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Crop–livestock interactions and livelihoods in the Gangetic Plains of West Bengal, India

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Crop–livestock interactions and livelihoods in the Gangetic Plains of West Bengal, India

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Acronyms

AI	artificial insemination
asl	above sea level
CIMMYT	International Wheat and Maize Improvement Centre (Texcoco, Mexico)
FYM	farm yard manure
GCA	Gross cropped area
hh	household
IGP	Indo-Gangetic Plains, South Asia
ILRI	International Livestock Research Institute (Nairobi, Kenya)
KVK	Krishi Vigyan Kendra (extension outreach program, India)
LGP	Lower-Gangetic Plain (subregion of the IGP, comprising the downstream plains in Eastern India [West Bengal], Ganges basin)
MGP	Middle-Gangetic Plain (subregion of the IGP, comprising the midstream plains in Eastern India [eastern U.P. and Bihar], Ganges basin)
MSP	minimum support price
n	number of observations
NCA	Net cropped area
NGO	non-governmental organization
ns	non-significant
p.	probability
PAU	Punjab Agricultural University
RCTs	resource-conserving technologies
RWC	Rice–wheat Consortium of the Indo-Gangetic Plains (New Delhi, India)
s.d.	standard deviation
SLP	CGIAR Systemwide Livestock Programme
TGP	Trans-Gangetic Plain (subregion of the IGP, comprising the plains in North-western India [Punjab, Haryana], straddling Ganges and Indus basin)
TW	tubewell
UGP	Upper-Gangetic Plain (subregion of the IGP, comprising the upstream plains in North-central India [western U.P.], Ganges basin)
U.P.	Uttar Pradesh
W.B.	West Bengal
ZT	zero tillage

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Foreword

The present study is the fourth in a series of five reports for the crop–livestock interactions scoping study. The first four reports each describe a particular subregion of the Indo-Gangetic Plains in India: the Trans-Gangetic Plains (TGP) comprising Punjab and Haryana (Erenstein et al. 2007b); Uttar Pradesh (Singh et al. 2007); Bihar (Thorpe et al. 2007) and West Bengal (this report). The fifth report synthesizes across the four subregions (Erenstein et al. 2007a). To facilitate write-up, synthesis and future reference, the reports all follow a similar outline and table format. This implies some repetition between reports, but this was still preferred over a single bulky report in view of the richness and diversity of the information and so as not to lose the local insights and relevance. Chapter 1 (Introduction), chapter 2 (Methodology), the action research needs for the IGP (part of 7.3) and most of the annexes are largely identical in each of the reports. Each of the reports can be read as a standalone report.

Executive summary

The research and development community faces the challenge of sustaining crop productivity gains, improving rural livelihoods and securing environmental sustainability in the Indo-Gangetic Plains (IGP). This calls for a better understanding of farming systems and of rural livelihoods, particularly with the advent of, and strong advocacy for, conservation farming and resource-conserving technologies. This scoping study presents an assessment of crop–livestock interactions and rural livelihoods in the Gangetic Plains of West Bengal, drawing from a village survey in three districts (Malda, Nadia and W Medinipur) and secondary data.

West Bengal is India's most densely populated state and is characterized by rural livelihoods based on rice–cattle farming systems. Nearly a third (32%) of the rural population live below the poverty line, with poverty concentrated rurally and socially. The formerly food-deficit state has had a significant spurt in agricultural production from the early 1980s and is now surplus in food grain. Intensification (particularly boro rice) and diversification (vegetables, particularly potato) were the main pathways for agricultural growth, aided by the advent of shallow tubewell irrigation. Rice–wheat systems are relatively limited (<3% of system area in IGP). West Bengal is the most densely stocked state of India in terms of cattle, small ruminants and poultry. Equity and growth benefited from the state's emphasis on land reform and decentralization through people's participation in Panchayat institutions. Agricultural growth has slowed down significantly in the 1990s in combination with an overall stagnation of aggregate rural employment.

Livelihood platforms

Land is the central asset for the livelihoods in the surveyed communities, with 69% of households having access to land and with an average landholding of 0.7 ha/farm household. The physical capital asset base is relatively undeveloped and scarce. Compared to the other IGP states, the relative lack of irrigation development and lack of mechanization are particularly striking. Only the Nadia cluster had significant irrigation development, with profound consequences for the corresponding cropping intensity and productivity. This is also associated with the proximity of the Nadia cluster to Kolkata (formerly known as Calcutta, including extensive rural electrification), whereas the Malda cluster (in the North) and the Medinipur cluster (in the West) were relatively remote. Human capital was limited by illiteracy, with 37% of the household heads in the surveyed villages having no formal education.

Despite the high pressure on land, capital remains the most limiting production factor, with informal interest rates averaging 8% per month. Daily wage rates were low (India Rupees,

INR,[1] 42–43 in the Malda and Nadia clusters, INR 33 in the Medinipur cluster) and are the lowest amongst all the clusters surveyed throughput the IGP. In view of abundant labour and small farm size, the Medinipur cluster and particularly the Malda cluster are labour surplus and net-suppliers of agricultural labour. Gender inequity still plays a key role, although Nadia was the sole cluster in the IGP to report un-gendered wage rates.

Livelihood strategies

Livelihood strategies in the surveyed communities predominantly revolved around rice–livestock systems and agricultural labour. Compared to the upstream IGP states, wheat largely disappears from the agricultural system in the West Bengal clusters, reflecting productivity constraints and its generally limited human consumption. Instead, rice asserts itself as the dominant crop in terms of food, feed and income, aided by the limited agricultural alternatives for the flood-prone lowlands during the monsoon. Rice is the dominant monsoon crop, with significant (upland) areas under horticulture in the Nadia and Malda clusters. In *rabi* season, cropping is relatively diverse, including horticulture, non-wheat cereals (particularly *boro* rice in the Nadia cluster), and pulses/oilseeds. Compared to the other IGP states, the lack of fodder (*kharif* and *rabi*) crops is particularly striking. The Medinipur cluster has a low cropping intensity, with widespread winter fallow due to irrigation constraints. The Nadia cluster has an intensive cropping year-round, whereas the Malda cluster takes an intermediate position.

