficient of 546.7. The jump in coefficients between stages 292 and 293 validated the three-cluster solution because there were 295 stages in total (Appendix H). I ran a frequency analysis on the data to ensure the distribution of the clusters was normal without having one cluster over represented (Table 8).

Table 8. Number of respondents in each cluster

Cluster	Frequency	Percentage
A	61	20.6
B	124	41.9
C	111	37.5
Total	296	100

I explored the relationship between the principal components and the three clusters by comparing the mean component scores against the three clusters (Table 9). Cluster A had a negative relationship with Component 1 and Component 2, but a strong positive relationship with Component 3. Cluster B had a negative relationship with Component 1, Component 2, and Component 3. Cluster C was primarily characterized by a positive relationship with Component 1 and Component 2, and a negative relationship with Component 3.

Table 9. Mean Component scores from the PCA for each cluster

Cluster	Community aspects	Trust	Networks
A	-0.069	-0.352	1.420
B	-0.410	-0.608	-0.455
C	0.496	0.872	-0.272

5.2.1 Demographic Characteristics, and Livelihoods of the Clusters

I used an Analysis of Variance (ANOVA) and Pearson's chi-square cross tabulations to explore relationships between demographic, and livelihood and resource variables for the three clusters. Due to the small sample size of 296, I chose a significance level of 10%. The variables that varied significantly across the three clusters included income category, the household wealth index[14], the total number of family members in the household, gender, and the likelihood of converting agricultural land and or polyculture pond area to shrimp pond area for the purpose of shrimp farming in the next 5 years. Several variables were not significant but are worth noting such as number of years of formal schooling, and the total amount of land owned (Table 10).

Income was segmented according to low, medium and high, with 24.6% of households in Cluster A identified as low income, 49.2% as medium income, and 26.2% in as high income. Cluster B had 48.8% of households in the low-income category, 23.6% in the medium income category, and 27.6% in the high-income category. Cluster C had the highest proportion of households in the high-income category, 33.6%, and 30.9% in the medium category, and 35.5% in the low-income category (χ^2 (4, N=296) =16.13, P=0.003).

The difference in mean household wealth index among the clusters was significant (F (2, 293)= 4.34, P=0.014). Tamhane's post hoc test revealed a significant difference between Cluster B (M=0.21, SD=2.69), which had the lowest mean household wealth index and Cluster C, which had the highest mean household wealth index (M=0.27, SD=0.19 P=0.021).

The total number of family members varied significantly across the clusters as determined by the one-way ANOVA (F (2, 293)= 4.16, P=0.017). The Bonferonni post hoc test revealed that the total number of family members was significantly larger in Cluster C (M=6.74, SD=3.75) when compared to Cluster A (M=6.36, SD= 2.69, P=0.005**),** and Cluster B (M= 5.61,SD= 2.41,P=0.014).

[14] Wealth index is a numeric variable using 3 variables from the HS: Number of adult members of the household (over 15 years of age); area of agricultural land, polyculture ponds, and shrimp ponds owned by the household; and the number of cattle owned by the household. The wealth index is measured on a scale from 0 to 1.

Table 10. Select demographic characteristics, livelihoods and resources variables by cluster

Variable	Cluster	Mean	SD	df	F	P
Household wealth index	Cluster A	0.24	0.12	2, 293	4.34	**0.014**
	Cluster B	0.21	0.14			
	Cluster C	0.27	0.19			
	Total	0.23	0.16			
Total income in Rupees	Cluster A	29538.38	37392.38	2, 291	1.13	0.325
	Cluster B	26985.20	34027.24			
	Cluster C	34560.91	44044.20			
	Total	30349.40	38751.02			
Number of years of schooling	Cluster A	6.21	4.04	2, 293	2.06	0.130
	Cluster B	5.27	3.73			
	Cluster C	6.18	3.94			
	Total	5.80	3.89			
Total number of family members in household	Cluster A	6.36	2.69	2, 293	4.16	**0.017**
	Cluster B	5.61	2.41			
	Cluster C	6.74	3.75			
	Total	6.19	3.06			
Total land owned (bighas)	Cluster A	3.63	2.70	2, 293	1.65	0.194
	Cluster B	3.14	3.66			
	Cluster C	4.03	4.31			
	Total	3.57	3.76			

The difference in the mean number of years of formal schooling was not significant, however Cluster A had the highest average number of years of formal schooling, 6.21 years, followed by Cluster C, which had 6.18 years of formal schooling. Cluster B had the lowest educational achievement with only 5.27 years of formal schooling completed.

When asked about the likelihood of converting agricultural land and or polyculture pond area to shrimp pond area for the purpose of shrimp farming in the next 5 years, 27.1% of respondents in Cluster A were very likely to convert land, while only 7% Cluster C, and 6.3% of Cluster B were very likely to convert land for the purpose of shrimp farming ($\chi^2(6, N=271) = 22.68$, $P= 0.001$).

Table 11. Likelihood of converting agricultural land and/or polyculture pond area to shrimp ponds for the purpose of shrimp farming in the next 5 years by cluster

Variable		Cluster A		Cluster B		Cluster C		Total		χ^2	df	P
		%	n	%	n	%	n	%	n			
Likelihood of converting agriculture/polyculture area to shrimp pond area in the next 5 years	Very unlikely	55.9	33	71.4	80	64.0	64	65.3	177	22.68	6	**0.001**
	More unlikely than likely	3.4	2	8.9	10	12.0	12	8.9	24			
	More likely than unlikely	13.6	8	13.4	15	17.0	17	14.8	40			
	Very likely	27.1	16	6.3	7	7.0	7	11.1	30			

Table 12. Select demographic characteristics, livelihoods and resources variables- Post hoc tests

Variable	Comparison	Mean Difference	SE	P	Post hoc test
Household wealth index	Cluster A and Cluster B	0.03	0.02	0.210	Tamhane
	Cluster A and Cluster C	-0.03	0.02	0.620	
	Cluster B and Cluster C	-0.06	0.02	**0.021**	
Total income in Rupees	Cluster A and Cluster B	2553.17	6065.77	1.000	Bonferonni
	Cluster A and Cluster C	-5022.53	6183.45	1.000	
	Cluster B and Cluster C	-7575.71	5083.04	0.412	
Number of years of schooling	Cluster A and Cluster B	0.95	0.61	0.358	Bonferonni
	Cluster A and Cluster C	0.03	0.62	1.000	
	Cluster B and Cluster C	-0.91	0.51	0.217	
Total number of family members in household	Cluster A and Cluster B	0.38	0.48	0.435	Bonferonni
	Cluster A and Cluster C	1.13	0.40	**0.005**	
	Cluster B and Cluster C	-1.13	0.40	**0.014**	
Total land owned	Cluster A and Cluster B	0.49	0.59	1.000	Bonferonni
	Cluster A and Cluster C	-0.40	0.60	1.000	
	Cluster B and Cluster C	-0.89	0.49	0.214	

Ranking of reasons for not converting agricultural land and or polyculture pond area to shrimp ponds in the next 5 years

To identify the potential barriers to undertaking shrimp aquaculture, respondents were asked to rank the reasons for not converting their agricultural land and or polyculture pond area to shrimp ponds for the purpose of shrimp farming in the next 5 years (Table 13). Cluster C ranked lack of household funds and credit as the most important reason for not converting agricultural land with a mean ranking of 1.71, followed by Cluster A with a mean

ranking of 1.97. Interestingly, Cluster B ranked lack of household funds and credit as 2.0. The financial risk associated with shrimp aquaculture had a mean ranking of 1.80 for Cluster A, 1.83 for Cluster C, and 1.91 for Cluster B. The ranking results indicated that Cluster A and Cluster C are more concerned with the financial aspects of shrimp aquaculture.

Table 13. Ranking of reasons for not converting agricultural land and/or polyculture pond area to shrimp ponds in the next 5 years by cluster

Reason for not converting	Cluster	Ranking mean[a]	SD	95% Confidence Interval for mean		N	Percentage of total
				Lower	Upper		
Lack household funds/credit	Cluster A	1.97	1.28	1.50	2.44	31	50.8%
	Cluster B	2.00	1.44	1.66	2.34	71	57.3%
	Cluster C	1.71	0.80	1.50	1.93	56	50.5%
Financial risk	Cluster A	1.80	0.81	1.50	2.10	30	49.2%
	Cluster B	1.91	1.08	1.64	2.18	64	51.6%
	Cluster C	1.83	0.90	1.58	2.08	52	46.8%
Lack of access to brackish water	Cluster A	3.69	2.36	2.27	5.12	13	21.30%
	Cluster B	2.64	1.29	2.22	3.06	39	31.50%
	Cluster C	2.30	1.15	1.81	2.80	23	20.70%
Risk of disease	Cluster A	3.88	1.54	3.05	4.70	16	26.20%
	Cluster B	3.54	1.31	3.09	3.99	35	28.20%
	Cluster C	3.11	1.49	2.60	3.63	35	31.50%
Government regulations	Cluster A	5.80	1.4	4.80	6.80	10	16.40%
	Cluster B	5.64	1.03	4.95	6.33	11	8.90%
	Cluster C	6.00	0.82	4.70	7.30	4	3.60%
Lack of technical knowledge	Cluster A	3.63	1.54	2.80	4.45	16	26.20%
	Cluster B	2.86	1.18	2.40	3.31	28	22.60%
	Cluster C	3.13	1.06	2.74	3.52	31	27.90%
Not interested	Cluster A	3.09	1.87	1.84	4.35	11	18.00%
	Cluster B	3.29	1.92	2.54	4.03	28	22.60%
	Cluster C	3.63	2.03	2.65	4.61	19	17.10%

[a] Ranking based on 1 as the most important rank and 8 as the least important rank.

Attitudes towards shrimp aquaculture, environmental and social conditions

To gauge support in the community for group aquaculture, the respondents were asked if "*there should be more community managed or cooperative shrimp farms on leased or common land"*. In this case the results were highly significant, (F (2, 292)= 8.49, P=0.000). Tamhanes's post hoc test revealed that Cluster A (M=3.67, SD= 1.11) scored higher on their level of agreement than both Cluster B (M=2.80, SD= 1.39, P=0.000), and

Cluster C (M=3.01, SD= 1.44, P=0.003). The difference in level of agreement between Cluster B and Cluster C was not significant (P=0.613).

Table 14. Select attitudes and perceptions towards shrimp aquaculture, environmental conditions, and social conditions- ANOVA

Variable	Cluster	Mean	SD	df	F	P
Concern about conversion of paddy land to shrimp farms	Cluster A	3.74	1.17	2, 291	6.29	**0.002**
	Cluster B	3.20	1.24			
	Cluster C	3.04	1.33			
	Total	3.25	1.28			
There should be more community managed or cooperative shrimp farms	Cluster A	3.67	1.11	2, 292	8.49	**0.000**
	Cluster B	2.80	1.39			
	Cluster C	3.01	1.44			
	Total	3.06	1.39			
Some kinds of fish are more abundant when there are mangrove forests nearby	Cluster A	3.69	1.50	2, 292	3.23	**0.041**
	Cluster B	3.73	1.47			
	Cluster C	4.14	1.17			
	Total	3.87	1.38			
Shrimp fry collection decreases number of fish	Cluster A	4.33	0.51	2, 292	2.35	**0.097**
	Cluster B	4.11	0.82			
	Cluster C	4.25	0.68			
	Total	4.21	0.72			

Note: 1 don't know and neutral aggregated into neutral category.

Note: 2 = strong disagree, 2 = disagree, 3 = neutral, 4 = agree 5 = strongly agree.

Table 15. Attitudes and perceptions towards shrimp aquaculture, environmental conditions, and social conditions- Post hoc tests

Variable	Comparison	Mean Difference	SE	P	Post hoc test
Concern about conversion of paddy land to shrimp farms	Cluster A and Cluster B	0.54	0.20	**0.020**	Bonferonni
	Cluster A and Cluster C	0.70	0.20	**0.002**	
	Cluster B and Cluster C	0.16	0.17	0.994	
There should be more community managed or cooperative shrimp farms	Cluster A and Cluster B	0.87	0.19	**0.000**	Tamhane
	Cluster A and Cluster C	0.66	0.20	**0.003**	
	Cluster B and Cluster C	-0.20	0.19	0.613	
Some kinds of fish are more abundant when there are mangrove forests nearby	Cluster A and Cluster B	-0.04	0.22	1.000	Bonferonni
	Cluster A and Cluster C	-0.45	0.22	0.125	
	Cluster B and Cluster C	-0.40	0.18	**0.076**	
Shrimp fry collection decreases number of fish	Cluster A and Cluster B	0.22	0.11	0.142	Bonferonni
	Cluster A and Cluster C	0.08	0.11	1.000	
	Cluster B and Cluster C	-0.15	0.09	0.351	

5.2.2 Social Capital Characteristics

Reciprocity and Exchanges

The amount of time dedicated to volunteering differed significantly among the clusters (F (2,291)= 19.08, P=0.000) (Table 15). Tamhane's post hoc test revealed that participation in voluntary groups was significantly higher in Cluster A (M=1.102, SD=1.729), compared to Cluster B (M= 0.30, SD=0.64, P=0.003). The difference in participation between Cluster C and Cluster B was also significant (M= 1.198 SD=1.313, P=0.000) (Table 16).

Participation in new community projects initiated in the village was significantly different, (F (2, 292)= 14.6, P=0.000). Tamhane's post hoc test revealed that Cluster C (M=3.78, SD=1.15) participated more often than Cluster A (M=3.21, SD= 0.88, P=0.001), and Cluster B (M=3.11, SD=0.88, P=0.000).

The Pearson's chi-squared analysis on being on a group management or organization committee revealed that households in Cluster C were most involved in management (38.5%), followed by Cluster A (20%). Not a single respondent in Cluster B was on the management or organizing committee of any group, (χ^2(2, N =296)= 57.41, P= 0.000) (Table17).

Table 16. Social capital numeric variables by cluster

Variable	Cluster	Mean	SD	F	df	P
Number of voluntary community groups, clubs or society respondent regularly participates in	Cluster A	1.10	1.73	19.09	2, 291	**0.000**
	Cluster B	0.30	0.64			
	Cluster C	1.20	1.31			
	Total	0.80	1.26			
Number of informal village events	Cluster A	27.15	17.05	87.98	2, 293	**0.000**
	Cluster B	7.96	5.14			
	Cluster C	11.62	6.88			
	Total	13.29	11.85			
Number of religious festivals outside village	Cluster A	6.53	4.70	74.14	2, 288	**0.000**
	Cluster B	1.44	1.56			
	Cluster C	2.32	2.18			
	Total	2.84	3.33			
Participation in new community projects	Cluster A	3.21	0.88	14.58	2, 292	**0.000**
	Cluster B	3.11	0.88			
	Cluster C	3.78	1.15			
	Total	3.39	1.03			

Relations of Trust

Households in Cluster C were most trusting of almost everyone inside the village (26.4%), followed by Cluster A (3.3%), and no households in Cluster B trusted almost everyone in the village χ^2(6, N =296)= 138.96, P= 0.000) (Table 16). Households were also asked if the people they encountered outside the village could be trusted. The results mirrored the results of trust within the village, Cluster C was most trusting of almost all people encountered outside the village (16.8%), Cluster A, and Cluster B were least trusting, not a single household trusted almost everyone they encountered outside the village, χ^2(6, N =296)= 100.88, P= 0.000.

Connectedness in Networks and Groups

The mean number of informal village events attended in the last 12 months differed significantly among clusters, (F (2, 293)= 87.98, P= 0.000). Households in Cluster A attended significantly more informal village events (M=27.15, SD=17.05) than either Cluster B, (M= 7.96, SD= 5.12, P=0.000), or Cluster C (M=11.62, SD=5.14, P=0.000). The post hoc tests revealed a significant difference between Cluster B and Cluster C (P=0.000). Similar results were witnessed when households were asked how many religious festivals they had attended outside the village in the last 12 months. Households in Cluster A travelled outside the village more frequently (M=6.72, SD=4.70), compared to Cluster B (M=1.44, SD= 1.56, P=0.000), and Cluster C (M= 2.32, SD= 2.18, P=0.000).

Table 17. Social capital categorical variables by cluster

Variable		Cluster A		Cluster B		Cluster C		Total		χ^2	df	P
		%	n	%	n	%	n	%	n			
Involved in management	Yes	20.0	12	0.0	0	38.5	42	18.4	54	57.41	2	**0.000**
	No	80.0	48	100.0	124	61.5	67	81.6	239			
Trust people inside village	Almost no one	3.3	2	10.7	13	0.9	1	5.5	16	138.96	6	**0.000**
	A few people	72.1	44	81.8	99	20.0	22	56.5	165			
	Most people	21.3	13	7.4	9	52.7	58	27.4	80			
	Almost everyone	3.3	2	0.0	0	26.4	29	10.6	31			
Trust people outside the village	Almost no one	1.6	1	11.1	13	0.9	1	5.3	15	100.88	6	**0.000**
	A few people	86.9	53	84.6	99	42.1	45	69.1	197			
	Most people	11.5	7	4.3	5	40.2	43	19.3	55			
	Almost everyone	0.0	0	0.0	0	16.8	18	6.3	18			
Festivals outside the village	Yes	100.0	61	55.3	68	71.2	79	29.5	87	39.25	2	**0.000**
	No	0.0	0	44.7	55	28.8	32	70.5	208			

Table 18. Social capital variables- Post hoc tests

Variable	Comparison	Mean Difference	SE	P	Post hoc test
Number of voluntary community groups, clubs or society respondent regularly participates in	Cluster A and Cluster B	0.80	0.23	0.003	Tamhane
	Cluster A and Cluster C	-0.10	0.26	0.975	
	Cluster B and Cluster C	-0.90	0.14	0.000	
Participation in new community projects	Cluster A and Cluster B	0.10	0.14	0.853	Tamhane
	Cluster A and Cluster C	-0.57	0.16	0.001	
	Cluster B and Cluster C	-0.67	0.14	0.000	
Number of informal village events	Cluster A and Cluster B	19.19	2.23	0.000	Tamhane
	Cluster A and Cluster C	15.52	2.28	0.000	
	Cluster B and Cluster C	-3.67	0.80	0.000	
Number of religious festivals outside village	Cluster A and Cluster B	5.08	0.62	0.000	Tamhane
	Cluster A and Cluster C	4.20	0.64	0.000	
	Cluster B and Cluster C	-0.88	0.25	0.002	

5.3 Regression Analysis

All the models in the community level and sub sample level analyses produced similar results, with significant coefficients for social capital and demographic variables. The village of residence, and high wealth income category emerged as significant in all models. I will discuss each model in turn, and analyze the marginal effects for the models of best fit.