Livestock ownership is widespread and complements the rice-based cropping systems as the basis of rural livelihoods. The average livestock herd varied from a low of 1.7 cow equivalents per household in the Nadia cluster to a high of 3.8 in The Medinipur cluster. Compared to the other IGP states upstream, the West Bengal clusters show: (i) a relatively limited role and income from dairy; (ii) near complete substitution of cattle for buffalo; (iii) a spatial heterogeneity in terms of the prevalence of *desi* (indigenous) cattle (the Malda and the Medinipur clusters) and cross-breds (Nadia cluster); and (iv) the importance of backyard poultry. In the Malda and Medinipur clusters small ruminants were also widely owned.

For landed households, the crop component generally was more important than the livestock component for household income; whereas landless depended primarily on farm labour. Only in the Nadia cluster were the agricultural systems relatively intensive. The combination of resource constraints and the relatively low productivity levels prevailing in the Malda and particularly in the Medinipur cluster strengthened risk aversion and made the systems subsistence oriented. Most farm labourers worked locally and when migrating seasonally,

1. India Rupees (INR). In May 2008, USD 1 = INR 40.542.

tended to remain within the state and did so during the times of rice harvesting and rice transplanting.

Crop–livestock interactions

West Bengal is characterized by the prevalence of rice as the traditional food and feed crop. This has a marked effect on crop residue management with universal and comprehensive harvesting of rice residues and their use as the basal animal feed. Particularly striking are the general lack of wheat residue use as feed and the labour intensive residue management and use practices. There is some grading of rice straw for feed associated with seasonal and varietal differences. West Bengal has a markedly high livestock pressure on crop and cereal residues, a reflection of its small farm size, intermediate herd size and relatively low cropping intensity (particularly due to the irrigation constraints in the Malda and Medinipur clusters). The practice of stubble grazing is markedly more common than in the other IGP states and there is also widespread non-feed use of residues. Crop residues are thereby intensively and comprehensively used, have scarcity value and in the case of rice straw are traded (INR 0.8 per kg).

In terms of livestock feeding practices, West Bengal had a number of marked differences compared to the other IGP states. First, the prevalence of rice residues as the main basal feed. The use of other than rice crop residues as feed (e.g. wheat and maize straw) was markedly limited. The virtual absence of wheat straw is particularly striking in view of its preponderance elsewhere. The use of other by-products was also generally limited (in terms of quantities). Second, both grazing and the reliance on collected grasses were markedly more common in West Bengal. Third, the use of produced green fodder was virtually absent. Similarly, chaff cutters which are generally used for chopping the green fodders and crop residues elsewhere in the IGP are markedly absent in West Bengal. A number of factors explain the observed divergences, not least the prevalence of lowly productive *desi* cattle in two of the West Bengal clusters and the rice food/feed tradition. The relatively limited extent of irrigation constrains overall fodder availability in the West Bengal clusters, particularly in Malda and Medinipur.

West Bengal combines relatively low mechanization with a high reliance on animal traction. Half of the manure is reportedly used as household fuel in the West Bengal clusters. In contrast to the dung-cakes elsewhere in the IGP, Bengal farmers have the tradition of using 'dung-sticks' and now due to the lack of (jute) sticks, 'dung-balls'. The livestock services to crop production (traction, FYM) vary across the clusters, from being very significant in The Medinipur cluster to a more limited role in the Nadia cluster. The surveyed communities in West Bengal thus presented a range of crop–livestock integration.

The most integrated systems were observed in The Medinipur cluster, with the most pronounced complementarities between crop (rice) and livestock (*desi* cattle for dairy and draught, small ruminants) production. The crop–livestock interactions thereby underpinned livelihood security, but did not really drive any system change and seemed more a reflection of subsistence and the status quo. In the Nadia cluster the systems were most commercially oriented, both in terms of the crops and the livestock produced, but integration between the two was relatively limited.

Based on these findings, the study goes on to explore the effects on livelihood security and environmental sustainability and provides an outlook and agenda for action for the West Bengal clusters as well as the generic action research needs that emerge from all the IGP clusters.

1 Introduction

The outstanding contribution of agricultural research towards improving the livelihoods of poor farmers on the Indo-Gangetic Plain (IGP) through the Green Revolution technologies is well documented (Frankel 1971; Pinstrup-Andersen and Hazell 1985; Lipton and Longhurst 1989; Hazell et al. 1991; Rosegrant and Hazell 2001; Evenson and Gollin 2003). During the 1960s to 1980s, the planting in the irrigated fields of the IGP of high-yielding wheat and rice varieties combined with the application of fertilizer gave much improved cereal production. As a result India moved from a deficit in the staple grains, wheat and rice, to a secure self-sufficiency. Now, in the face of diminishing groundwater supplies and degrading soils (Kumar et al. 1999; Pingali and Shah 1999), the challenge is to sustain crop productivity gains, while supporting the millions of families on the IGP—most of whom are resource-poor—to diversify their farming systems in order to secure and improve their livelihoods.

Central to this challenge of ensuring improved livelihoods and environmental sustainability are the ruminant livestock—particularly, buffalo, cattle and goats—that are an integral part of the IGP's farming systems. For decades beneficial interactions between rice and wheat cropping and ruminant livestock have underpinned the livelihood systems of the IGP. Yet until recently there has been little systematic research to assess the benefits of these interactions, nor to evaluate the potential for improvement. Based on a review of over 3000 papers from South Asia, Devendra et al. (2000) reported a paucity of research that incorporates livestock interactively with cropping, and a woeful neglect of social, economic and policy issues. Bio-physical commodity-based crop or livestock research dominated, a systems perspective was lacking and many of technologies which were developed were not adopted. More recently broad classifications of crop–livestock systems in South Asia and their component technologies have been documented (Paris 2002; Thomas et al. 2002; Parthasarathy Rao and Hall 2003; Parthasarathy Rao et al. 20042). However, it is clear that a better understanding of farming systems and of the livelihood objectives of landed and landless families, including how they exploit crop–livestock interactions, will be required if we are to be successful in improving rural livelihoods and securing environmental sustainability in the IGP.

Taking a systems approach and applying a livelihoods perspective (Ellis 2000) are particularly important because of the dynamics and diversity of the IGP's social geography, its agriculture and the complexity of the crop–livestock interactions. Current understanding of the interactions is only partial; hence the need to update our knowledge and to assess the implications for agricultural R&D—particularly with the advent of, and strong advocacy for, conservation farming and resource-conserving technologies (RCTs, e.g. zero-tillage, permanent beds and mulching). The RCTs are having some success in improving resource use efficiency for crop production (RWC 2005; Singh et al. 2005), but there is a lack of information about their impacts on overall farm productivity and its livestock components (Seth et al. 2003). Improving our understanding of crop–livestock interactions and their contributions to rural livelihoods will better position the R&D community to be more effective in addressing the major challenges of improving livelihoods while ensuring environmental sustainability.

It was against this background that the Rice–wheat Consortium designed a scoping study with the following objectives:

- To assess rural livelihoods and crop–livestock interactions in the IGP.
- To understand the spatial and seasonal diversity and dynamics of livelihoods and crop–livestock interactions, particularly in terms of the underlying drivers and modifiers.
- To assess the corresponding implications for R&D programs.

The study was carried out across the Indo-Gangetic Plains of India, comprising the states of Punjab, Haryana, Uttar Pradesh (U.P.), Bihar and West Bengal. For the purpose of this study, we grouped the Indian IGP into four subregions: the Trans-Gangetic Plains (TGP: Punjab and Haryana) and the Gangetic Plains of U.P., Bihar and West Bengal. The Gangetic Plains of U.P. thereby comprise the Upper-Gangetic Plains and part of the Middle-Gangetic Plains, Bihar comprises most of the Middle-Gangetic Plains and West Bengal the Lower-Gangetic Plains (Figure 1). This report describes the study carried out in Gangetic Plains of West Bengal. Its results and those from the other three subregion reports (TGP—Erenstein et al. 2007b; U.P.—Singh et al. 2007; and Bihar—Thorpe et al. 2007) are drawn together in the main synthesis report (Erenstein et al. 2007a).

The study reports are structured as follows. The second chapter presents the overall methodology followed and details about the specific survey locations. The third chapter presents the study area drawing primarily from secondary data and available literature. The fourth chapter analyses the livelihood platforms in the surveyed communities, distinguishing between the livelihood assets, access modifiers and trends and shocks. The fifth chapter describes the livelihood strategies in the surveyed communities, with particular attention for crop and livestock production. The sixth chapter assesses the crop–livestock interactions in the surveyed communities, with particular emphasis on crop residue management and livestock feeding practices. The seventh chapter first discusses the effects on livelihood security and environmental sustainability and subsequently dwells on the outlook for the surveyed communities and draws together an agenda for action.

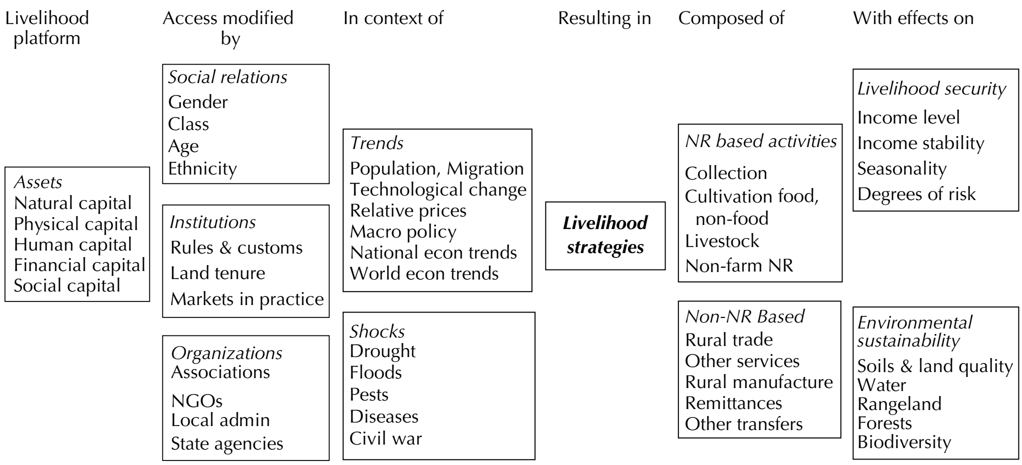
Legend: 1: Indus Plains; 2: Trans-Gangetic Plains [TGP]; 3: Upper Gangetic Plains [UGP]; 4: Middle Gangetic Plains [MGP]; 5: Lower Gangetic Plains [LGP].

Figure 1. *The Indo-Gangetic Plains and its five subregions.*

2 Methodology

Conceptual framework

The scoping study set out to assess rural livelihoods and crop–livestock interactions in the Indo-Gangetic Plains (IGP) through the combined use of secondary information and village-level surveys. In order to better dissect and understand livelihoods and the contributions of crops, livestock and interactions of the sample village communities, the scoping study took as its analytical framework the 'assets-mediating processes-activities' model presented by Ellis (2000, Figure 2).



Source: Ellis (2000).

Figure 2. *A framework for the analysis of rural livelihoods.*

The framework provides a systematic way of (i) evaluating the assets of households and communities and the factors (e.g. social relations or droughts) that modify access to these assets; (ii) describing and understanding current livelihood strategies; and then (iii) exploring the options for reducing poverty and addressing issues of sustainability. Of particular interest in our scoping study was to understand the dynamics of the livelihood systems and how these influenced decisions on the management of rice–wheat cropping and of livestock and their interactions, e.g. the trade-offs between RCTs (resource-conservation technologies) and the use of crop residues to feed buffalo for milk production. Taking this livelihoods approach ensured that natural resource-based and other activities were addressed and that their effects on livelihood security and environmental sustainability were assessed.