5.3.1 Community Models

Model 1 Social Capital Variables

Model 1 assessed the influence of seven social capital variables on agreement with more group shrimp farms on leased or common land. The overall model was significant at the 1% level according to the model chi-square statistic. The McFadden Pseudo R^2 value was 0.121. The AIC goodness of fit measure was 1.324, and the model correctly predicted 69.8% of the observations.

The model yielded four significant coefficients (Table 19). The number of religious festivals attended outside the village coefficient was significant at the 10% level and the coefficient was positive as expected. The positive coefficient indicated the number of religious festivals attended outside the village and attitudes towards more group shrimp

farms on leased or common land were positively correlated, meaning that the more religious festivals a respondent attends, the probability of agreeing with more group shrimp farms on leased or common land increases.

The village of residence coefficient was significant at the 5% level. The positive coefficient indicated that being a resident of Debnagar increases the probability of agreeing with more group shrimp farms on leased or common land.

The coefficient for number of years of formal schooling was negative and significant, indicating as educational achievement increases, the probability of agreeing with more group shrimp farms decreases. Finally, the high household wealth index category was positive and significant at the 10% level. If a respondent was in the high household wealth index category the probability that they will agree with more group shrimp farms increases.

Model 2 Social Capital Principal Components

Model 2 was significant at the 1% level according to the chi-square statistic. The model had a McFadden Pseudo R^2 value of 0.112, and an AIC value of 1.309, and correctly predicted 69.1% of the observations. In total the model yielded five significant coefficients (Table 19). Principal component 3, the principal component defined as networks and connections had a positive coefficient that was significant at the 5% level, which means as Principal component 3 increases (the respondent has more networks and connections) the probability that the respondent agrees with more group shrimp farms increases.

As in the social capital variable model the village of residence had a positive and significant coefficient (P=0.000). Additionally, the number of years of schooling, and high wealth index category both had significant coefficients at the 5% and 10% levels respectively.

Table 19. Probit regression models using "attitudes towards more group shrimp farms on leased or common land" as the dependent variable (N=291)

Variable	Model 1 Estimated coefficients	Model 1 (Std. errors)	Model 1 P- values	Model 2 Estimated coefficients	Model 2 (Std. errors)	Model 2 P- values	Model 3 Estimated coefficients	Model 3 (Std. errors)	Model 3 P- values
Constant	-0.314	(0.434)	0.470	0.232	0.353	0.51	0.226	0.368	0.539
Number of voluntary groups	-0.063	(0.074)	0.398	-	-	-	-	-	-
Management of groups	0.875	(0.238)	0.971	-	-	-	-	-	-
Number of informal village events	0.009	(0.007)	0.229	-	-	-	-	-	-
Number of religious festivals attended	0.050	(0.026)	*0.069	-	-	-	-	-	-
Trust of people inside the village	0.163	(0.187)	0.386	-	-	-	-	-	-
Trust of people outside the village	-0.024	(0.201)	0.909	-	-	-	-	-	-
Participation in new village projects	0.446	(0.327)	0.172	-	-	-	-	-	-
Principal Component 1	-	-	-	0.487	(0.079)	0.537	-	-	-
Principal Component 2	-	-	-	0.097	(0.079)	0.218	-	-	-
Principal Component 3	-	-	-	0.183	(0.080)	*0.022	-	-	-
Cluster A membership	-	-	-	-	-	-	0.354	(0.218)	0.104
Cluster B membership	-	-	-	-	-	-	-0.316	(0.177)	*0.074
Village of residence	0.621	(0.172)	***0.000	0.634	(0.168)	***0.000	0.648	(0.169)	***0.000
Gender of respondent	0.153	(0.236)	0.949	0.113	(0.229)	0.621	0.02	(0.227)	0.931
Age of respondent	-0.008	(0.006)	0.164	-0.007	(0.006)	0.231	-0.007	(0.006)	0.252
Number of years of formal school	-0.049	(0.024)	**0.042	-0.049	(0.024)	**0.041	-0.039	(0.024)	*0.099
Low income category	-0.250	(0.190)	0.189	-0.235	(0.187)	0.208	-0.164	(0.191)	0.390
High income category	0.121	(0.221)	0.585	0.124	(0.216)	0.565	0.181	(0.218)	0.406
Low household wealth index category	-0.184	(0.202)	0.361	-0.163	(0.199)	0.412	-0.190	(0.200)	0.342
High household wealth index category	0.351	(0.201)	*0.080	0.368	(0.198)	*0.064	0.365	(0.198)	*0.065
Log likelihood function	-176.592			-178.387			-176.933		
AIC	1.324			1.309			1.285		
McFadden Pseudo R2	0.121			0.112			0.120		
Prob (Chisqd>value)	0.000			0.000			0.000		
Correct prediction success	69.76%			68.14%			67.70%		

Note: Binary dependent variable derived from 6-point Likert scale. Strongly agree and agree = agree. Neutral, don't know, disagree & strongly disagree = does not agree.
***Significant at 1% **significant at 5% *significant at 10%

Model 3 Cluster Membership

As in the other two cases, Model 3 was significant at the 1% level according to the model chi square statistic. The McFadden Pseudo R^2 value was 0.120 and the model correctly predicted 67.7% of the observations. I used the AIC values to determine which was the best fitting model, smaller values indicating a better fitting model. Model 3 had an AIC of 1.285, which was smaller than Model 1 (1.324), and Model 2 (1.309), thus confirming it is the best fitting of the three models. As a result, I will only be discussing the marginal effects of the independent variables in Model 3.

Model 3 yielded four significant coefficients, and one marginally insignificant coefficient of interest. The coefficient for membership in Cluster B was significant at the 10% level, while the coefficient for membership in Cluster A was marginally insignificant (P=0.104). Cluster B had a negative coefficient, which indicated that being a member of this cluster decreases the respondent's probability of agreeing with more group shrimp farms on leased or common land. Membership in Cluster A had a positive coefficient, which indicated that it was positively correlated with the dependent variable. Membership of Cluster A increases the probability of agreeing with more group shrimp farms on leased or common land.

The marginal effect of Cluster A membership on whether the respondents agree with more group shrimp farms on leased or common land suggests that if a respondent was a member of Cluster A, the probability that they agree with more group shrimp farms increases by 13.8% relative to the reference case, a respondent is a member of Cluster C. However if a respondent was a member of Cluster B, the probability that they will agree with more group shrimp farms decreases by 12.5% relative to the reference case, a respondent is a member of Cluster C (Table 20).

Village of residence had a positive and significant coefficient (P=0.000). The marginal effect implies that if a respondent is from Debnagar the probability of agreeing with more group shrimps farms increases by 25.4% relative to the reference case, a respondent is from Chondinpiri North. Finally, the high household wealth index category had a positive and significant coefficient at the 10% level. The marginal effects implies if a respondent fell into the high household wealth index category the probability of agreeing with more group shrimp farms increases by 14.3% relative to the reference case, a respondent falls into the medium household wealth index category.

Table 20. Marginal effects of the independent variables for probit regression models using "attitudes towards more group shrimp farms on leased or common land" as the dependent variable (N=291)

	Model 1		Model 2		Model 3	
Variable	Marginal effect	Std. error	Marginal effect	Std. error	Marginal effect	Std. error
Constant	-0.120	(0.159)	0.092	(0.140)	0.090	0.146
Number of voluntary groups	-0.025	(0.029)				
Management of groups	0.003	(0.094)				
Number of informal village events	0.003	(0.003)				
Number of religious festivals	0.020	(0.011)				
Trust of people inside the village	0.064	(0.074)				
Trust of people outside the village	-0.010	(0.083)				
Participation in new village projects	0.176	(0.125)				
Principal Component 1			0.017	(0.031)		
Principal Component 2			0.039	(0.032)		
Principal Component 3			0.072	(0.032)		
Cluster A membership[a]					0.138	(0.082)
Cluster B membership[a]					-0.125	(0.070)
Village of residence	0.243	(0.066)	0.242	(0.065)	0.254	(0.064)
Gender of respondent	0.006	(0.094)	0.026	(0.092)	0.008	(0.090)
Age of respondent	-0.003	(0.002)	-0.003	(0.002)	-0.003	(0.002)
Number of years of formal school	-0.020	(0.010)	-0.018	(0.010)	-0.016	(0.009)
Low income category	-0.099	(0.075)	-0.104	(0.074)	-0.065	(0.076)
High income category	0.048	(0.087)	0.049	(0.085)	0.071	(0.085)
Low household wealth index category[b]	-0.073	(0.080)	-0.064	(0.080)	-0.075	(0.079)
High household wealth index category[b]	0.138	(0.077)	0.147	(0.076)	0.143	(0.076)

Note: Marginal effects evaluated at the computed variable means.
[a] The reference case for cluster membership is Cluster C
[b] The reference case is medium household wealth index category

5.3.2 Sub Sample Models

In this section I will present the results of the second set of models that focus on those respondents who are not converting their agricultural land and or polyculture pond area to shrimp ponds because of constraints that can be overcome by group shrimp farming. This group was identified as respondents who ranked lack of household funds/credit and or financial risk as the most important reason for not converting their land. The models used the same specification as the models in the community level analysis.

Model 1 Social Capital Variables

Model 1 was significant at the 5% level with a likelihood ratio test probability of 0.026. The McFadden Pseudo R^2 value was 0.147 and the model correctly predicted 66.9% of the observations. Finally the AIC goodness of fit measure was 1.398. Two social capital variables had positive and significant coefficients, “the number of informal village events attended” (P=0.003), and “the number of religious festivals attended outside the village” (P=0.070). Two demographic variable coefficients were negative and significant, low income and number of years of formal schooling. If a respondent was in the low-income category or was more educated the probability of agreeing with more group managed shrimp farms on leased or common land decreases. Similarly to the results obtained in the community level analysis, the high-income category had a positive relationship with more group shrimp farms on leased or common land (Table 21).

Model 2 Social Capital Principal Components

The model was significant at the 1% level, and had a likelihood ratio test of 0.009, and a McFadden Pseudo R^2 of 0.147. The model had an AIC value of 1.358 and correctly predicted 71.3% of the observations. Principal Component 2, which represents relations of trust, and Principal Component 3, which represents networks and connections both had positive coefficients that were significant (P=0.050), and (P=0.070) respectively. In addition, the village of resident had significant coefficient (P=0.090), as well high household wealth index category (P=0.037).

Model 3 Cluster Membership

Model 3 was significant at the 1% level according the model chi-square statistic. The McFadden R^2 was 0.127, and the model correctly predicted 67.7% of the observations. Model 3 had the lowest AIC value of 1.353 compared to Model 1 (1.398) and Model 2 (1.358). Therefore Model 3 was the best fitting of the three sub sample models; as such I will only discuss the marginal effects of the independent variables for Model 3. Cluster B had a negative coefficient that was significant (P=0.052). The marginal effect of Cluster B membership on attitudes towards more group shrimp farms on leased or common land suggests that if the respondent is in Cluster B the probability of agreeing with more group

shrimp farms decreases by 20%, relative to the reference case, a respondent is a member of Cluster C (Table 22).

The village of residence coefficient (Debnagar) was positive and significant at the 10% level, and the high wealth index category coefficient was positive and significant at the 5% level. The marginal effect implies that if a respondent is from Debnagar the probability of agreeing with more group shrimp farms increases by 23.8% relative to the case a respondent is from Chondinpiri North. Lastly, the high household wealth index category had a positive and significant coefficient at the 5% level. The marginal effects implies if a respondent fell into the high household wealth index category the probability of agreeing with more group shrimp farms increases by 23.8% relative to the reference case, a respondent falls into the medium household wealth index category.

Table 21. Probit regression models using "attitudes towards more group shrimp farms on leased or common land" as the dependent variable (N=136)

Variable	Model 1 Estimated coefficients	Model 1 (Std. errors)	Model 1 P- values	Model 2 Estimated coefficients	Model 2 (Std. errors)	Model 2 P- values	Model 3 Estimated coefficients	Model 3 (Std. errors)	Model 3 P- values
Constant	-0.208	(0.659)	0.752	0.18	0.506	0.722	0.218	0.52	0.674
Number of voluntary groups	-0.089	(0.118)	0.451	-	-	-	-	-	-
Management of groups	0.397	(0.388)	0.306	-	-	-	-	-	-
Number of informal village events	0.031	(0.014)	**0.032	-	-	-	-	-	-
Number of religious festivals attended	0.519	(0.292)	*0.076	-	-	-	-	-	-
Trust of people inside the village	-0.455	(0.334)	0.173	-	-	-	-	-	-
Trust of people outside the village	0.012	(0.045)	0.783	-	-	-	-	-	-
Participation in new village projects	0.089	(0.444)	0.841	-	-	-	-	-	-
Principal Component 1	-	-	-	0.141	(0.121)	0.243	-	-	-
Principal Component 2	-	-	-	0.234	(0.123)	*0.058	-	-	-
Principal Component 3	-	-	-	0.231	(0.129)	0.074*	-	-	-
Cluster A membership	-	-	-	-	-	-	0.269	(0.343)	0.432
Cluster B membership	-	-	-	-	-	-	-0.515	(0.265)	*0.052
Village of residence	0.416	(0.263)	0.113	0.426	(0.257)	*0.098	0.453	(0.251)	*0.071
Gender of respondent	0.052	(0.379)	0.89	0.141	(0.375)	0.706	0.086	(0.352)	0.807
Age of respondent	-0.005	(0.009)	0.563	-0.003	(0.009)	0.701	-0.003	(0.009)	0.750
Number of years of formal school	-0.063	(0.036)	*0.083	-0.054	(0.036)	0.134	-0.038	(0.036)	0.286
Low income category	-0.513	(0.276)	*0.063	-0.439	(0.269)	0.103	-0.362	(0.270)	0.179
High income category	0.052	(0.358)	0.886	0.186	(0.349)	0.594	0.179	(0.348)	0.608
Low household wealth index category	0.173	(0.308)	0.575	0.139	(0.298)	0.641	0.164	(0.299)	0.585
High household wealth index category	0.675	(0.308)	**0.029	0.618	(0.299)	**0.039	0.636	(0.299)	**0.034
Log likelihood function	-79.088			-80.331			-81.072		
AIC	1.398			1.358			1.352		
McFadden Pseudo R2	0.148			0.134			0.127		
Prob (Chisqd>value)	0.026			0.009			0.009		
Correct prediction success	66.91%			71.32%			67.65%		

Note: Binary dependent variable derived from 6-point Likert scale. Strongly agree and agree = agree. Neutral, don't know, disagree & strongly disagree = does not agree.
***Significant at 1% **significant at 5% *significant at 10%

Table 22. Marginal effects of the independent variables for probit regression models using "attitudes towards more group shrimp farms on leased or common land" as the dependent variable (N=136)

	Model 1		Model 2		Model 3	
	Marginal effect	Std. error	Marginal effect	Std. error	Marginal effect	Std. error
Constant	-0.035	(0.046)	0.071	(0.201)	0.086	(0.207)
Number of voluntary groups	0.148	(0.137)				
Management of groups	0.012	(0.006)				
Number of informal village events	0.005	(0.017)				
Number of religious festivals	0.196	(0.106)				
Trust of people inside the village	-0.179	(0.131)				
Trust of people outside the village	0.035	(0.175)				
Participation in new village projects						
Principal Component 1			0.055	(0.047)		
Principal Component 2			0.091	(0.048)		
Principal Component 3			0.090	(0.050)		
Cluster A membership[a]					0.102	(0.126)
Cluster B membership[a]	0.162	(0.102)			-0.200	(0.101)
Village of residence	0.020	(0.149)	0.166	(0.100)	0.177	(0.097)
Gender of respondent	-0.002	(0.003)	0.056	(0.148)	0.034	(0.139)
Age of respondent	-0.024	(0.014)	-0.001	(0.003)	-0.001	(0.003)
Number of years of formal school	-0.199	(0.106)	-0.021	(0.014)	-0.015	(0.014)
Low income category	0.020	(0.139)	-0.171	(0.104)	-0.141	(0.105)
High income category	0.067	(0.117)	0.071	(0.132)	0.069	(0.132)
Low household wealth index category[b]	0.251	(0.107)	0.054	(0.114)	0.063	(0.114)
High household wealth index category[b]	0.138	(0.077)	0.232	(0.105)	0.238	(0.105)

Note: Marginal effects evaluated at the computed variable means.
[a] The reference case for cluster membership is Cluster C.
[b] The reference case is medium household wealth index category.

Chapter: 6 Discussion

In this chapter I explore the segmentation of social capital in the study area and how it affects attitudes towards more group shrimp farms on leased or common land. I begin by discussing the findings from the Principal Component Analysis, followed by a description of the three cluster profiles that emerged from the Hierarchical Cluster Analysis. Then I discuss the outcome of the probit models and analyze the variables that influence attitudes towards more group shrimp farms on leased or common land. Finally, I synthesize the findings of my research to identify households best suited for group shrimp aquaculture development.

6.1 Principal Component Analysis

The three components that emerged from the PCA strongly confirm the conceptualization of social capital as a multidimensional concept. The three components captured the elements of social capital—reciprocity and exchanges, relations of trust, and connectedness in network and groups. The factors that loaded on the first component include: membership in voluntary groups, organization of voluntary groups, and participation in new community projects capturing reciprocity and exchanges. The first component represented community aspects and explained the majority (25.6%) of the variance. The second component indicated the importance of relations of trust within and outside the village and explained 19.9% of the variance. The third component accounts for elements required for developing a network both inside and outside the village, facilitated by the number of informal events attended in the village, and the frequency of traveling outside the village to religious festivals. Component 3 called networking, explained 19.6% of the total variance and captured the connectedness in networks aspect of social capital. Social norms did not emerge as a distinct component, but was implicit in the other components. Component 1 had elements of social norms in the rules that govern participation in voluntary groups and new community projects. Component 3 also had social norms and rules implied

through attendance of informal village events and religious festivals outside the village, where certain protocols are followed, and members of the community demonstrate mutually understood behaviour. Social norms may have emerged as a distinct component if there had been more social capital questions included in the PCA.