Figure 3 schematically presents the linkages between crop and livestock systems in the IGP that further guided the study. The scoping study did not intend a comprehensive assessment of the crop and livestock subsectors of India's IGP. Instead emphasis was on the linkages—the crop–livestock interactions—at the farm and village level between the two subsectors. The study therefore focused on the dynamics at the interface of the crop and livestock subsectors. Within that dynamics a further focus was the management of crop residues because of their importance as ruminant livestock feeds and their role in natural resources management.

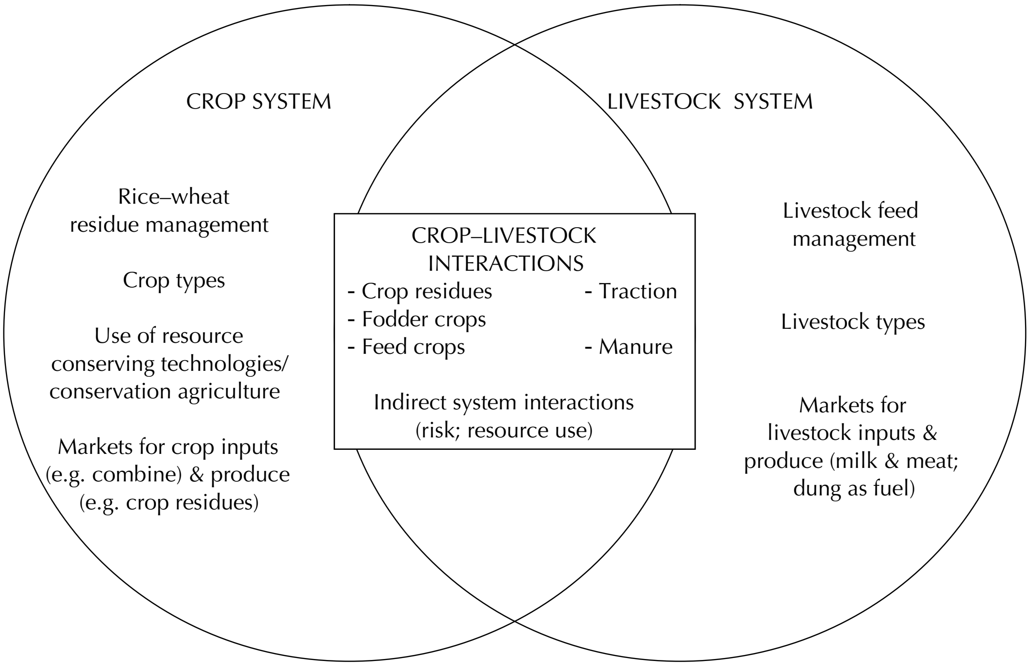
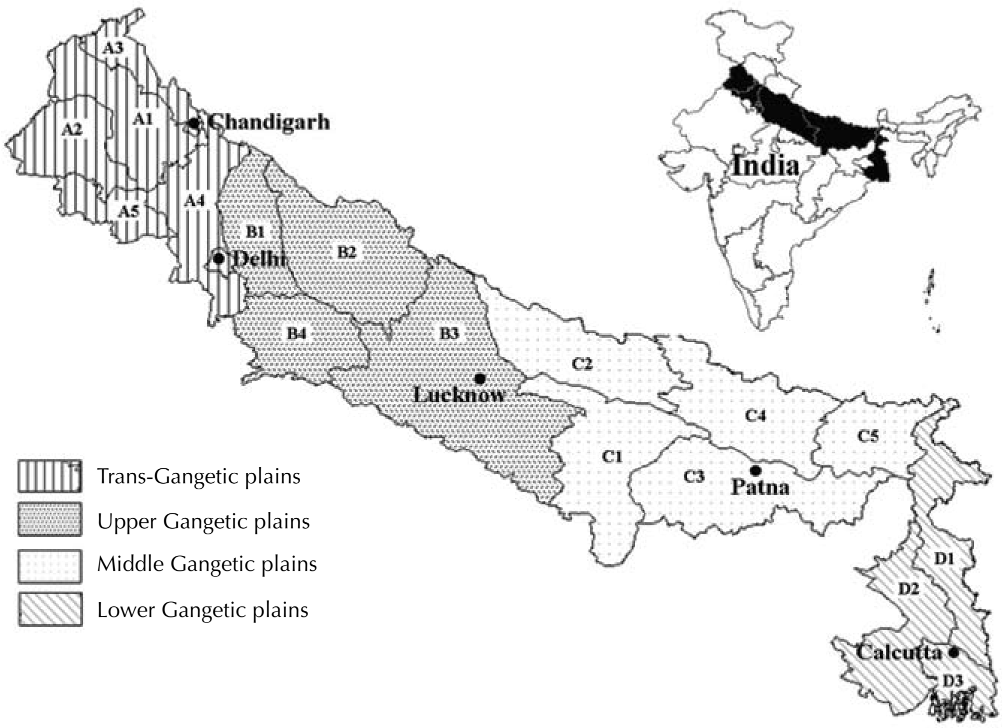


Figure 3. *A schematic representation of crop–livestock interactions in the Indo-Gangetic Plains.*

Village-level survey

The main data source for the scoping study was a village level survey of a total of 72 communities from April to June 2005. The communities were randomly selected using a stratified cluster approach. At the first level, we grouped the Indian IGP into four subregions: the Trans-Gangetic Plains (TGP: Punjab and Haryana) and the Gangetic Plains of U.P., Bihar and West Bengal. Each subregion comprises various agro-ecological subzones as described in the classification by Narang and Virmani (2001, Figure 4) and Kumar et al. 2002). At the second level, we purposively selected a representative district from each of the 3 main IGP agro-ecological subzones within the subregions. These locations were selected to reflect the range of agro-ecological conditions in the IGP and to capture the expected variation in farming systems, including level of access to irrigation services. There is some inconsistency between the various classifications. For instance, Narang and Virmani have omitted the Barind Plains, yet this area was included for this study as it was expected to capture the transition from the rice–wheat to rice–rice systems. No sites were selected for this study from the coastal plain zone (D3) as it was perceived to be a very specific ecology with relatively minor relevance in terms of R&D implications for the IGP in general. At the third and final cluster level, we randomly selected 6 villages around a central point, typically the district headquarters. The villages were randomly selected by taking two villages off the main road along three opposing directions, one village typically relatively close (generally within 5 km) and the second further away (generally more than 15 km). Table 1 shows the name, cluster and agro-ecological classification of each village in West Bengal for which a survey was carried out. Figure 5 shows the location of the 18 villages (based on readings from GPS units) within the three West Bengal clusters. It is important to flag the proximity of the Nadia cluster to a major urban agglomeration (Kolkata), as this directly influences intensification and diversification incentives, particularly compared to the more remote the Malda and Medinipur clusters.