6.2 Clusters and Social Capital

6.2.1 Cluster Profiles

The Principal Component Analysis and Hierarchical Cluster Analysis of the social capital variables revealed distinct social groups in the study area. Three clusters emerged from the analysis further validating different forms of social capital. Component 3, (networks and connections) defined Cluster A, all components had a negative relationship with Cluster B, and Component 2 (trust inside and outside the village) defined Cluster C. The different loading of the social capital components on the clusters indicates that each cluster has different social capital characteristics. The different social capital characteristics can be used to create unique cluster profiles. Members of Cluster A are Networkers, members of Cluster B are Marginals, and members of Cluster C are Community organizers.

Networkers

Cluster A *(Networkers)* was the smallest cluster comprising 61 households, or 20.6% of the sample. An average level of participation in voluntary community groups characterized this cluster; they had more memberships in voluntary groups than Cluster B, but fewer memberships than Cluster C. Cluster A was not involved with the management and organization of the voluntary group of which they were members. They were not trusting of fellow village members, and people they encountered when travelling outside the village. As a group they demonstrated high levels of civic engagement by attending the greatest number of informal village events. Members of Cluster A also travelled more frequently outside the village to attend religious festivals. Travelling outside the village allows them to develop external networks, indicating they have the potential to form social relationships and cooperate with people outside their village. Cluster A only moderately participated in new community projects that are initiated in the village. They displayed elements of both bonding and bridging social capital. Cluster A has external social networks and connections, which

allows them access to opportunities and forms of capital beyond the confines of the village. For example, the networks may provide them with access to formal and informal institutions, supply chains and markets, financial capital in the form of loans from external lenders, and human capital through education provided by extension services (linking social capital). The networks developed outside the village allow this group to overcome the pitfalls of extensive bonding social capital, which may hinder development and economic opportunities through the pursuit of narrow interests.

Marginals

Cluster B *(Marginals)* was the largest cluster, comprising 124 households, or 41.9% of the entire sample. Cluster B did not exhibit any strong social capital characteristics. Volunteerism in community groups was extremely low which indicates they have few opportunities for reciprocity and exchanges thus limiting their ability to receive favours and goodwill gestures from the rest of the community. Cluster B had a complete lack of involvement in the organization of voluntary community groups— not a single household had a member on the management committee of a community voluntary group. Out of all the clusters, members in Cluster B attended the least number of informal village events indicating their lack of civic engagement in the village. They travelled infrequently to religious festivals outside the village and were distrusting of fellow villagers, and people they encountered outside the village. They had the lowest level of participation in new community projects initiated in the village. The low levels of participation may be attributable to the low level of trust exhibited by households in this cluster. Onyx and Bullen (2000) suggest that "trust entails a willingness to take risks in a social context based on a sense of confidence that others will respond as expected and will act in mutually supportive ways" (p.24). Based on my findings, households in Cluster B can be classified as marginalized, having limited power or social status within the community. The low levels bonding and bridging social capital indicates that this group is not well embedded in the social fabric of the village.

Community Organizers

Cluster C *(Community organizers)*, comprised 111 households or 39.5% of the entire sample. Cluster C exhibited average to high levels of volunteerism through membership in voluntary community groups. The members of Cluster C were more involved than either

Cluster A or Cluster B in the management or organization of community groups in the village. Cluster C also attended many informal village events, however their civic engagement was not as high as Cluster A's. Members of Cluster C travelled moderately outside the village to attend religious festivals. They were highly active participants in new community projects that were initiated in the village. Members of this cluster demonstrate short-term altruism by giving their time and commitment to voluntary groups. One of the key features that distinguish Cluster C from Cluster A and Cluster B is their trust of people in and outside the of village. The trust of fellow village members may explain their high level of participation in new community projects initiated in the village. Trust simplifies cooperation by reducing transaction costs between people making participation in new community projects less time consuming and costly. Cluster C has a high level of involvement in community life, and this is what Reno, Cialdini and Kallgren (1993) refer to as "prosocial behaviour" (as cited in Onyx & Bullen, 2000, p.24). The members of Cluster C are likely respected decision makers, and powerful in the village.

6.2.2 Comparison to Other Studies

The results of the cluster analysis are comparable to the results of previous studies on social capital that have used the same methodology to analyze similar social capital questions in rural communities in the developing world. Wood (2003) used a PCA and HCA to identify groups with similar social characteristics when assessing the prospects for collective management of Himalayan musk deer. Three clusters emerged in the village, each with a unique combination of social capital. Cluster A, which was termed Participants, was characterized by high participation in community groups and high levels of trust inside and outside the village. The second cluster, which Wood called Neutrals, displayed low levels of social capital and did not appear to be embedded in the village. The last cluster that emerged was the Leaders, whose members were highly involved in decision-making, but expressed low levels of trust inside and outside the village. Sawatsky (2008) also employed a PCA and HCA methodology exploring the role of social capital in influencing the development of nature tourism in Mexico. Three clusters also emerged from the analysis: Cluster A, the Individuals displayed low levels of social capital, Cluster B, the Community orientated group exhibited medium levels of trust, volunteerism, and travelled outside the village, and the final cluster described by Sawatsky (2008) was Cluster C, the Organizers,

who were characterized by high levels of trust inside and outside the village, travelled infrequently outside the village and had low levels of volunteerism (Table 22).

The comparison reveals differences in the cluster characteristics across the three studies. However several common themes emerge. The first common theme is that in each study a cluster exists with low levels of social capital, termed Marginals in my study, Individualists in Sawatsky (2008), and Neutrals in Wood (2003). Differences in wealth levels among clusters are not significant in Sawatsky's study, however Wood (2003) describes the Neutrals in his study as poor, less educated and more reliant on wage labour, mirroring the demographic results of my study, which finds the cluster with low levels of social capital to be the poorest and least educated. Another finding that is common to the three studies is that trust of people outside the village is not associated with frequency of travel outside the village, as might have been expected. In my study, Networkers travelled most frequently outside the village yet did not have high levels of trust. In Sawatsky (2008), Organizers had high levels of trust yet travel outside the village infrequently, while leaders in Wood (2003) travel frequently outside the village and have low levels of trust. In all three studies the distinction between trust inside and outside the community is not apparent; trust appears to be generalized. The clusters that are trusting have high levels of participation in voluntary community groups and projects, which implies that trust may result from repeated cooperation with other village members. This view is supported by the work of Putnam (2000) who finds that greater community involvement results in more trust among community members.

Despite the similarities in cluster characteristics across the three studies, key differences exist. In Sawatsky (2008), and in Wood (2003), the clusters associated with leadership had low to medium levels of volunteerism and participation in voluntary community groups. In contrast the cluster associated with leadership in my study, are the most active participants in voluntary community groups. The difference in findings, despite employing the same methodology, and using very similar social capital questions underscores the importance of considering social capital within the local context.

Table 23. Comparing the characteristics of the clusters from my study, Sawatsky (2008) and Wood (2003)

Study	Cluster characteristics		
My study	***Networkers*** High attendance of informal village events Frequent travel outside the village Low levels of trust inside and outside the village	***Marginals*** Low levels of social capital	***Community organizers*** High levels of participation in voluntary groups Involved in management of groups High levels of trust inside and outside the village Infrequent travel outside the village
Sawatsky (2008)	***Community orientated*** Medium trust of people inside village and Low levels of trust outside the village Medium levels of volunteerism Medium travel outside the village	***Individualists*** Low levels of social capital	***Organizers*** High levels of trust inside and outside the village Infrequent travel outside the village Low levels of volunteerism
Wood (2003)	***Participants*** High levels of participation in community groups High levels of trust inside and outside the village Infrequent travel outside the village	***Neutrals*** Low levels of social capital	***Leaders*** Involved in decision making Low levels of trust inside and outside the village Frequent travel outside the village

6.3 Economic and Cultural Context

Understanding the local economic and cultural context of the region is important to avoid considering social capital in an asocial and ahistorical context (Sawatsky, 2008; Fine, 2002). “Most social scientists recognize that social capital is contingent on political economy, or, in other words, that it is embedded in a wider set of social and political relations that affect social inequality” (Mosse, 2006; Molyneux, 2002 as cited in Classen et al., 2008, p.2403). Booth and Richard (1998) and Portney and Berry (1997) suggest that local context can exert an influence on the type of social capital that emerges. Some studies of social capital have found that wealth and income are positively correlated with a household’s level of social capital (Grooataert, 1999; Narayan & Pritchett, 1997). In contrast other studies find no correlation among social capital and demographic indicators such as age, gender, income or education levels (Onyx & Bullen, 2000). Krishna and Uphoff (2002) in their study of social capital in Rajasthan failed to reveal a relationship between wealth and individual levels of social capital. “Poorer households are as likely to share norms and attitudes associated with higher social capital, as were their richer better-endowed counterparts in the same village” (p.116). The results of my social capital analysis run contrary to some of the findings of Onyx and Bullen (2000), and Krishna and Uphoff (1999). Similar to Portney and Berry (1997) and Booth and Richard (1998), I do find a relationship among levels of social capital and household demographic characteristics. My findings further demonstrate the importance of recognizing the cultural context in a social capital analysis.

Households in Cluster A had a mean household wealth index of 0.24 and a mean total income of 29,538.38 Rs, placing the majority of Networkers (49.2%) in the medium income category, 26.2% in the high-income category, and 24.6% in the low-income category. Cluster A owned 3.62 bighas of agricultural land in the village. They were also the most educated of the clusters, attaining a mean of 6.21 years of formal schooling. Research by Pretty (2002) has revealed that households with greater connectedness and networks tend to have above average incomes, and higher educational achievements. Cluster A households were not the wealthiest households in the district, but they have the potential to improve their livelihoods and wealth status because of access to resources in the form of land and education.

Cluster B had the lowest mean household wealth index and total income of all the three clusters. Close to half (48.8%) of all households in Cluster B were in the low-income category. Education levels in Cluster B were low compared to the other clusters; the households had an average of 5.27 years of formal schooling. Households in Cluster B were not well endowed with land, and only owned 3.14 bighas in total. They were not as well established in the district as the other two clusters, having only lived in the area for an average of 2.17 generations. The lack of resources in the form of wealth, income, land, and education is associated with the low levels of social capital in Cluster B. Volunteering in a community group requires households to devote time to group meetings and activities; Cluster B being the poorest group has less 'leisure time' to devote to voluntary community groups. Due to the livelihood constraints faced by Cluster B, the opportunity cost of volunteering time is too great. The marginalized households in Cluster B may also be purposefully excluded from voluntary group membership due to their low social status. Community groups require their members to contribute to structurally support the group and its activities; however, with low levels of wealth, income, and education the households in Cluster B are unable to do so. The exclusion of the poor from participating in all types of community groups has been well documented in the literature. Thorp et al. (2005), Rai and Buchy (2004), and Agarwal (2001) reported on the exclusion of marginalized community members from group formation and participation. Their lack of financial resources also restricts their ability to travel to religious festivals outside the village, which limits the opportunity to create connections and networks with external actors beyond the village. The lack of opportunity to create external networks and access bridging capital and all its benefits entraps the households in Cluster B in a marginalized state.

Community organizers were the wealthiest of the clusters; the mean household wealth index for households in this cluster was 0.27, and their total mean income of 34560.91 Rs was considerably higher than the mean income of the other two clusters. Households in Cluster C were mostly in the high-income category (33.6%). Cluster C households owned more land, (4.03 bighas), than the other two clusters; they also had significantly larger families, with an average of 6.74 individuals. The Community organizers are well established in the community, and have lived in the district for more generations than the other two clusters. My findings support research that claims there is a positive association between wealth and social capital. Cluster C households were the most active participants in voluntary groups; wealthier households can afford to devote time to activities

such as membership organizations. Frequent participation in community groups or organizations is associated with a greater stock of social capital (Grootaert & Van Bastelaer, 2002).

Research has explored the gender dimensions of social capital, Sawatsky (2008) found a less social capital among women in Mexico, which was hypothesized to be a result of the local culture. Traditionally women in rural India have been systematically disadvantaged in the allocation of subsistence resources, which are controlled by men, including resources used for food, health care, and education (Agarwal, 1997). An investigation of the gender dimensions of social capital in my study was not possible because the data set comprises only 16 female led households, which is too small a sample to make a statistically meaningful comparison to male led households.

6.4 Attitudes Towards Group Shrimp Aquaculture

I focused my analysis specifically on the social capital characteristics of households in the Sundarbans regions. The outcomes of the regression analysis employed in my study provide crucial insight into the social capital characteristics that influence attitudes towards group shrimp aquaculture development.

The results of the community and sub sample probit models confirm that social capital characteristics affect attitudes towards group shrimp aquaculture. All the models produced similar results, correctly predicting an acceptable number of observations. Cluster membership was significant and proved to be the best proxy for social capital. A closer look at the results at the community level reveal that cluster membership affected the probability of agreeing with more group shrimp farms. This is an important finding because the clusters are very different in terms of their social capital characteristics clearly demonstrating that clusters created on the basis of social capital perceive group shrimp aquaculture differently. The coefficient for membership in Cluster A was positive, and almost significant at the 10% level meaning that being a member of this cluster had a positive if, small effect on increasing the probability of agreeing with more group shrimp farms, while membership in Cluster B, which is characterized by low levels of social capital reduces the probability that a respondent agrees with more group shrimp farms.

The coefficient for membership of Cluster B was also significant in the subsample model. The sub sample consisted of respondents who were unlikely to convert their agricultural land and or polyculture area to shrimp pond area, and the majority of households in Cluster A were likely to convert, therefore Cluster A is underrepresented in the sub sample. Given the potential financial rewards associated with shrimp aquaculture, I expected Cluster B, the Marginals, to agree with more group shrimp farms because they are the poorest households and lack the financial resources to practice shrimp farming independently. However, the results of the probit model analysis refuted my initial expectation.

Shrimp farming requires access to financial capital, labor, and land. The comparison of shrimp farmers and households interested in shrimp farming in Section 2.4.1 suggests that shrimp farming is an activity of the wealthy. Shrimp farmers had a higher household wealth index and total income, owned more land, and were more educated than households interested in shrimp farming (Table 2). A reexamination of the demographic characteristics of households in Cluster B revealed they had the lowest household wealth index, smallest family size, and owned the least amount of land (Table 10). The start up costs and risks associated with shrimp farming may be too high for households in Cluster B, even in a group setting, where start up costs and risk is spread across many members. The inability of the poor households in Cluster B to contribute to a group shrimp aquaculture casts doubts on the appropriateness of shrimp aquaculture as a vehicle for poverty alleviation.

Furthermore, households in Cluster B were also more reliant on agriculture and had a higher total income from farm production than the other two clusters (Appendix I). The conversion of agricultural land to shrimp pond area could negatively affect their income. The potential loss of agricultural land may explain their lack of support for more group shrimp farms. Low levels of social capital may also be responsible for Cluster B's lack of support for more group shrimp farms on leased or common land. The households in Cluster B have low levels bonding social capital, which is important for developing a shared sense of identity, common purpose, and trust. Bonding social capital facilitates the sharing of resources such as labour, expertise and financial capital. Thus their ability to cooperate with other members of the community is hindered by their low levels of bonding social capital.

The results of my research challenge the conventional understanding of the relationship between bonding social capital and poverty, and differ from other studies that have examined social capital in communities. Woolcock and Narayan (2000) found that an

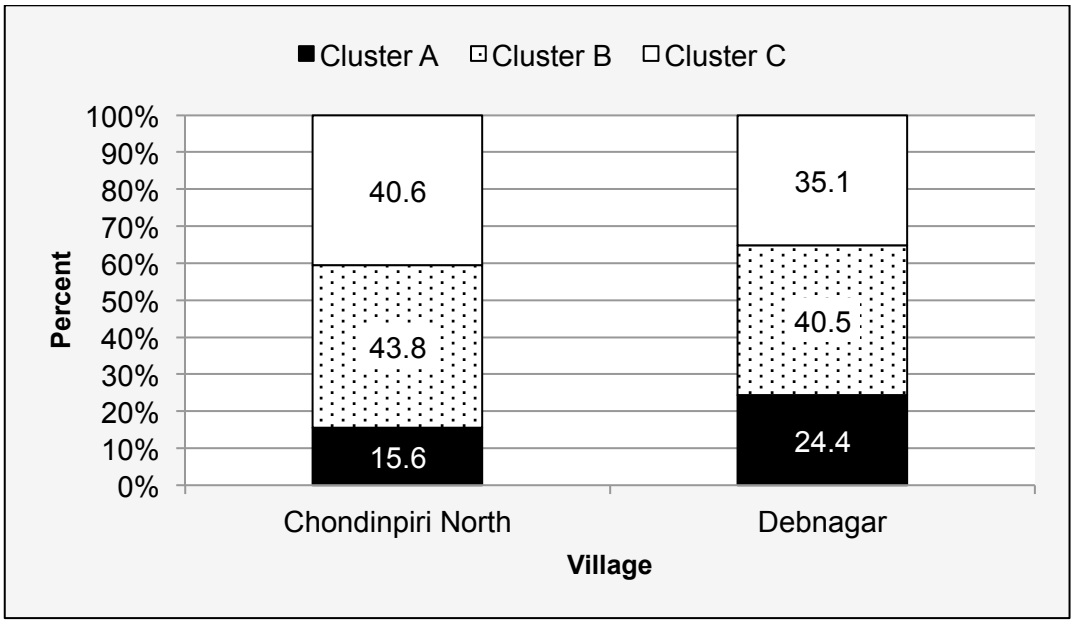
intensive stock of bonding social capital is usually associated with the poor. “The social capital of the poor is the one asset they can potentially draw upon to help negotiate their way through an unpredictable and unforgiving world. As Dordick (1997) astutely notes, the very poor have something left to lose, namely each other” (p.32). The poor rely on bonding social capital in times of hardship, by insulating themselves against the effects of ill health and natural disasters. Their social networks can mean the difference between survival and despair (World Bank, 2011). “Poor people typically have plenty of bonding social capital” (Woolcock, 2000, p. 2). However, emerging social capital research has cast doubts on claims that the poor have plenty of bonding social capital. Studies in the development field are increasingly acknowledging that chronic poverty and structural constraints affect the quantity and quality of bonding social capital possessed by the poor. The lack of bonding social capital among the poor is partly “due to small fragile families, unstable marital arrangements, and wider derogatory perceptions of the poor ” (Cleaver, 2005, p.895). The lack of financial resources required to maintain social relations beyond their immediate household constrains their ability to develop strong stocks of bonding social capital (Cleaver, 2005), concurrently poor family members are unable to provide sustained assistance in times of need (Beall, Crankshaw, & Parnell, 1999). Low levels of bonding social capital among the poor is documented by Korbore, Diaw, and Devas (1999) in their case study in Ghana, where funerals for the poor attended by close relatives have become acrimonious gatherings, punctuated by conflicts rather than opportunities to build social ties. In Tanzania, Cleaver (2005) reveals that even basic neighborly activities that can build bonding social capital such as attending a funeral are a financial burden that cannot be met. These case studies provide a plausible explanation for why the poor households in my study have low levels of bonding social capital, a theory that is also supported by the findings of Wood (2003), who found low levels of bonding social capital associated with the poor. In addition, the poor households in Cluster B also lacked bridging social capital, and had low levels of education. Bridging social capital can be leveraged to access economic opportunities, and education can help develop an entrepreneurial spirit. The few economic networks possessed by the poor hinder their ability to acquire information about potential market opportunities beyond their village (Thorp et al.,2005).