Source: Adapted from Narang and Virmani (2001).

Figure 4. *Subregions and agro-ecological subzones of the Indo-Gangetic Plains.*

Within each village we interacted with self-selected groups of key informants. We thereby attempted to include a representative range of village stakeholders during a half-day village visit, covering the diverse spectra of gender, social and wealth categories (including landed and landless). The half-day visit thereby typically included a briefing with key informants of the village, a larger group meeting with villagers (mainly landed), a separate smaller group meeting with landless, and a visual survey by walking through and around the village. The separate meeting with the landless was deemed necessary to enable their more active participation. However, we were less successful in involving women, who were underrepresented in the village group discussions in West Bengal (Table 2). In part, this was dictated by the prevailing social norms and definitely not aided by the male-biased team composition. Team members were thereby requested to be assertive and pay particular attention to gender issues in an attempt to re-address the imbalance. However, the landless group discussions in West Bengal had a more balanced gender participation (Table 2).

Table 1. *Name, cluster and zone of the 18 surveyed villages in the Gangetic Plains of West Bengal (WB)*

Cluster (State)	Malda (W.B.)	Nadia (W.B.)	W Medinipur (W.B.) **
Village	Muchia Kailwaspur Habibpur–Begunwadi Shailpur–Narhota Gosaipur–Araidanga Barakona Aligarh–North	Uttar Rajapur Sat Simulia Narayanpur Santipur Shan Para Bareni	Nachda Aulia Ashakanti Polashboni Japhla Jeenanpur
Zone*	Barind Plains (D1)	Central Alluvial Plains —Old and new alluvial zone (D2)	Central Alluvial Plains —Laterite and red soil zone (D1)

*Combining Narang and Virmani (2001, 6) and Kumar et al. (2002, 22). Figure 4 maps the coded subzones.
** West (or Paschim) Medinipur (also known as Midnapore West) was formed on January 1, 2002 after the Partition of Midnapore into Paschim Medinipur and Purba Medinipur (http://en.wikipedia.org/wiki/Midnapore_West accessed 22 Dec 2006). In the current study 'the Medinipur cluster' will be used to refer to surveyed villages in W Medinipur.

Table 2. *Median number and gender of participants in the village group discussions in each cluster in the Gangetic Plains of West Bengal*

Cluster	Village group discussion		Landless group discussion	
	# of participants	# of female participants	# of participants	# of female Participants
Malda	25	2	13	8
Nadia	15	4	7	5
Medinipur	21	0	6	3
Overall	20	0	10	5

The village survey used semi-structured interviews using a survey instrument (Annex 4). A village leader was generally first asked to provide quantitative descriptors of the village (people, resources, infrastructure). Then group discussions described the crop and livestock subsystems practiced in the village and other significant aspects of village livelihoods. Particular attention was given to the management of crop residues and to livestock feed resources. Data were collected on the expected drivers of crop–livestock interactions, like the cost of daily-hired labour and the level of access to irrigation.

At each stage of the survey process, respondents were asked to identify and discuss the critical issues that affected their living standards and the constraints to, and the opportunities for, improving their livelihoods and that of the village. In this way, the discussions attempted to provide a sound understanding of the opinions and perspectives of each village community and of its major social groupings regarding policy issues and policy making, i.e. to gain a 'user' or bottom–up perspective and to avoid being prescriptive.

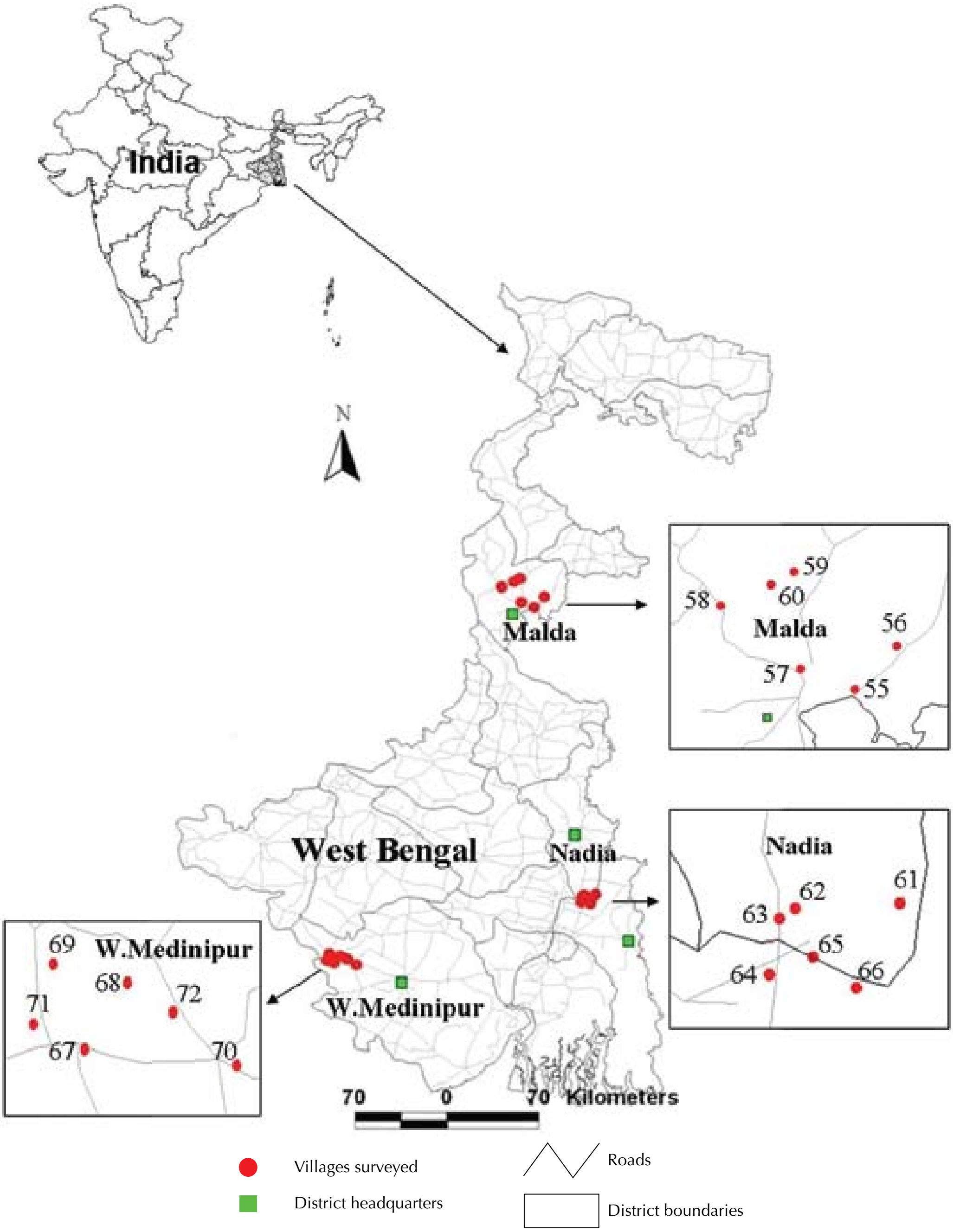


Figure 5. *Location of the 18 surveyed villages within the Malda, Nadia and W Medinipur clusters in the Gangetic Plains of West Bengal.*

At each location within each region three teams completed the survey instrument for two villages within a day. Members of a core team participated in the surveys in each of the four regions and in each of the three locations which constituted the subregion of each region. This gave continuity and consistency of research approach and ensured that the core team members absorbed and analysed the survey and related information from the village studies across the Indian IGP from Punjab in the NW to West Bengal in the east (Figure 1). Within each survey team at each cluster, the core members were joined by staff from the local KVK (Krishi Vigyan Kendra) or other State Agricultural University Departments and/or their counterparts in the Departments of Agriculture and Animal Husbandry of the State Government. (Annex 3). In the case of West Bengal, the survey teams were variously assisted and sometimes accompanied by members of the local level grassroots administration (Gram Panchayat).

Analysis and integration of information

The quantitative primary data from the village surveys were summarized using descriptive statistics. These results were complemented by the information and statistics gathered from secondary sources. The descriptive statistics not only helped gain a better understanding of the type and extent of crop–livestock interactions within each subregion but also showed the variation within and across the four major regions. The descriptive statistics were also useful in examining informal hypotheses about the possible drivers of interactions between crops and livestock and in helping to identify the key modifiers of the effects of the drivers.

It should be noted that the nature of the survey method of collecting data dictates that each quantitative observation (e.g. area of irrigated land in the village or the number of buffalo) is a guesstimate from a respondent or group of respondents. As such, estimates of variables (e.g. mean number of buffalo for the subregion sample of villages) calculated from these guesstimates are indicative, not definitive, results and are therefore presented in the results section at an appropriate level of rounding (e.g. village population to the nearest 100).

The nature of the data and study also implies that the analysis is mainly descriptive. All the tables in the present report refer to village level survey data unless otherwise mentioned. These tables typically present un-weighted averages across surveyed villages—i.e. the average of the 6 surveyed villages in each cluster and 18 villages in case of the overall mean for the subregion. This applies to both absolute and relative values (i.e. in the case of % of households [hh] the % was estimated at the village level and subsequently averaged across villages). These tables also present measures of variability and the significance of differences between the village clusters. However, with 6 villages per cluster and a total of 18 villages for the subregion, the likelihood of finding significant cluster effects is somewhat limited and some measures like Chi-square cannot be interpreted.

The livelihood framework can be applied at different scales. Our focus here is on the village and household levels. At the household level, we will often distinguish between farm households (with land access and crop-production activities), landless households (no access to agricultural land [owned or rented] or crop production activities) and village households (includes both farm and landless). Finally, in applying the livelihood framework in this study, we use the principle of 'optimal ignorance,' seeking out what is necessary to know in order for informed action to proceed (Scoones as cited in Ellis 2000, 47).

It is important to remember that a scoping study, by its very nature, is not designed to provide definitive answers, but rather to flag issues for subsequent in-depth research. Therefore, the emphasis of the study methods was learning through drawing on available information and current knowledge from secondary sources and from the village surveys, interpreting and synthesizing the data from these sources and finally identifying gaps both in the information and our knowledge and in its application.

3 Study area[1]

The Indo-Gangetic Plain (IGP, Figure 1) can be divided broadly into eastern and western subregions. The Gangetic Plain of West Bengal covered by this report is within the eastern subregion in which rainfed (monsoon/*kharif*) lowland rice is the traditional cereal staple and the mainstay of food security. Only in recent decades have wheat and other cool season crops been introduced on a large scale in the eastern Plains north of the Tropic of Cancer. West Bengal and the eastern subregion in which it lies has a subhumid climate and problems of poor water control and flooding. By contrast the western subregion of the IGP is mainly semi-arid and would be water scarce were it not for an excellent irrigation infrastructure of canals and groundwater tubewells. These sustain the winter/*rabi* wheat crop—the preferred cereal staple there—which in recent decades has been complemented in the monsoon/*kharif* season by a major increase in the area of rice, resulting in higher cropping intensities and annual cereal yields in the western than the eastern subregion. Another important contrast between the two subregions is that whereas in the eastern IGP cattle are the predominant livestock, in the western IGP buffalo dominate. In broad terms, therefore, the eastern IGP, including West Bengal, is characterized by rural livelihoods based on rice–cattle farming systems, while rural livelihoods in the western IGP are based on wheat–buffalo farming systems.