Membership in Cluster A had a positive, if small, effect on increasing the probability a respondent will agree with more group shrimp farms on leased or common land. Cluster A has stocks of bridging social capital. Bridging social capital has exposed Cluster A to the outside world, and given the households a general awareness of economic and market opportunities that exist, such as shrimp aquaculture. The households in Cluster A can leverage their bridging social capital to gain access to the economy outside of their local villages. Their external networks can link them to donors, government agencies and extension services that support development. Entrepreneurial research has emphasized the importance of networks and the social capital inherent in them for the creation of new ventures (Walker, Kogut, & Shan, 1997; Uzzi, 1996; Aldrich & Zimmer, 1986 as cited in Egbert, 2009). Therefore, the networks possessed by Cluster A may have fostered an entrepreneurial spirit among its members explaining why they are more supportive of group shrimp aquaculture. However, it must be noted that Cluster A was not trusting of people in or outside of the village. Trust is particularly important for cooperation to occur, and essential for the formation and success of group shrimp farming.

The high household wealth index category coefficient was positive and significant for both the community level and sub sample analysis, thus being in the high household wealth index category increased the probability of agreeing with more group shrimp farms on leased or common land. The variable was included in the model to explain whether varying levels of wealth affected attitudes towards group shrimp farming. The high household wealth index category was hypothesized to have a negative relationship with the dependent variable; meaning that if a respondent was in a wealthy household the probability of agreeing with more group shrimp farms would decrease because wealthier households would have less to gain from pooling resources than poorer households. I expected households with the high household wealth index category to be capable of pursuing shrimp aquaculture independently, and therefore not support group based approaches. One possible explanation why wealthy households are more likely to agree with more group shrimp farms is because shrimp aquaculture is viewed as a prestigious activity due to the associated financial rewards. “Wealthier households join village organizations for social recognition in the community” (Alesina & La Ferrara, 2002 cited in Katungi, Machethe, & Smale, 2007, p. 170).

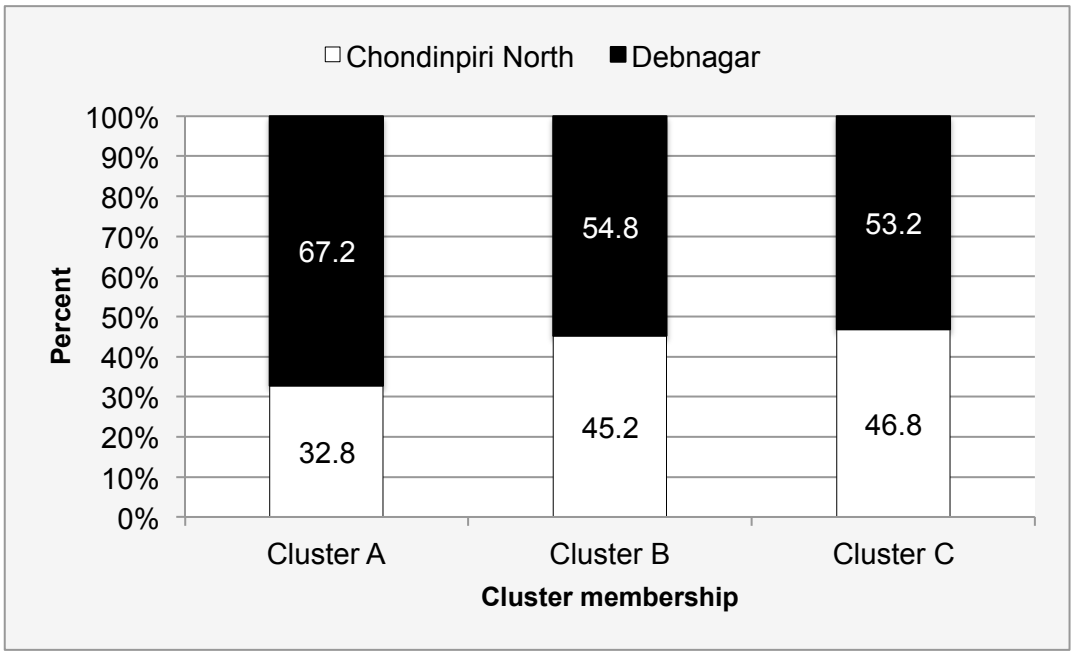
The village of residence coefficient was positive and significant in all the models, confirming that being a resident of Debnagar increased the probability of agreeing with more group shrimp farms on leased or common land compared. A division of village by cluster was conducted and it was found that Debnagar had a higher proportion of residents who were in Cluster A (24.4%), compared to Chondinpiri North, which had 15.6% (Figure 2). As mentioned before, membership in Cluster A increases the probability that a respondent agrees with more group shrimp farms.

Figure 2. Division of communities by clusters



In addition, the division of cluster by village was examined (Figure 3). Cluster A had the highest proportion of households from the village of Debnagar 67.2%. Cluster B and Cluster C had a lower proportion of residents from Debnagar 54.8%, and 53.2% respectively.

Figure 3. Division of clusters by communities



Several demographic variables that were hypothesized to influence agreement with more group shrimp farms were not significant. Either there is no influence at all, or the small sample size of 291 and 136 respondents does not have enough variability for the model to identify statistically significant relationships.

In my study the age of the respondent did not influence attitudes towards group shrimp farming, however in some cases research has shown that age increased the likelihood of participating in social groups that require trust (Haddad & Maluccio, 2003). Group shrimp farming much like social groups or organizations requires a degree of trust in order to facilitate cooperation. Sabates-Wheeler (2002) found that older farmers preferred group farming approaches. As the age of the farmer increased the lower the willingness to engage in entrepreneurial ventures that entailed a degree of risk. Therefore, older farmers may view group shrimp aquaculture favorably.

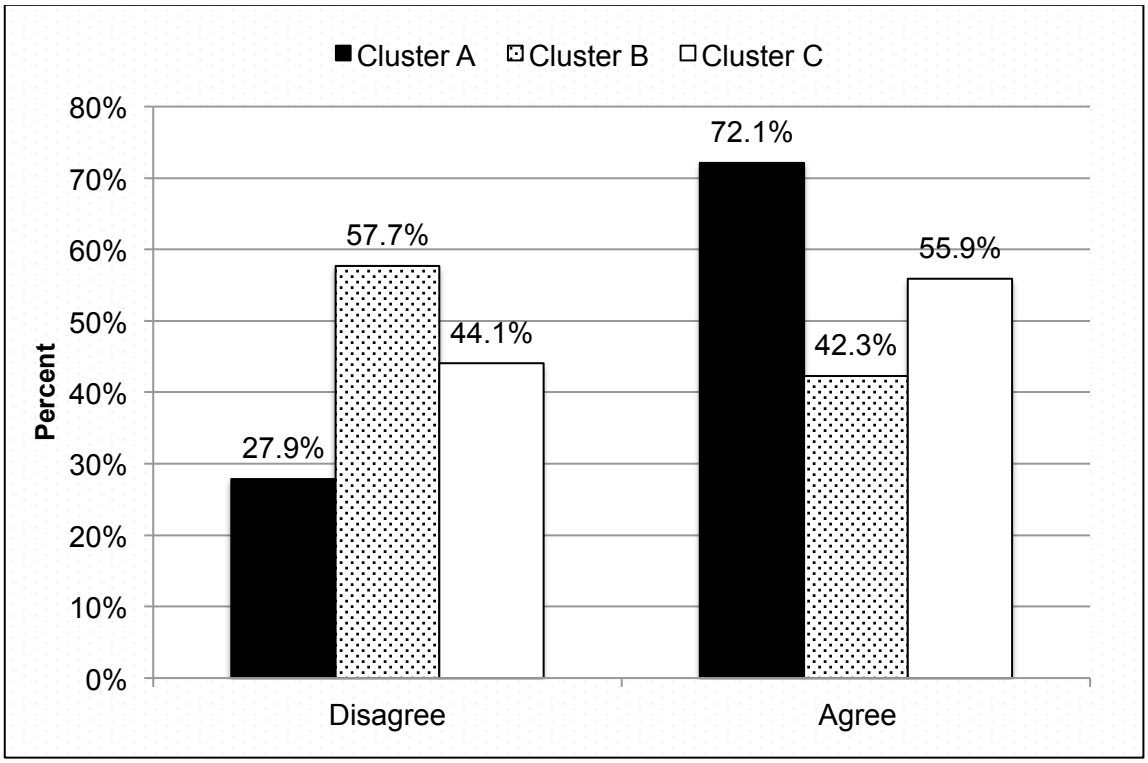
6.5 Identifying Households Suited for Group Shrimp Aquaculture Development

The Principal Component and Hierarchical Cluster Analysis identified three unique groupings in the community, each with very different social capital characteristics. Cluster A and Cluster C are both endowed with social capital, but they hold it in different ways, while Cluster B has the lowest levels of social capital. The regression analysis established that the distinct groupings affected the probability of agreeing with more group shrimp farms on leased or common land at the community wide level, and at the sub sample level. I will use this information to identify the households that are suitable for group shrimp aquaculture development. Members of Cluster A overwhelmingly agreed that there should be more group shrimp farms, (72.1%). Cluster C was neutral, if slightly supportive of group shrimp farms, 55.9% agreed, and 44.1 % disagreed. Households in Cluster B were least supportive, only 42.3% agreed (Figure 4). Based on these findings, households in Cluster A are most suitable, and households in Cluster C can potentially play a role in group shrimp aquaculture development, while households in Cluster B are not suitable for group shrimp aquaculture development.

Cluster A comprised the most educated households, and the advantages of education in relation to group shrimp aquaculture are twofold. Firstly, membership in organizations has a positive association education (Katungi, et al., 2007). Better educated households are more likely to join economically orientated groups, such as agricultural groups, which are geared towards rural interventions (Godquin & Quisumbing, 2006; Haddad & Maluccio, 2003; Alesina & La Ferrara, 2002 as cited in Katungi et al., 2007). Less educated households are reluctant to join groups to avoid being perceived as ignorant by the more educated group members (Godquin & Quisumbing, 2006). Education is a very important element of sustainability; it allows farmers to learn about improved sustainable practices, especially in shrimp aquaculture where participants can learn to prevent some of the damaging effects of shrimp farming that lead to mangrove forest and wetland destruction, coastal erosion, salt water intrusion into soil, surface and ground water, the loss of biodiversity, and reduced fishery catch yields of commercially important species (Bhat & Bhatta, 2004; Bhattacharya & Sarkar, 2003; Hein, 2000; Flaherty & Vandergeest, 1999; Dierberg & Kiattisimkul, 1996).

Households in Cluster A are suited for group aquaculture development because of their stocks of bridging social capital and potential for developing linking social capital. These households frequently travel outside the village and are aware of economic opportunities beyond the boundaries of their community. They possess bridging social capital to develop links with government agencies and NGO's to access resources such as financing, training and other extension services. Cluster A was classified as middle income, 49.2% fell in the middle-income category; therefore pursuing shrimp farming independently may not be a financially feasible option, and entails a large degree of risk. Group shrimp aquaculture is a lower cost, and lower risk opportunity to improve their livelihoods.

Figure 4. Response to question: should there be more group shrimp farms on leased or common land



Note: Strongly disagree, disagree and neutral binned into disagree, and strong agree and disagree binned into agree. (1 non-response N=295).

In addition, households in Cluster A expressed a greater interest in shrimp farming than the other two clusters, 27% of Cluster A were very likely to convert their agricultural land to shrimp pond area for the purpose of shrimp farming in the next 5 years, while only

6.3% of households in Cluster B, and 7% of households in Cluster C were very likely to convert their land. Cluster A's social capital characteristics, demographic indicators, agreement with more group shrimp farms, and willingness to convert their land to shrimp ponds for the purpose of shrimp farming make households in this cluster well suited for group shrimp aquaculture development. However, they do not possess strong bonding social capital which is crucial for cooperation, therefore it is important to consider Cluster C to determine if they have a role to play in group shrimp aquaculture development.

Cluster C members were neutral, if slightly supportive of more group shrimp farms on leased or common land, over half (55.9%) agreed. Cluster C households actively participate in voluntary groups; have high levels of trust and regularly participate in new community projects initiated in the village. Unlike Cluster A, Cluster C is heavily endowed with bonding social capital and has good relations within the community. Bonding social capital is responsible for the creation of trust because it is based on intra community relations; people get a sense of shared identity, which can lead to a sense of solidarity. Trust facilitates cooperation because it lowers the transaction costs of working together. Therefore, community members can invest their labour, land and financial resources in a community managed shrimp farm and this trust and sense of joint ownership will discourage theft and free riding. Cluster C exhibits characteristics that are usually associated with village elites, such as higher wealth, higher income and ownership of large amounts of land. Their active involvement in village affairs also implies that they are likely to be well respected in the community.

Almost half, (44.1%) of households in Cluster C disagreed with more group shrimp farms. Members of this cluster are relatively wealthy and can potentially engage in shrimp aquaculture independently. Their access to wealth in the form of land, labour, and financial capital reduces the appeal of group approaches. Additionally, research by Molnar, Schwartz, and Lovshin (1985) and Johnston and Clark (1982) on group aquaculture development claimed that local elites oppose the collective adoption of aquaculture to secure their social and economic status relative to other members of the community. Households in Cluster C may possess the bonding social capital to be successful in a group approach, but they appear to be disinterested in shrimp farming. The vast majority of the households were reluctant to convert their agricultural land to shrimp pond area for the purpose of shrimp farming, and expressed a neutral attitude towards more group shrimp farms on leased or

common land, therefore households in Cluster C will not play a central role in group shrimp aquaculture development.

The village of Debnagar appears to be a better location than Chondinpiri North for group shrimp aquaculture development. The regression analysis confirmed that residents of Debnagar are more supportive of group shrimp aquaculture on leased or common land. Interest in the activity by the community is important for the success of collective management projects Wood (2003). The importance of community support is further highlighted by White (1989) who compared the outcomes of community based marine resource management projects in two villages in the Philippines, and finds that one project was more successful than the other because of support and involvement of the local community.

The results of the analysis confirm that households in Cluster A are most suitable for group shrimp aquaculture development because of their bridging social capital, support of more group shrimp farms on leased or common land, and interest in converting their agricultural land to shrimp pond area. Households in Cluster C possessed the bonding social capital characteristics to be successful in a group approach, however they lacked an interest in shrimp farming. Households in Cluster A will play a key role in group shrimp aquaculture development, while the role of households in Cluster C will be less prominent. The village of Debnagar is a more suitable location for group shrimp aquaculture development because of local village support for more group shrimp farms on leased or common land.

Chapter: 7 Final Thoughts

In this chapter I discuss the implications of my research and provide recommendations for the development of group shrimp aquaculture in the Sundarbans region. The implications that have arisen must be taken in the larger policy context of poverty reduction and shrimp aquaculture development in India. National aquaculture plans like the Indian *Coastal Authority Act* 2005 aim to encourage the development of the aquaculture industry in rural parts of the country. The Act mandates the Central Government to regulate coastal aquaculture by recommending guidelines to ensure that aquaculture does not have a detrimental effect on coastal environments and protects the livelihoods of people living in coastal areas. In essence, the act annuls the Supreme Court moratorium on practicing shrimp aquaculture development within 500 meters of the high tide line. The Act may have negative consequences for the sustainable development of the shrimp aquaculture industry because the Indian government's policy of supporting large-scale shrimp farms may result in the pursuit of environmentally and socially damaging intensive shrimp aquaculture methods (Knowler et al., 2009). The expansion of intensive shrimp aquaculture in the Sundarbans region will defeat the goals of the Indian government's costal development platform to eliminate poverty.

The amount of non-traditional shrimp cultivation in West Bengal is limited; therefore policy makers have an opportunity to encourage more sustainable shrimp aquaculture development. The results of my study provide a strong argument in favour of more equitable sustainable practices like group shrimp aquaculture. A group shrimp aquaculture approach that utilizes traditional methods of shrimp cultivation reduces environmental impacts, and provides equitable distribution of the economic benefits of shrimp aquaculture. The fact remains that poor households in the Sundarbans region have limited resources to form and sustain successful group shrimp aquaculture. A major policy objective should be to support the development of viable shrimp aquaculture groups in the Sundarbans region.

7.1 Prospects for Group Shrimp Aquaculture Development

Shrimp as an agricultural product is particularly well suited to a group farming approach. Berdegue (2002) found that farmers rarely benefited from group farming of undifferentiated commodities such as wheat and potatoes, but rather the most successful farmers organizations were involved in the cultivation of high value agricultural products. Shrimp is a high value commodity and has been described as pink gold (Rubinoff 2001; Cruz-Torres, 2000).

The capacity of members in the community to engage in group shrimp aquaculture relies on their ability to work together to achieve collective goals. Correctly identifying the households that have the resources to act collectively is paramount to the success or failure of group aquaculture development. My research has demonstrated that social capital is pertinent to group shrimp aquaculture development, in part, because it influences attitudes towards more group shrimp farms on leased or common land. Based on social capital and demographic characteristics, I have identified households in Cluster A as most suitable for group shrimp aquaculture development. Cluster A is endowed with bridging social capital, has access to external networks and market opportunities, and expressed an interest in shrimp farming. Households in Cluster C were not as suitable as households in Cluster A due to less interest in shrimp farming. However it should be noted that households in Cluster C have high levels of bonding social capital, which implies the ability to act collectively. In contrast low levels of both bonding and bridging social capital characterize the households in Cluster B, thus these households do not possess characteristics that are amenable to group shrimp aquaculture development, nor are they interested in shrimp farming.

The disinterest of marginalized households in Cluster B in shrimp farming casts doubts on the appropriateness of shrimp farming as a tool to alleviate poverty. The cost and risks of associated with participating group shrimp aquaculture may be too high for the marginalized village members. Gaining the participation of the chronically poor in agricultural groups has been notoriously challenging. The development field is littered with failed group formation attempts among the poorest community members. Research has demonstrated the incentive for the poor with few assets to participate in groups is minimal because the personal benefits accrued from participation in group approaches are proportional to assets the assets owned or contributed (Wade, 1987; Olson, 1965). Lack of education, capital and social status result in the poor not being able to make “ productive contributions that make

their inclusion worthwhile" (Thorp et al., 2005, p. 913), and in circumstances when the poor have been included in groups they are exploited by more powerful members of the group (Copestake, 2002). This is not to say the eventual inclusion of the poorer members of the community in shrimp aquaculture is impossible, however changes will have to be made to government and NGO development policies to address the root causes of chronic poverty.

Poverty alleviation efforts should focus on forming groups that encourage empowerment, which will strengthen and improve the position of poor members in the social fabric of the community. Successful group formation has been witnessed among the chronically poor, for example, in Columbia, a scavenger cooperative involved in the informal recycling of waste provided its members with an income one and half times the minimum wage. Members were also eligible for loans and scholarships for the cooperative (Medina, 1998 as cited in Thorp et al., 2005). A key feature of the scavenger group in Columbia is the sense of dignity and empowerment instilled by the community. Thorp et al. (2005) refer to scavengers in Asia as "ecoaids" and "street beautifiers".

Although an opportunity exists to develop sustainable group shrimp aquaculture in the Sundarbans, a number of factors can hinder its development. Social capital is important for group formation, however it is only one, albeit important part of the equation. Various recommendations can be made with respect to creating an environment that is conducive for group shrimp aquaculture development.

7.2 Recommendations

My recommendations for group shrimp aquaculture development in the Sundarbans region take into consideration the factors that can be supportive of a group shrimp aquaculture approach. I provide recommendations that are focused on specific shrimp aquaculture practices, the community, and the external environment, within which shrimp aquaculture development is nested.

7.2.1 Shrimp Aquaculture

Encourage the adoption of sustainable traditional and improved traditional farming technology for group shrimp aquaculture

Traditional and improved traditional methods are already practiced in the Sundarbans region and are considered to be environmentally benign except for the use of wild shrimp fry. An economic comparative study in West Bengal of traditional versus non-traditional shrimp farming methods found farmers who employed traditional methods profited more than their counterparts who used non-traditional methods (Bhattacharya, 2009). Furthermore, Gupta et al. (2006) developed a shrimp farm model in the district of 24 Parganas South and discovered that traditional shrimp farms incur lower losses than non-traditional farms. An economic argument exists for promoting sustainable traditional methods of shrimp cultivation for group aquaculture. One of the criticisms of traditional shrimp farming methods is its low productivity, however constraints can be overcome with better management practices, including monitoring water quality and stocking healthy shrimp fry seed.

Site selection and zoning for shrimp farming

The encroachment of shrimp farms on mangrove areas in West Bengal has been minimal (Gupta et al., 2006). However, productive agricultural land is under threat of conversion to shrimp ponds because of the higher profits associated with shrimp farming. Site selection for future shrimp pond construction should be carefully considered because doing so is the most effective method to limit the environmental damages associated with shrimp farming (Kautsky, Ronnback, Tedengren, & Troell, 2000). Appropriate site selection can be a component of enforceable zoning laws that can be created at the village or block level. The shrimp zoning laws will ensure shrimp pond construction does not occur on agriculturally productive land or in mangrove forest areas. Lessons can be learned from the Thai shrimp aquaculture industry, where zoning laws prevent shrimp farms from being constructed in the vicinity of mangrove areas or agricultural land (Anantanasuwong, 2000).

7.2.2 Community

Target interested communities

Local community interest and support is partially responsible for the success or failure of group or community based approaches (see Wood, 2003; White, 1989). Therefore attitudes towards group shrimp farming needs to be assessed before selecting a community to promote and encourage group shrimp aquaculture development. Residents in the village of Debnagar were more supportive than residents in Chondinpiri North of group shrimp farming on leased or common land. Therefore, based on community interest and support, group shrimp aquaculture has a higher chance of success in Debnagar.

Build social capital

Efforts should be made to build more social capital in the community when planning development projects. Isham (2002) states, “investments in social capital should be considered alongside investments in physical and human capital when planning development projects” (p.172). The stream of costs and benefits of investing in social capital must be evaluated. If the benefits from investing in social capital are minimal, then development projects should not be undertaken in areas of low social capital. However, if the ultimate goal of the development project is to improve livelihoods and promote social justice, then investment in social capital may be warranted. Warner et al. (1999) claim that social capital can be intentionally developed through creating fora of interaction.

Social capital building programs targeted specifically at the marginalized community members should be created, for example promoting and supporting inclusive groups. These groups should encourage the empowerment of members because as Thorp et al. (2005) conclude that empowerment can reinforce economic viability. Traditionally discriminated members of society; especially women should be recruited as they rarely participate in group projects. In addition, more powerful members of the community should not be allowed to dominate group affairs, and mechanism that ensure equal representation should be put in place. The purpose of such a mechanism is twofold, firstly it will give the poorer members a voice in decision-making, and secondly it will also prevent the more powerful members in the group from capturing all the private benefits associated with group participation. Examples of inclusive groups that have built social capital among the most marginalized members of society include micro-finance institutions like the Grameen Bank (Dowla, 2006).

Build human capital and long-term capacity

Building human capital in the Sundarbans region is an important step in creating the foundations for successful group shrimp aquaculture development. Farmer field schools can be used to increase social learning, promote better management practices, increase environmental awareness, and promote cooperation. Households can be trained and educated about the importance of healthy mangrove ecosystems for sustainable shrimp aquaculture production (Ronnback, Troell, Zetterstrom, & Babu, 2003). Cooperation in a farmer school will result in greater bonding social capital and learning from other communities involved in shrimp aquaculture, which will foster bridging social capital. For example, In India, the Marine Products Export Development Authority (MPEDA) and Network of Aquaculture Centre's in Asia-Pacific (NACA) created a successful project to build capacity in shrimp farming by organizing poor farmers into aqua clubs. The aqua clubs shared resources, and knowledge, while helping each other adopt better management practices in shrimp aquaculture (Umesh et al., 2010).

7.2.3 External Environment

Bottom up approach to development

The Government of India should create policies to support the grass roots development of group shrimp aquaculture. A bottom up approach to development will require decentralization and devolution of decision-making power to the community. A bottom up approach to group shrimp aquaculture development is advantageous because it acts as a mechanism for enhancing sustainability, improving efficiency, and making development more inclusive, thereby empowering the poor and building social capital. According the World Bank's Poverty Reduction Strategy Paper Sourcebook, decentralized approaches spearheaded by communities, reverses the decision making power, from top down, to bottom up approaches, which allows the poor to play a central role in the outcomes of development initiatives. The poor are given an opportunity to be involved in decision making, deciding how development assistance is allocated, which has direct impacts on the development process (Mansuri, 2004).

Play a central role in group formation

The Government of India and NGO's need to act as catalysts in the initial formation stages of shrimp aquaculture groups by providing support in the form enabling legal frameworks, financial incentives and various extension services. However they should avoid rushing or forcing the formation of groups. If groups do not have a clear purpose they fail to become self-sufficient and rely on handouts from the government. The intervention of the government in establishing shrimp aquaculture groups will create links with the communities. Uphoff (1993) found that nations with established and extensive networks between the government and local communities were characterized by productive agriculture industries, which resulted improved social indicators.

Enforcement of property rights

The National and State Governments need to ensure that property rights are legally enforced in order for group shrimp aquaculture to be successful in the Sundarbans region. This is especially true for the poorer members of society whose property rights may be based on traditional long-term patterns of use. The lack of clear property rights has led to failure of group approaches. In Thailand, Johnson and Forsyth (2002) found that despite the adoption of state legislation to promote community forestry, immigrants who were unable to gain Thai citizenship did not benefit from this because they lacked political entitlements.

Discourage social differentiation

Efforts should be made to create a more egalitarian society in the Sundarbans region because social differentiation creates a highly stratified society resulting in a low probability of successful group formation (Harriss-White, 2002 as cited in Thorp et al., 2005). Studies of group formation and participation in South Asia demonstrated that social stratification is responsible for lack of successful group formation and participation. "This seems especially true where caste and ethnic factors interact with class. For example, in the wet-rice areas of West Bengal, the only 'cooperation' found is a form of forced labor for building roads" (Bandyopadhyay & Von Eschen, 1988 as cited in Thorp et al., 2005, p. 915). The most marginalized members of society; usually the lower castes are disadvantaged and trapped within the confines of their caste with very few options for upward mobility. It is crucial for group shrimp aquaculture development that the government discourages the discrimination

that occurs under the caste system to allow all households in the Sundarbans to escape poverty by sharing the benefits of shrimp aquaculture development.

Creative financing

Efforts should be made to create flexible financing structures for shrimp aquaculture development. Options include informal saving schemes, credit markets, and micro financing. Priority sectors can be created such as, financing for group approaches, the landless, poor, and women (Karmakar, Mehta, Ghosh, & Selvaraj, 2009). Credit and financial systems can be structured to be more favourable towards certain groups, for example micro financing institutions services could require that loans only be given to groups that have a certain proportion of women involved in leadership or management of the group. However the pitfalls associated with institutional credit need to be avoided. The development literature has extensively documented the failings of formal credit programs. Many credit-financing institutions have failed to be viable and effectively deliver credit services (Karmakar et al., 2009). Aquaculture development, in particular has become an activity subsidized by donors, rather than a financially sustainable activity (Stutzman, 2010). The failure of donor driven aquaculture development stems from village elites capturing all the resources meant for the group, thus discouraging poorer members from engaging in aquaculture development. In addition, Moehl (2005) and Molnar (1985) report that farmers groups form for the sole purpose of receiving development aid and once received the groups disband. One way to ensure the success of financing is to make sure groups that are formed have a set objective and purpose before financial support is awarded. Additionally the donation of gifts such as credit, feed, and seed to spur shrimp aquaculture development should be avoided as this hinders self-sufficiency and long-term development.

7.3 Limitations

The main limitation of my research lies in accurately capturing the concept of social capital. The various definitions of social capital are partly responsible for the difficulty in measurement, coupled with use of proxies to measure social capital, " which are an indirect measure of the phenomenon and not the phenomenon itself " (Johnston & Percy-Smith, 2003, p.327). Characteristics are measured and taken as evidence of the existence or nonexistence of social capital. I think the measurement and the study of social capital in general is very context specific, and therefore empirical studies are not easily replicable. "Communities are located in specific geographic, historical, cultural, and ecological landscapes and possess unique socioeconomic characteristics" (Dale, 2005, p.16). This will create a challenge in comparing the results of my findings to other parts of the world. However the general recommendations are applicable to other regions if the context and cultural milieu is taken into consideration. Lastly community survey-based approaches can be challenging because the respondents may have anticipated the questions or had a desire to please the researcher (Mitchell & Slim, 1991). There may also have been a discrepancy between the opinions and attitudes respondents reported, and how they behaved or felt in reality (Borgerhoff-Mulder & Caro, 1987).

7.4 Conclusion

My research assessed the prospects for group shrimp aquaculture development in the Sundarbans region by using social capital information. Three research questions were posed: i) Does social capital vary among households in the Sundarbans? ii) Does social capital affect attitudes towards group aquaculture farming on leased or common land? and iii) Based on social capital characteristics which households are suitable for group shrimp aquaculture development? I used a Principal Component Analysis and Hierarchical Cluster Analysis to explore the variation of social capital in the community, and utilized a regression analysis to determine the factors that influenced attitudes towards group shrimp aquaculture.

The PCA confirmed that social capital is a multidimensional concept, various aspects of social capital loaded onto the Principal components. The three components that emerged from the analysis explained 65.1% of the variance, Component 1—community aspects, Component 2—trust, and Component 3— connectedness and networks. The remaining

unexplained variation could be due to factors outside the scope of my study. Social capital cannot be treated as an ahistorical concept because its emergence depends on the specific cultural context of a locality. Therefore the cultural milieu must be considered in a social capital analysis. The clusters generated from the HCA confirmed that different groupings of social capital exist in the district of 24 Parganas South. Three distinct clusters emerged from the analysis: Cluster A—Networkers, characterized by bonding and bridging social capital, Cluster B—Marginals, characterized by low levels of social capital, and Cluster C—Organizers, who possessed high levels of bonding social capital. The clusters also exhibited different demographic characteristics, and wealth indicators such as income, land owned and level of education were associated with the clusters that possessed high levels of social capital.

A regression analysis using binary probit models was used to determine which factors influenced attitudes towards more group shrimp farms on leased or common land. The explanatory variables were organized in two categories, social capital variables, and demographic variables, which included: village of residence, gender, age, number of years of formal schooling, income category and wealth index category. The results of the regression analysis conclude that a mix of social capital and demographic variables influence attitudes to more group shrimp farms on leased or common land. Cluster membership proved to the best predictor of attitude towards group shrimp farms. Membership in Cluster B decreased the probability of agreeing with more group shrimp farms. The village of residence had a significant coefficient indicating that being a resident of Debnagar increases the probability of agreeing with more group shrimp farms.

Households in Cluster A were deemed most suitable for group shrimp aquaculture development. This conclusion was reached based on Cluster A's favourable attitude towards more group shrimp farms, their interest in converting their agricultural land to shrimp ponds, and their mix of demographic, and most importantly, social capital characteristics. Members of Cluster A were educated and had access to networks outside the village. Households in Cluster C had high levels of bonding social capital, which facilitates cooperation in groups, however they did not appear to be interested in shrimp farming. Households in Cluster B did not possess the demographic or social capital characteristics necessary to be successful in group formation; therefore their role in future group shrimp aquaculture development may be limited.

The goal of the Indian Government is to use shrimp aquaculture to alleviate poverty in rural coastal areas, however the high start up costs of shrimp farming excludes the most marginalized members of the community from partaking in shrimp aquaculture. Poverty alleviation can still be successful even if the most marginalized members remain excluded from group shrimp aquaculture development. Attempts should be made to promote group shrimp aquaculture among households capable of forming and sustaining successful groups. Group formation among households that are willing and financially capable of shrimp farming will contribute to overall poverty reduction in the Sundarbans region.

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Appendices

Appendix A: SHARP Household Survey

ASSESSING ENVIRONMENTAL MANAGEMENT OPTIONS TO ACHIEVE SUSTAINABILITY IN THE SHRIMP-MANGROVE SYSTEM IN THE INDIAN COASTAL ZONE OF THE BAY OF BENGAL
SHARP PROJECT – HOUSELHOLD SURVEY / CHOICE EXPERIMENT QUESTIONNAIRE

HOW TO USE THIS INTERVIEW PROTOCOL

Notes and remarks are [**BOLD AND CONTAINED IN SQUARE BRACKETS AND UPPER CASE**]. These are for your information.

Text marked in **lower case and bold** is for you to "read" to the respondent, but try not to read this protocol word for word. Just try to capture the main ideas within your own natural style of speaking.

INTRODUCTION

[ASK TO SPEAK TO THE HEAD OF HOUSEHOLD (AN ADULT OVER THE AGE OF 21).]

Hello, my name is _____. We are conducting a survey with local residents about shrimp farming in the Indian Sundarbans. We would like to know your personal opinions about the environmental, social and economic impacts of shrimp farming, and the value of the natural resources in your area. This survey is part of a collaborative research project between Simon Fraser University, in Canada, and Jadavpur University and Burdwan University, in India. Everything that you tell us will be kept strictly confidential.

If you could lend me about one hour of your time, we would really value your input. Would you be willing to participate at this time?

[IF YES, CONTINUE SURVEY]
[IF NO, THEN ASK IF IT WOULD BE MORE CONVENIENT TO COME BACK AT ANOTHER TIME]
[IF YES, ARRANGE A MUTUALLY AGREEABLE TIME]
[IF NO, THANK SINCERELY AND END INTERVIEW]

Thank you for agreeing to participate. Where would you like to complete the survey?

Before we start, I would like you to know that your participation is entirely voluntary and that you may choose not to participate at any time. As a reminder, any information that you provide will be kept strictly confidential. The study results will be presented only as summaries in which no personal information is used.

START SURVEY

In the first part of the survey, I will read each question to you. Please listen carefully to the questions and try to answer them as accurately as possible.