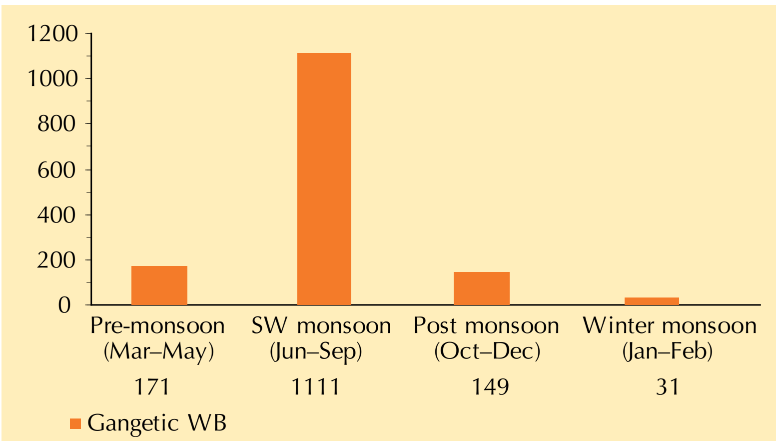
The Lower-Gangetic Plains (LGP) with its rice-based cropping system comprises most districts of West Bengal State[2] and neighboring western Bangladesh (Figure 1). According to Kumar et al. (2002), the West Bengal Plains in India encompass four subregions: Barind Plains, Central Alluvial Plains, Coastal Saline Plains and the Rorh Plains. Narang and Virmani (2001) subdivides the Central Alluvial Plains along a North–South axis into the alluvial zone east of the Hogly River and the laterite and red soil zone on the western side. The village clusters for this study fall in the Barind Plains in northern West Bengal and one each in the two subzones of the Central Alluvial Plains (Table 1, Figure 4, Figure 5). The Central Alluvial Plains are also dissected by the Tropic of Cancer, with wheat cultivation largely confined to the northern plains with its cooler winters. Both of the village clusters in the Central Alluvial Plains fall south of the Tropic of Cancer and only the village cluster in the Barind Plains lies to its north.

The research clusters are in a subhumid climate with an annual rainfall ranging from 1450 to 1800 mm (Table 3). The rains prevail during the warm monsoon season (with 76% falling in June–Sept), with the summer and cool winters being drier (Figure 6). The topography in Gangetic West Bengal is generally gently sloping with deep alluvial soils with more lateritic

1. The chapter presents background information for the study area drawing primarily from secondary data and available literature. Results from the village survey are presented in subsequent chapters.

2. Excluded from Gangetic West Bengal are the northern regions of the state's Hill (Darjeeling) and Tarai zone (Cooch Bihar and Jalpaiguri) and Purulia in the SW.

soils proceeding west wards. In 2000–01, the irrigated area of West Bengal State was 44% (Annex 1), although relatively lower in the northern Barind Plains (Table 3). Both the irrigated area and cropping intensity have generally increased somewhat across West Bengal over the last decades (Table 4). Within West Bengal, the cropping intensity is 184% and highest in the Central Alluvial Plains, which compares to 152% for the Barind Plains and somewhat lower levels elsewhere (Table 4). There are extensive water bodies in Gangetic West Bengal (particularly tanks/ponds and brackish water), comprising an estimated 6% of its geographical area (as against an IGP average of 2%, derived from Minhas and Samra 2003). In contrast, surface irrigation canals are relatively limited, and the variation in access to water is also reflected in a low density of rivers and canals (2.8 km length per km^2 geographical area as against an IGP average of 11.0, derived from Minhas and Samra (2003).



Source: IASRI (2005, 17).

Figure 6. *Season-wise normal rainfall (mm) in Gangetic West Bengal (1462 mm p.a.).*

Table 3. *Rice, wheat and irrigated area, mean annual rainfall and prevalent soils in the Gangetic Plains of West Bengal*

Zone*	Rice–wheat area (× 10^6 ha)	Area (% of GCA) 1996		Irrigated area (% of GCA)	Mean rainfall, mm/year	Soil type
		Rice	Wheat			
Barind (Malda)	0.09	65	7	17	1800	Alluvial
Central Alluvial (Nadia, Medinipur)	0.14	65	4	39	1450	Alluvial
Coastal Saline	0.01	76	1	29	1700	Alluvial
Rorh Plain	0.03	80	2	54	1200	Laterite and lateritic
West Bengal	0.26					

Source: Sharma et al. (2004) (RW area) and Kumar et al. (2002, 24) (other indicators).
*In '( )' survey cluster names for current study.

Table 4. *Changes in input use and cropping intensity in the Gangetic Plains of West Bengal*

Zone*	Year	Irrigated area (% of GCA)	Fertilizer (NPK kg/ha cropped)	Cropping intensity (%)	Rural literacy (%)
Barind (Malda)	1982	12	26	148	22
	1996	17	74	152	28
Central Alluvial (Nadia, Medinipur)	1982	34	43	138	34
	1996	39	102	184	49
Coastal Saline	1982	8	29	124	35
	1996	29	102	140	46
Rorh Plain	1982	59	36	118	35
	1996	54	94	145	42

Source: Kumar et al. (2002, 29).
* In '( )' survey cluster names for current study.

West Bengal is the most densely populated state of India with some 900 inhabitants per km^2 (nearly 3 times the Indian average): a reflection of 80 million people (7.8% of India total) living on a geographical area of 89 thousand km^2 (2.7% of India total) (Annex 1). This reflects a great concentration of population over the centuries in the alluvial lands of the Gangetic Plains of West Bengal, aggravated by historical and socio-economic factors. West Bengal has witnessed significant internal migration from neighboring states such as Bihar, Orissa and U.P. to Kolkata, Howrah and other industrial areas of the states, whereas partition led to an almost continuous stream of migrants into the state from across Indo-Bangladesh borders (GoWB 2004, 9–10). West Bengal over the last decade now has a lower than average population growth, 1.8% p.a. (Annex 1). The population is predominantly rural (72%). Nearly a third (32%) of the rural population live below the poverty line, reflecting the rural concentration of poverty with 84% of the state's absolutely poor (compared to 74% for India as a whole) (GoWB 2004, 9). Scheduled Castes, Scheduled Tribes and minorities together account for more than half the population, and are the three poorest groups in rural Bengal (GoWB 2004). Agricultural labourers remain the poorest section of the population: 47% were reportedly below the poverty line in 1999–2000 and the group comprised 55% of the state's poor population (GoWB 2004, 81).