[IF THE RESPONDENT WANTS TO READ THE QUESTIONS WITH YOU, LET THEM]

A IDENTIFICATION DATA & DEMOGRAPHIC INFORMATION

A.1. Name of panchayat/village:_____

A.2. Name of location:_____

A.3. Name of the respondent: _____

A.4. Gender of the respondent: Male □ Female □

A.5. Age of the respondent: _____Years

A.6. Have you been surveyed with respect to shrimp farming in the last 12 months? Yes □ No □

A.7. Is the respondent head of the household? Yes □ **[GO TO A.9.]** No □ **[GO TO A.8.]**

A.8. If not head of the household, what is the relationship to head of the household?

A.9. Can the respondent read? Yes □ No □

A.10. Can the respondent write? Yes □ No □

A.11. Year of formal schooling completed: _____Years

A.12. Number of family members in the household: _____ People

Category	Reside in household	Reside elsewhere more than 6 months continuously in a year
Male (15 years and over)		
Female (15 years and over)		
Children (14 years and younger)		

A.13. Was the respondent born in this district **[24 PARGANAS SOUTH]**? Yes □ **[GO TO A.14.]**No □ **[GO TO A.15.]**

A.14. How many generations has the respondent's family lived in this district?____Generations **[GO TO A.16.]**

A.15. If not from this district, which district is the respondent from?_____

Type of home and number owned:

Type of house	Owned	Other	Roof type 1=thatch, 2=tile, 3=tin 4=asbestos, 5 = concrete
Hut			
Kacha			
Paka			
Other			

B. LAND HOLDING & PRODUCTION INFORMATION

B.1. Please complete the following information regarding the household's landholdings:

Land Characteristics	Type	Owned (Bighas)		Leased in (Bighas)	Other (Bighas)
		Own cultivation	Leased out		
Agricultural land	Irrigated				
	Non-irrigated				
Aquaculture land	Polyculture pond				
	Shrimp pond (brackishwater)				
Other land (please specify)					

[IF THE HOUSEHOLD HAS <u>NO OWNED, LEASED IN, OR OTHER LAND</u> IN B.1. GO TO B.14.]

[COMPLETE B.2. – B.12. ONLY IF AGRICULTURAL LAND, AQUACULTURE LAND, OR OTHER LAND IS <u>OWNED</u> BY THE HOUSEHOLD IN B.1. FOR ALL OTHERS GO TO B.13.]

B.2. Has there been a change in the salinity of the soil on the respondent's agricultural land in the last 10 years?

Increased ☐ **[GO TO B.3.]** Decreased ☐ **[GO TO B.4.]** No change ☐ **[GO TO B.4.]** Don't know ☐ **[GO TO B.4.]**

B.3. What does the respondent think is the cause of the increase in soil salinity on the respondent's agricultural land in the last 10 years?

Canal water ingress ☐ Loss of mangroves ☐ Embankment erosion ☐

Other ☐ Don't know ☐ *(please specify)*_____

B.4. Is the respondent close enough to a source of brackishwater **[CANAL/RIVER/ESTUARY, ETC.]** to practise shrimp farming? Yes ☐ No ☐ Don't know ☐

B.5. How far is the closest source of brackishwater?_____ Meters

B.6. Has the household converted any agricultural land to shrimp pond area for the purpose of shrimp farming in the last 10 years? Yes ☐ How much land _____ Bighas No ☐

Stocking density _____ fry/m^2

B.7. Has the household converted any polyculture pond area to shrimp pond area for the purpose of shrimp farming in the last 10 years? Yes ☐ How much pond area _____ Bighas No ☐ Stocking density _____ fry/m^2

[IF "YES" TO B.6. AND/OR B.7. GO TO B.8. IF "NO" TO B.6. AND B.7. GO TO B.9.]

B.8. What are the reasons for converting land/ponds to shrimp pond area for the purpose of shrimp farming **[MORE THAN ONE REASON IS ACCEPTABLE]**? Please rank the reasons **[1=MOST IMPORTANT]**.

Reason		Rank	Reason		Rank
Decreasing yields from agricultural land and/or polyculture pond area	☐		Access to credit for shrimp farming	☐	
Lower labour cost than agriculture and/or polyculture	☐		Higher profit margin from shrimp farming	☐	
Access to technical advice for shrimp farming	☐		Other *(please specify)*	☐	

B.9. How likely is it that the household will convert any agricultural land and/or polyculture pond area to shrimp pond area for the purpose of shrimp farming in the next 5 years?

Very likely ☐ **[GO TO B.10.]** More likely than unlikely ☐ **[GO TO B.10.]**

More unlikely than likely ☐ **[GO TO B.12.]** Very unlikely ☐ **[GO TO B.12.]**

B.10. How much agricultural land and/or polyculture pond area will the household convert?_____Bighas

B.11. What will the stocking density be of the converted agricultural land and/or polyculture pond area?

5-14 fry/m^2 (traditional/extensive) ☐ **[GO TO B.13.]** 15-19 fry/m^2 (semi-intensive) ☐ **[GO TO B.13.]** 20 fry/m^2 and up (intensive) **[GO TO B.13.]** Don't know ☐ **[GO TO B.13.]**

B.12. Why is the household **"More unlikely than likely"** or **"Very unlikely"** to convert agricultural land and/or polyculture pond area to shrimp pond area for the purpose of shrimp farming in the next 5 years **[MORE THAN ONE REASON IS ACCEPTABLE]**? Please rank the responses **[1=MOST IMPORTANT]**.

Reason		Rank	Reason		Rank
Lack of household funds or access to credit	☐		Government regulations	☐	
Financial risk	☐		Lack of technical knowledge or access to technician	☐	
Lack of access to brackishwater source	☐		Not interested	☐	
Risk of disease in shrimp	☐		Other *(please specify)*	☐	

B.13. Please fill out the following household production information for the last 12 months (agriculture only).

Type	Production in last 12 months (Quintals)			Total income from amount sold (Rupees)
	Total produced (Quintals/Leafs)	Amount sold (Quintals/Leafs)	Amount consumed from own production (Quintals)	
Rice (Quintals)				
Betel (Leafs)				
Vegetables				
Other *(please specify)*				

B.14. How much rice did the household purchase in the last 12 months?_____Quintals

B.15. Does the household own any livestock? Yes ☐ **[GO TO B.16.]** No ☐ **[GO TO C.1.]**

B.16. Please fill out the following livestock information:

Livestock	Number owned
Cattle	
Goat/Sheep	
Poultry/Ducks	
Other (please specify)	

C. OTHER LIVELIHOOD & INCOME GENERATION

C.1. **SURE YOU ACCOUNT FOR EACH ADULT MEMBER OF THE HOUSEHOLD 15 YEARS OR OLDER. MAKE SURE YOU ACCOUNT FOR ALL THEIR ACTIVITIES, SINCE ADULT MEMBERS OF THE HOUSEHOLD MAY BE INVOLVED IN MORE THAN ONE ACTIVITY]**:

Type	Activity	Respondent	No. of other household members participating	Total income to household in last 12 months (Rupees)
C.1.1. Agriculture related	Farm labour	☐		
C.1.2. Aquaculture related	Shrimp farming	☐		
	Shrimp fry collection (by boat)	☐		
	Shrimp fry collection (on foot)	☐		
	Polyculture pond farming	☐		
	Aquaculture labour	☐		
	Mixed-use farming (polyculture component)	☐		
C.1.3. Fishing related	Artisanal fishing	☐		
	Industrial fishing	☐		
	Fishing labour	☐		
	Other fishing related *(please specify)*	☐		
C.1.4. Remittances	**Refer to A.12.**	☐		
C.1.5. Other	Landowner (rental income)	☐		
	Shopkeeper/Merchant/Trader	☐		
	General wage labour	☐		
	Government related	☐		
	Pension	☐		
	Transport related	☐		
	Other *(please specify)*	☐		

[IF SHRIMP FRY COLLECTION CHECKED IN C.1.2., COMPLETE SECTION D.]

D. SHRIMP FRY COLLECTION DATA & INFORMATION

D.1. Please complete the following information about household fry collection by boat **[IF APPLICABLE]**:

Season	No. of boats	Total no. of days per week (all boats)	Total no. of fry collected per week (all boats)
Pre-monsoon (Mar – June)			
Monsoon (July – Oct)			
Post-monsoon (Nov – Feb)			

D.2. Please complete the following information about household fry collection on foot **[IF APPLICABLE]**:

Season	No. of people	Total no. of days per week (all persons)	Total no. of fry collected per week (all persons)
Pre-monsoon (Mar – June)			
Monsoon (July – Oct)			
Post-monsoon (Nov – Feb)			

D.3. Has the number of shrimp fry collectors changed in the last 5 years?

Increased ☐ Decreased ☐ No change ☐ Don't know ☐

D.4. Has there been a change in the abundance of shrimp fry in the last 5 years?

Increase in abundance ☐ **[GO TO D.6.]** Decrease in abundance ☐ **[GO TO D.5.]** No change ☐ **[GO TO D.6.]** Don't know ☐ **[GO TO D.6.]**

D.5. What does the respondent think is the cause of the decrease in abundance of shrimp fry **[MORE THAN ONE CATEGORY IS ACCEPTABLE]**?

Too many fry collectors ☐ Offshore trawlers ☐ Loss of mangroves ☐Other☐ ***(please specify)***

D.6. Is there any by-catch when shrimp fry are collected? Yes ☐ **[GO TO D.7.]** No ☐ **[GO TO D.8.]**

D.7. What happens to the by-catch?

Thrown back into the water alive ☐Discarded on shore as waste ☐ Other ☐ *(please* ***specify)***_____

D.8. How are the shrimp fry sold?

Local market ☐ Middleman/agent ☐ Directly to shrimp farms ☐

Other ☐ *(please specify)*_____

D.9. Do any member(s) of the household have health problems they believe may be caused by shrimp fry collecting?

Yes ☐ **[GO TO D.10.]** No ☐ **[GO TO E.1.]** Don't know ☐ **[GO TO E.1.]**

D.10. What types of health problems do any member(s) of the household experience **[MORE THAN ONE CATEGORY IS ACCEPTABLE]**?

Skin ☐ Eyes ☐ Gynaecological ☐ Other ☐*(please specify)*_____

E. NATURAL RESOURCE USE

E.1 How far is the closest mangrove forest on foot or by boat?_____ Meters

E.2. In the past, did any members of the household use mangrove forests for subsistence or income generation purposes? **Yes** ☐ **[GO TO E.3.]** **No** ☐ **[GO TO E.4.]**

E.3. For what purposes did members of the household use mangrove forests in the past **[MORE THAN ONE CATEGORY IS ACCEPTABLE]**?

Use	Subsistence	Income generation
Biomass fuel	☐	☐
Building material	☐	☐
Food	☐	☐
Medicine	☐	☐
Other (please specify)	☐	☐

E.4. Do any members of the household currently use mangrove forests for subsistence or income generation purposes? **Yes** ☐ **[GO TO E.5.]** **No** ☐ **[GO TO E.6.]**

E.5. For what purposes do members of the household currently use mangrove forests **[MORE THAN ONE CATEGORY IS ACCEPTABLE]**?

Use	Subsistence	Income generation
Biomass fuel	☐	☐
Building material	☐	☐
Food	☐	☐
Medicine	☐	☐
Other (please specify)	☐	☐

E.6. Has the area covered by mangrove forests changed near the respondent's village in the last 10 years?

Increased☐ Decreased ☐ No change ☐Don't know ☐

E.7. Is there a social forestry program near the respondent's village? Yes ☐ **[GO TO E.8.]** No ☐ **[GO TO E.9.]**

E.8. What impact has the social forestry program had on your household?

Many benefits ☐ Some benefits ☐ No effect ☐ Somewhat harmful ☐ Very harmful ☐

Don't know ☐

E.9. Overall, what impact has the protection of mangrove forests had on your household **[E.G. FOREST RESERVE, WILDLIFE SANTUARIES, ETC.]**?

Many benefits ☐ Some benefits ☐ No effect ☐ Somewhat harmful ☐ Very harmful ☐

Don't know ☐

E.10. Does the household get its potable water from a borehole/hand-pump?

Yes ☐ **[GO TO E.11.]** No ☐ **[GO TO E.13.]**

E.11. Has there been a change in salinity of the potable water from the borehole in the last 10 years?

Increased ☐ **[GO TO E.12.]** Decreased ☐ **[GO TO E.13.]** No change ☐ **[GO TO E.13.]**

Don't know ☐ **[GO TO E.13.]**

E.12. What does the respondent think is the cause of the increase in potable water salinity?

Canal water ingress ☐ Loss of mangroves ☐ Embankment erosion ☐

Other ☐ Don't know ☐ *(please specify)*_____

E.13. Has there been a change in the level of competition between different natural resources users in the area in the last 10 years? **[GIVE EXAMPLES, E.G. BETWEEN SHRIMP FRY COLLECTORS, FISHERMEN, AGRICULTURAL FARMERS, SHRIMP FARMERS, ETC.]**

Increased ☐ **[GO TO E.14.]** Decreased ☐ **[GO TO F.]** No change ☐ **[GO TO F.]** Don't know ☐ **[GO TO F.]**

E.14. What does the respondent think is the source of the increase in competition between different natural resource users **[MORE THAN ONE CATEGORY IS ACCEPTABLE]**? Please rank the responses **[1=MOST IMPORTANT]**.

Reason		**Rank**	**Reason**		**Rank**
Population growth	☐		Limited access to resources	☐	
Decline in availability of resources	☐		Other *(please specify)*	☐	

CHOICE EXPERIMENT SECTION FOR SHRIMP-MANGROVE SURVEY

We are now near the end of the survey. I think that you will find the next section particularly interesting, because you will have an opportunity to choose between different possible options for development in the Indian Sundarbans.
[!!!CRITICAL!!! IT IS ABSOLUTELY ESSENTIAL THAT YOU USE THE CORRECT VERSION OF THE CHOICE SETS. IF THE CORRECT SET IS NOT USED, WE WILL NOT BE ABLE TO ANALYSE THE RESULTS AT ALL!!! DOUBLE CHECK THAT THE VERSION OF THE CHOICE SET YOU SELECT MATCHES THE VERSION NUMBER CONTAINED IN THE SURVEY YOU ARE USING]

Most people agree that to improve the conditions of people living in the Sundarbans more economic development is needed. One development alternative is shrimp farming using improved methods (feed supplements, higher stocking rates, year round production, etc.), as opposed to traditional methods involving some form of polyculture. Improved shrimp farming increases the incomes of shrimp farmers and also creates employment for shrimp fry collectors, hatchery workers, wage earners, input suppliers, etc. However, in other regions where improved shrimp farming is practised on a large scale, there have been detrimental environmental effects. These include the destruction of mangroves and/or the conversion of land for shrimp pond construction, land degradation, pollution, and salinization of groundwater and soil.

I will now show you a card that presents different activities that are associated with improving the conditions of people living in the Sundarbans. Most of these activities require some form of funding. Since funds for development are limited, only a portion of these activities could be undertaken.
[INTERVIEWER: HAND RESPONDENT THE CARD WITH 5 ATTRIBUTES AND EXPLAIN EACH ATTRIBUTE]

- **<u>Mangrove forest area near villages</u> – Protection and replanting programs (social forestry) can increase the area of mangroves near villages. Increases in mangrove area could range from 0% to 20% of the current level.**

- **<u>Number of improved shrimp farms</u> - Limiting the maximum number of shrimp farms can help reduce the negative impacts associated with improved shrimp farming. The number of improved shrimp farms range from 1000 to 5000.**

- **<u>Employment in shrimp fry collection</u> - By investing in hatcheries to increase the supply of shrimp seed, the number of shrimp fry collectors is likely to decline. Employment in shrimp fry collection ranges from 20,000 to 60,000.**

- **<u>Credit for income generation activities</u> - Micro-credit programs with modest repayment conditions would be made available to households for income generating activities, such as small-scale cash crop production, honey production, mushroom cultivation, purchase of livestock, etc. The share of households receiving credit assistance ranges from 0% to 20%.**

- **<u>Household contribution</u> – Most development funding would come from outside sources (e.g. government development funds, private investments, development projects, etc.). A small, <u>one-time</u> contribution would come from local households (through panchayat payments, house tax, etc.). Assume that these contributions from local households are made into a separate fund controlled by a specially formed NGO or community group. The contributions would <u>NOT</u> go into general government revenues. The <u>one-time</u> household payment ranges from Rs 0 to Rs 100.**

[INTERVIEWER: HAND RESPONDENT THE CHOICE CARD BUNDLE, WITH THE FIRST CARD ON TOP. RECORD THE COLOUR OF THE BUNDLE, AND COMPLETE THE RESPONSES IN THE SPACE BELOW.]

Card colour

Blue (block 1) ☐ Pink (block 2) ☐ Green (block 3) ☐
Yellow (block 4) ☐ White (block 5) ☐
Blue (block 6) ☐ Pink (block 7) ☐ Green (block 8) ☐
Yellow (block 9) ☐ White (block 10) ☐

Now I want you to examine these approaches in more detail. Each card describes a scenario of management approaches for mangroves and shrimp farming; each approach may be more or less favourable for you. On each card, there is the current situation, and two possible other scenarios. You will need to look at the levels in each option and consider the trade-offs carefully. Here are several cards depicting pairs of scenarios with different amounts of each option.

QUESTION:

Please select your most preferred option. You may select Scenario 1, Scenario 2, the Current Situation, or you may tell us that 'None of these is acceptable' to you.

	Option 1	**Option 2**	**Status Quo**	**None of these options is acceptable**
Card 1	☐	☐	☐	☐
Card 2	☐	☐	☐	☐
Card 3	☐	☐	☐	☐
Card 4	☐	☐	☐	☐
Card 5	☐	☐	☐	☐

G. ATTITUDINAL INFORMATION

Please ask the respondent to answer the following questions about their attitude towards shrimp aquaculture, environmental conditions, social conditions, and government policy.

Statements	Opinion					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
G.1. I am concerned about the conversion of paddy land to shrimp farms.	☐	☐	☐	☐	☐	☐
G.1.2. If shrimp farming has negative effects on the environment, shrimp farmers should pay for any damages or correction.	☐	☐	☐	☐	☐	☐
G.1.3. There should be more community managed or cooperative shrimp farms on leased or common land.	☐	☐	☐	☐	☐	☐
G.1.4. Some kinds of fish and shrimp are more abundant when there are mangrove forests nearby.	☐	☐	☐	☐	☐	☐
G.1.5. Mangrove forests mitigate the destructive force of natural disasters (flooding, cyclones, waves, etc.) and should be preserved.	☐	☐	☐	☐	☐	☐
G.1.6.Villagers' access to mangrove forests to collect forest products (fuelwood, honey, building materials, etc.) should be increased.	☐	☐	☐	☐	☐	☐
G.1.7. Shrimp fry collection decreases the number of fish available for fishers to capture.	☐	☐	☐	☐	☐	☐
G.1.8. I am concerned about the damage to the embankments caused by shrimp fry collectors.	☐	☐	☐	☐	☐	☐

H. HOUSEHOLD AWARENESS/PARTICIPATION/SOCIAL CAPITAL

I would like to ask you some questions about your village and your involvement in your village.

H.1. Most communities have a number of clubs or societies. How many voluntary community groups, clubs or societies do you regularly participate in? _____ **[GIVE EXAMPLES, E.G. SELF-HELP GROUPS, ETC.]** **[IF "NONE" GO TO H.3.]**

H.2. Are you on a management or organising committee for any of these groups? Yes ☐ No ☐

H.3. Overall, how would you rate the performance of the groups in which you participate?

Very poor o Poor o Neutral o Satisfactory o

Very satisfactory o

H.4. How many informal village events have you attended in the last 12 months? _____ Events

(e.g. traditional dances, jatra, cricket/soccer, village meetings, birth/marriage/funeral ceremonies, etc.)

H.5. Do you feel most people within the village can be trusted?

Almost no-one o A few people ☐ Most people o Almost everyone ☐

H.6. Have you attended any religious festivals in the last 12 months that required you to travel outside the village? Yes o How many have you attended Religious festivalsNo **o**

H.7. When you travel outside the village, do you feel most people you encounter can be trusted?

Almost no-one o A few people ☐ Most people o Almost everyone ☐

H.8. Generally, do you participate in new community projects that are initiated in your village?

Never o Rarely o Sometimes o Usually ☐ Always o

Appendix B: Land and Income

Land owned	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Owned irrigated land - own cultivation (bighas)	.00	10.00	.7703	1.24683
Owned irrigated land - leased OUT (bighas)	.00	2.00	.0118	.13288
Leased IN irrigated land (bighas)	.00	10.00	.1427	.82010
Other irrigated land (bighas)	.00	4.00	.1005	.51527
Owned non-irrigated land - own cultivation (bighas)	.00	20.00	2.1777	3.21915
Owned non-irrigated land - leased OUT (bighas)	.00	10.00	.0693	.69338
Leased IN non-irrigated land (bighas)	.00	7.00	.1706	.76165
Other non-irrigated land (bighas)	.00	9.00	.1291	.67148
Owned polyculture pond - own cultivation (bighas)	.00	3.00	.7504	.64301
Owned polyculture pond - leased OUT (bighas)				
Leased IN polyculture pond (bighas)	.20	3.00	1.1714	1.14085
Income generation	Minimum	Maximum	Mean	Std. Deviation
Total income from betel sold (rupees)	900.00	231000.00	27294.17	33094.24
Total income from vegetables sold (rupees)	80.00	60000.00	5909.32	8520.19
Total farm income	80.00	291000.00	19711.47	32693.42
Total income from other agriculture production (rupees)	100.00	5000.00	1350.61	1176.28
Total income from rice sold (rupees)	800.00	25000.00	6182.35	5059.51
Cattle owned	.00	12.00	2.6318	1.96310
Total livestock owned	0.00	204.00	8.75	15.12

Appendix C: Livelihood Activities

Respondent's primary activity	Frequency	Percent	Valid Percent
Farm labour	103	34.8	39.2
Shrimp farming	4	1.4	1.5
Shrimp fry collection by boat	5	1.7	1.9
Shrimp fry collection on foot	8	2.7	3.0
Polyculture pond farming	112	37.8	42.6
Aquaculture labour	6	2.0	2.3
Mixed-use farming (polyculture component)	1	.3	.4
Fishing labour	1	.3	.4
Landowner	1	.3	.4
Shopkeeper/merchant/trader	3	1.0	1.1
General wage labour	4	1.4	1.5
Government related	4	1.4	1.5
Other	11	3.7	4.2
Respondent's secondary activity	Frequency	Percent	Valid Percent
Shrimp farming	1	.3	.6
Shrimp fry collection by boat	7	2.4	4.1
Shrimp fry collection on foot	6	2.0	3.5
Polyculture pond farming	63	21.3	36.8
Aquaculture labour	7	2.4	4.1
Mixed-use farming (polyculture component)	5	1.7	2.9
Artisinal fishing	1	.3	.6
Industrial fishing	1	.3	.6
Fishing labour	9	3.0	5.3
Other fishing related	2	.7	1.2
Landowner	3	1.0	1.8
Shopkeeper/merchant/trader	22	7.4	12.9
General wage labour	22	7.4	12.9
Government related	6	2.0	3.5
Pension	3	1.0	1.8
Transport related	1	.3	.6
Other	12	4.1	7.0

Appendix D: Demographic Characteristics of Shrimp Farmers and Those Interested in Shrimp Farming

Demographic variables	Interested in shrimp farming/ Shrimp Farmers	N	Mean	SD	Sig.
Household wealth index	Interested in shrimp farming	51	0.24	0.15	**0.000**
	Shrimp farmer	88	0.35	0.17	
Total income	Interested in shrimp farming	51	30498.04	31134.43	**0.001**
	Shrimp farmer	88	59448.01	52898.76	
Number of years of schooling	Interested in shrimp farming	51	6.82	3.96	**0.010**
	Shrimp farmer	88	8.47	3.29	
Total land owned	Interested in shrimp farming	51	3.87	3.50	**0.003**
	Shrimp farmer	88	6.03	4.30	
Distance from brackishwater	Interested in shrimp farming	51	360.80	498.28	**0.027**
	Shrimp farmer	87	192.24	237.98	

Appendix E: Shrimp Farming Technology

Shrimp Farming system	Main Characteristics[a]	Stocking density fry/m² [b]
Purely traditional	Traditional aquaculture A variety of polyculture systems with a large component of miscellaneous fish and a small component of shrimps. Ponds are filled with tidal water with no control over quality and quantity of stocking. Average production is low and ranges from 200 to 500 kg/ha/year of mixed sizes and species. The most well-known of these systems are the bheries system of West Bengal and the paddy-cum-aquaculture systems of Kerala, Goa, and Karnataka.	0 to 4.49
Improved traditional	Improved traditional systems Traditional ponds stocked with shrimp seed. Most of the limitations of the production system remain: the entrance of predators and competitors, insufficient pond depths, and full dependence on natural food in the ponds. Nevertheless, overall yields increase to 300 to 600 kg/ha/year, with one-third of the crop being shrimps.	4.5 to 6.49
Extensive	Extensive systems Extensive systems are usually square ponds with excavated walls some 1.5 to 2 in m height. Water is generally supplied by pumping from canals or creeks. Stocking is done at rates of 2–5/m2, with one or two crops a year. The farmers use pond-side prepared feed from clams, fishmeal, and oilcake. Crop yields are of the order of 300 to 700 kg/ha, with large variations among the different ponds.	6.5 to 14.49
Modified extensive	Modified extensive systems Laid out as extensive systems, but involving pond preparation with tilling, liming, and fertilization and application of higher stocking densities, of the order of 5 to 10/m2. Farmers often use a combination of local feeds and locally produced or imported pellet feeds. One or two crops of 600 to 1100 kg/ha can be harvested per year.	N/A
Semi-intensive	Semi-intensive systems The ponds are 0.25 to 1.0 ha in size, with regular supply and drainage canals and controlled water exchange. Stocking densities are of the order of 15–30/m2. Imported pellet feeds are used, and application of drugs and chemicals is common. Average yields of semi-intensive farms in India are about 2200 kg/ha/year, with an average of 1.2 to 1.5 crops a year (ADB/NACA 1998).	14.5 to 19.49
Intensive	Intensive systems The ponds are 0.25–0.50 ha in size, with four aerators per pond and a central drainage system to remove accumulated sludge. Management practices, including salinity manipulation, are as for semi-intensive systems, but with a stocking density of 30 to 80/m2. Yields of over 8000 kg/ha are possible, but the actual average yield in India is about 4500 kg/ha/year, with 1.6 crops per year.	> 19.5

Source [a] ADB/NACA (1998)

Source [b] Gupta et al. 2006

Appendix F: Total Variance Explained from the PCA of Social Capital Variables

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.134	30.48	30.48	2.134	30.482	30.482	1.794	25.625	25.625
2	1.314	18.78	49.26	1.314	18.778	49.260	1.393	19.898	45.523
3	1.110	15.86	65.12	1.110	15.861	65.120	1.372	19.598	65.120
4	.828	11.83	76.95						
5	.593	8.48	85.43						
6	.570	8.14	93.57						
7	.450	6.43	100.00						

Appendix G: Rotated Component Analysis of Social Capital Variables

Social capital variables	Component 1	Component 2	Component 3
Number of voluntary community groups, clubs or society respondent regularly participates in	**0.797**	0.010	0.219
Is respondent involved in management/organization	**0.786**	0.115	0.115
Participation in new community projects	**0.644**	0.079	-0.056
Trust in people in the village	0.185	**0.808**	-0.036
Trust in people outside the village	-0.006	**0.840**	0.078
Number of informal village events	0.297	-0.068	**0.760**
Number of religious festivals outside village	-0.059	0.103	**0.850**

Appendix H: Agglomeration Schedule for Hierarchical Clusters

Stage	Cluster Combined		Coefficients	Differences between the coefficients
	Cluster A	Cluster B		
291	1	61	353.547	44.370
292	1	25	405.081	51.534
293	4	23	541.752	136.671
294	1	2	692.951	151.199
295	1	4	885.000	162.049

Appendix I: Descriptive Data for Each Cluster

ANOVA, Chi- squared & Post hoc tests

Variable	Cluster	Mean	SD	df	F	P
Household wealth index (adults, owned land, cattle)	Cluster A	0.24	0.12	2, 293	4.339	0.014
	Cluster B	0.21	0.14			
	Cluster C	0.27	0.19			
	Total	0.23	0.16			
Total income in Rupees	Cluster A	29538.38	37392.38	2, 291	1.128	0.325
	Cluster B	26985.20	34027.24			
	Cluster C	34560.91	44044.20			
	Total	30349.39	38751.02			
Total livestock	Cluster A	10.82	14.70	2, 293	2.374	0.095
	Cluster B	6.52	6.21			
	Cluster C	10.09	21.03			
	Total	8.75	15.12			
Respondent's age	Cluster A	44.73	14.73	2, 291	0.558	0.573
	Cluster B	42.52	15.23			
	Cluster C	42.68	12.17			
	Total	43.03	14.02			
Number of years of schooling	Cluster A	6.21	4.04	2, 293	2.055	0.130
	Cluster B	5.27	3.73			
	Cluster C	6.18	3.94			
	Total	5.80	3.89			
Total number of family members in household	Cluster A	6.36	2.69	2, 293	4.162	0.017
	Cluster B	5.61	2.41			
	Cluster C	6.74	3.75			
	Total	6.19	3.06			
Number of adult male family members (15 years and over) resident in the hh	Cluster A	2.34	1.30	2, 293	3.464	0.033
	Cluster B	1.90	1.14			
	Cluster C	2.30	1.53			
	Total	2.14	1.34			
Number of adult female family members (15 years and over) resident in the hh	Cluster A	2.02	1.24	2, 293	1.951	0.144
	Cluster B	1.92	1.04			
	Cluster C	2.23	1.33			
	Total	2.05	1.20			
Number of child family members (14 years and younger) resident in the hh	Cluster A	2.00	1.52	2, 293	2.299	0.102
	Cluster B	1.71	1.24			
	Cluster C	2.12	1.71			
	Total	1.92	1.49			
Number of generations in 24 Parganas South	Cluster A	2.20	0.88	2, 266	.113	0.893
	Cluster B	2.17	0.76			
	Cluster C	2.23	0.88			
	Total	2.20	0.83			

ANOVA results continued

Total number of homes	Cluster A	1.18	0.59	2, 293	1.058	0.349
	Cluster B	1.11	0.34			
	Cluster C	1.21	0.6			
	Total	1.16	0.51			
Total land owned	Cluster A	3.62	2.7	2, 293	1.647	0.194
	Cluster B	3.14	3.66			
	Cluster C	4.03	4.31			
	Total	3.57	3.76			
Distance from brackishwater (meters)	Cluster A	340.97	512.04	2, 269	0.115	0.891
	Cluster B	367.29	358.32			
	Cluster C	344.14	405.74			
	Total	352.98	411.82			
Closest mangrove on foot/boat (meters)	Cluster A	490.85	869.2	2, 293	1.014	0.364
	Cluster B	437.02	434.25			
	Cluster C	373.59	364.51			
	Total	424.32	532.72			
Likelihood of converting agriculture/polyculture area to shrimp pond area in the next 5 years	Cluster A	2.12	1.34	2, 268	5.796	0.003
	Cluster B	1.54	0.95			
	Cluster C	1.67	1			
	Total	1.72	1.08			
Total farm income	Cluster A	15698.30	18875.33	2, 198	.424	.655
	Cluster B	21011.43	35308.63			
	Cluster C	20667.50	36071.48			
	Total	19711.47	32693.42			
Total income from rice sold (rupees)	Cluster A	5209.09	4050.79	2, 48	.253	.777
	Cluster B	6404.76	5124.99			
	Cluster C	6500.00	5662.55			
	Total	6182.35	5059.51			
Total income from betel sold (rupees)	Cluster A	21195.65	19508.59	2, 100	.593	.554
	Cluster B	30789.19	35505.98			
	Cluster C	27548.84	36724.85			
	Total	27294.17	33094.24			
Total income from vegetables sold (rupees)	Cluster A	5244.44	4118.75	2, 129	.129	.879
	Cluster B	5886.42	8333.13			
	Cluster C	6277.88	10326.76			
	Total	5909.32	8520.19			
Total income from other agriculture production (rupees)	Cluster A	432.50	322.76	2, 38	5.269	.010
	Cluster B	1788.89	1338.19			
	Cluster C	1450.00	997.91			
	Total	1350.61	1176.28			

Chi squared

Variable		Cluster A		Cluster B		Cluster C		Total		$\chi 2$	df	P
		%	n	%	n	%	n	%	n			
Income category	Low	24.6%	15	48.8%	60	35.5%	39	38.8%	114	16.132	4	0.003
	Medium	49.2%	30	23.6%	29	30.9%	34	31.6%	93			
	High	26.2%	16	27.6%	34	33.6%	37	29.6%	85			
Gender	Female	14.8%	8	22.6%	28	10.8%	12	16.6%	49	6.054	2	.0048
	Male	85.2%	52	77.4%	96	89.2%	99	83.4%	247			

ANOVA Post hoc tests

Variable	Comparison	Mean Difference	SE	P	Post hoc text
Household wealth index (adults, owned land, cattle)	Cluster A and Cluster B	0.0343	0.0192	0.2099	
	Cluster A and Cluster C	-0.0257	0.0235	0.6200	
	Cluster B and Cluster C	-.0600091*	0.0220	0.0210	Tamhane
Total income	Cluster A and Cluster B	2553.1738	6065.7658	1.0000	
	Cluster A and Cluster C	-5022.5320	6183.4520	1.0000	
	Cluster B and Cluster C	-7575.7058	5083.0369	0.4116	Bonferonni
Total livestock owned	Cluster A and Cluster B	4.2955	2.3533	0.2069	
	Cluster A and Cluster C	0.7296	2.3983	1.0000	
	Cluster B and Cluster C	-3.5659	1.9662	0.2123	Bonferonni
Respondent's age	Cluster A and Cluster B	2.2130	2.2112	0.9532	
	Cluster A and Cluster C	2.0577	2.2500	1.0000	
	Cluster B and Cluster C	-0.1554	1.8383	1.0000	Bonferonni
Number of years of schooling	Cluster A and Cluster B	0.9470	0.6064	0.3583	
	Cluster A and Cluster C	0.0329	0.6180	1.0000	
	Cluster B and Cluster C	-0.9141	0.5066	0.2167	Bonferonni
Total number of family members in hh	Cluster A and Cluster B	0.3781	0.4832	0.4346	
	Cluster A and Cluster C	1.126*	0.3961	0.0048	
	Cluster B and Cluster C	-1.126*	0.3961	0.0144	Bonferonni
Number of adult male family members (15 years and over) resident in the hh	Cluster A and Cluster B	0.4410	0.2079	0.1042	
	Cluster A and Cluster C	0.0470	0.2119	1.0000	
	Cluster B and Cluster C	-.394*	0.1737	0.0721	Bonferonni
Number of adult female family members (15 years and over) resident in the hh	Cluster A and Cluster B	0.0970	0.1871	1.0000	
	Cluster A and Cluster C	-0.2088	0.1907	0.8233	
	Cluster B and Cluster C	-0.3059	0.1564	0.1542	Bonferonni
Number of child family members (14 years and younger) resident in the hh	Cluster A and Cluster B	0.2903	0.2328	0.6398	
	Cluster A and Cluster C	-0.1171	0.2372	1.0000	
	Cluster B and Cluster C	-0.4074	0.1945	0.1111	Tamhane
Number of generations in 24 Parganas South	Cluster A and Cluster B	0.0253	0.1365	1.0000	
	Cluster A and Cluster C	-0.0291	0.1385	1.0000	
	Cluster B and Cluster C	-0.0543	0.1142	1.0000	Bonferonni

Post hoc tests continued

Total number of homes	Cluster A and Cluster B	0.0674	0.0818	0.797	Tamhane
	Cluster A and Cluster C	-0.0269	0.0951	0.989	
	Cluster B and Cluster C	-0.0943	0.0651	0.385	
Total land owned	Cluster A and Cluster B	0.4859	0.5871	1.000	Bonferonni
	Cluster A and Cluster C	-0.4024	0.5984	1.000	
	Cluster B and Cluster C	-0.8883	0.4906	0.214	
Distance from brackishwater (meters)	Cluster A and Cluster B	-26.321	66.4645	1.000	Bonferonni
	Cluster A and Cluster C	-3.1725	67.7018	1.000	
	Cluster B and Cluster C	23.1485	56.6953	1.000	
Closest mangrove on foot/boat (meters)	Cluster A and Cluster B	53.8363	83.3075	1.000	Bonferonni
	Cluster A and Cluster C	117.2669	84.9008	0.505	
	Cluster B and Cluster C	63.4305	69.6042	1.000	
Likelihood of converting	Cluster A and Cluster B	.57400*	0.1961	0.013	Tamhane
	Cluster A and Cluster C	.44864*	0.2009	0.081	
	Cluster B and Cluster C	-0.1254	0.1339	0.726	
Total farm income	Cluster A and Cluster B	-5313.13	6196.34	1.000	Bonferonni
	Cluster A and Cluster C	-4969.2	6153.95	1.000	
	Cluster B and Cluster C	343.93	5234.49	1.000	
Total income from rice sold (rupees)	Cluster A and Cluster B	-1195.67	1911.88	1.000	Bonferonni
	Cluster A and Cluster C	-1290.91	1946.16	1.000	
	Cluster B and Cluster C	-95.24	1626.43	1.000	
Total income from betel sold (rupees)	Cluster A and Cluster B	-9593.54	8822.7	0.838	Bonferonni
	Cluster A and Cluster C	-6353.19	8583.5	1.000	
	Cluster B and Cluster C	3240.35	7450.76	1.000	
Total income from vegetables sold (rupees)	Cluster A and Cluster B	-641.97	2028.06	1.000	Bonferonni
	Cluster A and Cluster C	-1033.44	2034.63	1.000	
	Cluster B and Cluster C	-391.47	1674.21	1.000	
Total income from other agriculture production (rupees)	Cluster A and Cluster B	-1356.39	331.52	0.002	Tamhane
	Cluster A and Cluster C	-1017.5	294.99	0.011	
	Cluster B and Cluster C	338.89	419.63	0.811	

Appendix J: Summary of Social Capital Variables in Each Cluster

ANOVA, Chi-square cross tabulations & Post hoc tests

Social capital variables		Mean	SD	df	F	Sig.
Number of voluntary community groups, clubs or society respondent regularly participates in	Cluster A	1.10	1.73	2, 291	19.08	**0.000**
	Cluster B	0.30	0.64			
	Cluster C	1.20	1.31			
	Total	0.80	1.26			
Number of informal village events	Cluster A	27.15	17.05	2, 293	87.98	**0.000**
	Cluster B	7.96	5.14			
	Cluster C	11.62	6.88			
	Total	13.29	11.85			
Number of religious festivals outside village	Cluster A	6.52	4.70	2, 288	74.14	**0.000**
	Cluster B	1.44	1.56			
	Cluster C	2.32	2.18			
	Total	2.84	3.33			
Participation in new community projects	Cluster A	3.21	0.88	2, 292	14.58	**0.000**
	Cluster B	3.11	0.88			
	Cluster C	3.78	1.15			
	Total	3.39	1.03			

Chi-square cross tabulations

Variable		Cluster A		Cluster B		Cluster C		Total		χ^2	df	P
		%	n	%	n	%	n	%	n			
Involved in management	Yes	30.0	12	0.0	0	38.5	42	18.4	54	57.4	2	.000
	No	80.0	48	100.0	124	61.5	67	81.6	239			
Trust people inside village	Almost no one	3.3	2	10.7	13	0.9	1	5.5	16	140	6	.000
	A few people	72.1	44	81.8	99	20.0	22	56.5	165			
	Most people	21.3	13	7.4	9	52.7	58	27.4	80			
	Almost everyone	3.3	2	0.0	0	26.4	29	10.6	31			
Trust people outside the village	Almost no one	1.6	1	11.1	13	0.9	1	5.3	15	100.9	6	.000
	A few people	86.9	53	84.6	99	42.1	45	69.1	197			
	Most people	11.5	7	4.3	5	40.2	43	19.3	55			
	Almost everyone	0.0	0	0.0	0	16.8	18	6.3	18			
Festivals outside the village	Yes	100.0	61	55.3	68	71.2	79	29.5	87	39.3	2	.000
	No	0.0	0	44.7	55	28.8	32	70.5	208			

Variable	Comparison	Mean Difference	SE	P	Post hoc test
Number of voluntary community groups, clubs or society respondent regularly participates in	Cluster A and 2	0.803	0.232	**0.003**	Tamhane
	Cluster A and 3	-0.097	0.257	0.975	
	Cluster B and 3	-0.900	0.137	**0.000**	
Participation in new community projects	Cluster A and 2	0.099	0.138	0.853	Tamhane
	Cluster A and 3	-0.571	0.156	**0.001**	
	Cluster B and 3	-0.670	0.135	**0.000**	
Number of informal village events	Cluster A and 2	19.191	2.231	**0.000**	Tamhane
	Cluster A and 3	15.524	2.278	**0.000**	
	Cluster B and 3	-3.668	0.800	**0.000**	
Number of religious festivals outside village	Cluster A and 2	5.082	0.618	**0.000**	Tamhane
	Cluster A and 3	4.201	0.637	**0.000**	
	Cluster B and 3	-0.881	0.253	**0.002**	

Appendix K: Attitudinal Information in Each Community and Cluster

ANOVA

Variable	Cluster	Mean	SD	df	F	P
Concern about conversion of paddy land to shrimp farms	Cluster A	3.74	1.17	2, 291	6.29	**0.002**
	Cluster B	3.2	1.24			
	Cluster C	3.04	1.33			
	Total	3.25	1.28			
If shrimp farming has a negative effect on the environment farmers should pay	Cluster A	4.39	0.76	2, 292	0.88	0.417
	Cluster B	4.42	0.57			
	Cluster C	4.29	1			
	Total	4.37	0.8			
There should be more community managed or cooperative shrimp farms	Cluster A	3.67	1.11	2, 292	8.49	**0.000**
	Cluster B	2.8	1.39			
	Cluster C	3.01	1.44			
	Total	3.06	1.39			
Some kinds of fish are more abundant when there are mangrove forests nearby	Cluster A	3.69	1.5	2, 292	3.24	**0.041**
	Cluster B	3.73	1.47			
	Cluster C	4.14	1.17			
	Total	3.87	1.38			
Mangrove forests mitigate the destructive force of natural disasters	Cluster A	4.85	0.36	2, 292	1.05	0.351
	Cluster B	4.88	0.52			
	Cluster C	4.94	0.24			
	Total	4.89	0.4			
Villagers access to mangrove forests should be increased	Cluster A	1.36	0.52	2, 292	0.16	0.852
	Cluster B	1.38	0.84			
	Cluster C	1.32	0.83			
	Total	1.36	0.78			
Shrimp fry collection decreases number of fish	Cluster A	4.33	0.51	2, 292	2.35	**0.097**
	Cluster B	4.11	0.82			
	Cluster C	4.25	0.68			
	Total	4.21	0.72			
I am concerned about the damage to the embankments caused by shrimp fry collectors	Cluster A	4.39	0.59	292	1.54	0.216
	Cluster B	4.2	0.78			
	Cluster C	4.21	0.79			
	Total	4.24	0.75			

Post hoc tests

Variable	Comparison	Mean Difference	SE	P	Post hoc text
Concern about conversion of paddy land to shrimp farms	Cluster A and Cluster B	0.541	0.197	**0.020**	Bonferonni
	Cluster A and Cluster C	0.702	0.201	**0.002**	
	Cluster B and Cluster C	0.161	0.165	0.994	
If shrimp farming has a negative effect on the environment farmers should pay	Cluster A and Cluster B	-0.029	0.125	1.000	Bonferonni
	Cluster A and Cluster C	0.105	0.127	1.000	
	Cluster B and Cluster C	0.134	0.104	0.595	
There should be more community managed or cooperative shrimp farms	Cluster A and Cluster B	0.867	0.189	**0.000**	Tamhane
	Cluster A and Cluster C	0.663	0.197	**0.003**	
	Cluster B and Cluster C	-0.204	0.185	0.613	
Some kinds of fish are more abundant when there are mangrove forests nearby	Cluster A and Cluster B	-0.043	0.215	1.000	Bonferonni
	Cluster A and Cluster C	-0.447	0.218	0.125	
	Cluster B and Cluster C	-0.403	0.179	**0.076**	
Mangrove forests mitigate the destructive force of natural disasters	Cluster A and Cluster B	-0.026	0.066	0.972	Tamhane
	Cluster A and Cluster C	-0.084	0.051	0.279	
	Cluster B and Cluster C	-0.059	0.052	0.599	
Villagers access to mangrove forests should be increased	Cluster A and Cluster B	-0.021	0.123	1.000	Bonferonni
	Cluster A and Cluster C	0.036	0.125	1.000	
	Cluster B and Cluster C	0.058	0.103	1.000	
Shrimp fry collection decreases number of fish	Cluster A and Cluster B	0.222	0.111	0.142	Bonferonni
	Cluster A and Cluster C	0.076	0.113	1.000	
	Cluster B and Cluster C	-0.147	0.093	0.351	
I am concerned about the damage to the embankments caused by shrimp fry collectors	Cluster A and Cluster B	0.190	0.117	0.314	Bonferonni
	Cluster A and Cluster C	0.186	0.119	0.356	
	Cluster B and Cluster C	-0.004	0.098	1.000	

Appendix M: Prediction Tables for Binary Probit Analysis

Community Model 1

Predictions for Binary Choice Models		Predicted value		
		0	1	Total actual
Actual value	0	83 (28.5%)	51 (17.5%)	134 (46.0%)
	1	37 (12.7%)	120 (41.2%)	157 (54.0%)
	Total predicted	120	171	291
		41.20%	58.80%	100%

Prediction Success	
Sensitivity = actual 1s correctly predicted	76.43%
Specificity = actual 0s correctly predicted	61.94%
Positive predictive value = predicted 1s that were actual 1s	70.18%
Negative predictive value = predicted 0s that were actual 0s	69.17%
Correct prediction = actual 1s and 0s correctly predicted	69.76%
Prediction Failure	
False pos. for true neg. = actual 0s predicted as 1s	38.06%
False neg. for true pos. = actual 1s predicted as 0s	23.57%
False pos. for predicted pos. = predicted 1s actual 0s	29.83%
False neg. for predicted neg. = predicted 0s actual 1s	30.83%
False predictions = actual 1s and 0s incorrectly predicted	30.24%

Community Model 2

Predictions for Binary Choice Models		Predicted value		
		0	1	Total actual
Actual value	0	80 (27.5%)	54 (18.6%)	134 (46.0%)
	1	40 (13.7%)	117 (40.2%)	157 (54.0%)
	Total predicted	120	171	291
		41.20%	58.80%	100%

Prediction Success	
Sensitivity = actual 1s correctly predicted	74.52%
Specificity = actual 0s correctly predicted	59.70%
Positive predictive value = predicted 1s that were actual 1s	68.42%
Negative predictive value = predicted 0s that were actual 0s	66.67%
Correct prediction = actual 1s and 0s correctly predicted	67.70%
Prediction Failure	
False pos. for true neg. = actual 0s predicted as 1s	40.30%
False neg. for true pos. = actual 1s predicted as 0s	25.48%
False pos. for predicted pos. = predicted 1s actual 0s	31.58%
False neg. for predicted neg. = predicted 0s actual 1s	33.33%
False predictions = actual 1s and 0s incorrectly predicted	32.30%

Community Model 3

Predictions for Binary Choice Models		Predicted value		
		0	1	Total actual
Actual value	0	84 (28.9%)	50 (17.2%)	134 (46.0%)
	1	39 (13.4%)	118 (40.5%)	157 (54.0%)
	Total predicted	123	168	291
		42.3%	57.7%	100%

Prediction Success	
Sensitivity = actual 1s correctly predicted	75.16%
Specificity = actual 0s correctly predicted	62.69%
Positive predictive value = predicted 1s that were actual 1s	70.24%
Negative predictive value = predicted 0s that were actual 0s	68.29%
Correct prediction = actual 1s and 0s correctly predicted	69.42%
Prediction Failure	
False pos. for true neg. = actual 0s predicted as 1s	37.31%
False neg. for true pos. = actual 1s predicted as 0s	24.84%
False pos. for predicted pos. = predicted 1s actual 0s	29.76%
False neg. for predicted neg. = predicted 0s actual 1s	31.71%
False predictions = actual 1s and 0s incorrectly predicted	30.58%

Sub Sample Model 1

Predictions for Binary Choice Models		Predicted value		
		0	1	Total actual
Actual value	0	32 (23.5%)	26 (19.1%)	58 (42.6%)
	1	19 (14.0%)	59 (43.4%)	78 (57.4%)
	Total predicted	51	85	136
		37.5%	62.5%	100.0%

Prediction Success	
Sensitivity = actual 1s correctly predicted	75.64%
Specificity = actual 0s correctly predicted	55.17%
Positive predictive value = predicted 1s that were actual 1s	69.41%
Negative predictive value = predicted 0s that were actual 0s	62.75%
Correct prediction = actual 1s and 0s correctly predicted	66.91%
Prediction Failure	
False pos. for true neg. = actual 0s predicted as 1s	44.83%
False neg. for true pos. = actual 1s predicted as 0s	24.36%
False pos. for predicted pos. = predicted 1s actual 0s	30.59%
False neg. for predicted neg. = predicted 0s actual 1s	37.26%
False predictions = actual 1s and 0s incorrectly predicted	33.09%

Sub Sample Model 2

Predictions for Binary Choice Models		Predicted value		
		0	1	Total actual
Actual value	0	32 (23.5%)	26 (19.1%)	58 (42.6%)
	1	13 (9.6%)	65 (47.8%)	78 (57.4%)
	Total predicted	45	91	136
		33.1%	67.9%	100.0%

Prediction Success	
Sensitivity = actual 1s correctly predicted	83.33%
Specificity = actual 0s correctly predicted	55.17%
Positive predictive value = predicted 1s that were actual 1s	71.43%
Negative predictive value = predicted 0s that were actual 0s	71.11%
Correct prediction = actual 1s and 0s correctly predicted	71.32%
Prediction Failure	
False pos. for true neg. = actual 0s predicted as 1s	44.83%
False neg. for true pos. = actual 1s predicted as 0s	16.67%
False pos. for predicted pos. = predicted 1s actual 0s	28.57%
False neg. for predicted neg. = predicted 0s actual 1s	28.89%
False predictions = actual 1s and 0s incorrectly predicted	28.68%

Sub Sample Model 3

Predictions for Binary Choice Models		Predicted value		
		0	1	Total actual
Actual value	0	30 (22.1%)	28 (20.6%)	58 (42.6%)
	1	16 (11.8%)	62 (45.6%)	78 (57.4%)
	Total predicted	46	90	136
		33.8%	66.2%	100.0%

Prediction Success	
Sensitivity = actual 1s correctly predicted	79.49%
Specificity = actual 0s correctly predicted	51.72%
Positive predictive value = predicted 1s that were actual 1s	68.89%
Negative predictive value = predicted 0s that were actual 0s	65.22%
Correct prediction = actual 1s and 0s correctly predicted	67.65%
Prediction Failure	
False pos. for true neg. = actual 0s predicted as 1s	48.28%
False neg. for true pos. = actual 1s predicted as 0s	20.51%
False pos. for predicted pos. = predicted 1s actual 0s	31.11%
False neg. for predicted neg. = predicted 0s actual 1s	34.78%
False predictions = actual 1s and 0s incorrectly predicted	32.35%

Appendix N: Binary Probit Model Descriptive Statistics

Community models

Variable	Mean	Std.Dev.	Minimum	Maximum
VGROUP	0.804	1.265	0.000	9.000
MAN	0.186	0.389	0.000	1.000
EVENTS	13.392	11.912	0.000	100.000
TRUSTV	0.378	0.486	0.000	1.000
TRUSTO	0.244	0.430	0.000	1.000
FEST	2.876	3.316	0.000	27.000
PART	0.924	0.265	0.000	1.000
FAC1	0.003	1.003	-1.764	3.257
FAC2	-0.008	1.001	-2.446	2.974
FAC3	0.012	1.004	-1.307	5.548
CLU1	0.210	0.408	0.000	1.000
CLU2	0.416	0.494	0.000	1.000
GENDER	0.842	0.365	0.000	1.000
AGE	43.131	14.045	19.000	94.000
VILL	0.574	0.495	0.000	1.000
INC1	0.381	0.487	0.000	1.000
INC3	0.296	0.457	0.000	1.000
SCHOOL	5.804	3.870	0.000	15.000
WEALTH1	0.282	0.451	0.000	1.000
WEALTH3	0.368	0.451	0.000	1.000

Sub sample models

Variable	Mean	Std.Dev.	Minimum	Maximum
VGROUP	0.794	1.248	0.000	6.000
MAN	0.176	0.383	0.000	1.000
EVENTS	13.529	10.190	0.000	55.000
TRUSTV	0.368	0.484	0.000	1.000
TRUSTO	0.257	0.439	0.000	1.000
FEST	2.743	2.989	0.000	23.000
PART	0.912	0.285	0.000	1.000
FAC1	-0.050	1.004	-1.764	3.139
FAC2	-0.065	0.987	-2.446	2.906
FAC3	0.014	0.939	-1.275	5.288
CLU1	0.199	0.400	0.000	1.000
CLU2	0.449	0.499	0.000	1.000
GENDER	0.860	0.348	0.000	1.000
AGE	43.677	14.733	19.000	94.000
VILL	0.603	0.491	0.000	1.000
INC1	0.419	0.495	0.000	1.000
INC3	0.213	0.411	0.000	1.000
SCHOOL	5.368	3.483	0.000	12.000
WEALTH1	0.294	0.457	0.000	1.000
WEALTH3	0.346	0.477	0.000	1.000