West Bengal still is heavily dependent on agricultural production. 'For most of its post-independence history, West Bengal was a food deficit state, dependent upon the central government for a major part of its supply, to be routed through the public distribution system. For a long time, food production remained stagnant and the technology of the green revolution bypassed the state. However, there was a significant spurt in agricultural production from the early 1980s and the state is now surplus in food grain.' (GoWB 2004, 5). Over the last two decades the net sown area has remained more or less the same (GoWB 2004, 175), implying intensification and diversification of land use as the sole pathways for agricultural growth.

West Bengal is a major and traditional rice producer. With a rice area of 5.9 million hectare in 2003–04, it provided 14% of the national area, equaled only by U.P. further upstream. Due to its slightly more favourable average yields of 2.5 t/ha in 2003–04 (against a national average of 2.1 t/ha), it was the main rice producer with 17% of national production, with only 42% of rice area being irrigated (MoA 2005a; Annex 2). The prevalence of rice in the plains implies that at least 2/3 of the gross cropped area is devoted to rice cultivation (Table 3).

In comparison, the wheat area is relatively limited, with 0.43 million hectare (1.6% of national area) in 2003–04 and below average yields of 2.3 t/ha (against a national average of 2.7 t/ha), with 79% of wheat area being irrigated (MoA 2005a; Annex 2). With an estimated 0.3 million hectare of rice–wheat system area, West Bengal comprises only 2.7% of the rice–wheat system area of the IGP in India (Sharma et al. 2004). Most of the rice–wheat system falls in the central alluvial and the Barind Plains (Table 3). The State of West Bengal dominates jute production in India, with its area of 0.6 million hectare amounting to 63% of the national area and 75% production in 2003–04 (MoA 2005a). Cropping patterns are thus primarily rice based, including rice (*aman*)–rice (*boro*), rice–jute, rice (*aman*)–potato–rice (*boro*), rice–potato–onion and rice–wheat.

West Bengal's rice production was boosted during the 1980s by the introduction of *boro* rice in combination with the advent of shallow tubewell irrigation. Before winter irrigation, the principal rice crops were *aus* rice (planted in the early rains) and *aman* rice (planted in the mid- to late-rains). Since the advent of irrigation, there was a significant shift of cultivated area away from *aus* towards higher yielding *boro*: irrigated rice planted during the dry winter (*rabi*) season and harvested in April–May. *Boro* cultivation spread rapidly during the 1980s, but has slowed in the 1990s due to increasing constraints to converting further land to *boro*, including limited water availability (Sarkar 2006). *Aman* remains the most important rice crop, accounting for 62% of rice production and is harvested in November–December. *Boro* rice now contributes approximately 32% of total rice production of the state and *aus* rice only 3% (Sen et al. 2003).

There was substantial crop diversification in West Bengal in the 1980s and 1990s. Potato production increased rapidly in the 1980s at nearly 9% p.a., making West Bengal the second largest producer of potato (after U.P.) and first in terms of average yields. The state also showed a significant increase of horticulture and is now a major producer of vegetables, accounting for around 17% of total vegetable production in the country—aided by the provision of cold chain facilities for preservation of perishable goods in producing areas (GoWB 2004, 75). In addition to potato, eggplant (*brinjal*), cabbage, cauliflower and tomato are important vegetables. Mango, pineapple, papaya, guava and litchi are important fruits.

Although the performance of the agricultural sector has been well above the national average, its prospects have been dented by the decline in crop prices for farmers from 1996 onwards and rising input prices (GoWB 2004, 8).

The rice-based cropping systems are complemented by the livestock sector. Compared with the low poultry numbers reported in Bihar and U.P. further upstream, poultry reasserts itself as the dominant stock with 3 fowls for every 4 humans in West Bengal. Poultry includes significant numbers of ducks (28%). Excluding poultry, the remaining herd at the state level is about equally split between small ruminants (49%) and cattle (45%). Small ruminants are primarily goats and typically local breeds (e.g. Black Bengal). The cattle comprise primarily *desi* (indigenous) cattle, only 5.9% being crossbred, both for dairy and draught. Pigs and buffalo contribute about 3% each to the herd numbers (Table 5).[3] Overall the State of West Bengal has witnessed an increase in livestock numbers over the last decade (+41%), although the relative increases in the livestock population vary by type (Table 5). The major shift was the increase in the number of poultry (+62%) followed by significant increases in the number of pigs (+36%) and small ruminants (+30%). Large ruminants also increased, but at significantly slower rates: cattle increased 8% and buffalo numbers increased 7%. These trends have made West Bengal the most densely stocked state of India for a number of livestock types in addition to being the most densely human populated state. Whereas West Bengal comprises only 2.7% of India total geographic area, it has 11% of the nation's cattle population (*desi* and crossbred), 12% of the small ruminants and poultry and 10% of the pigs (Table 5).

Table 5. *Livestock populations in West Bengal State and India in 1992 and 2003*

	1992			2003		
	West Bengal ($\times 10^3$)	%	India ($\times 10^3$)	West Bengal ($\times 10^3$)	%	India ($\times 10^3$)
Crossbred cattle	17,453*	8.5%	15,215	1,119	5.1%	22,073
Indigenous cattle			189,369	17,794	11.3%	156,865
Buffaloes	1,012	1.2%	84,206	1,086	1.2%	93,225
Small ruminants	15,658	9.4%	166,062	20,299	11.5%	176,101
Pigs	955	7.5%	12,788	1,301	9.6%	13,571
Poultry	37,407	12.2%	307,069	60,656	12.4%	489,012

Source: MoA (2004b). * crossbred cattle and indigenous cattle combined. % reflects the state's share of the national herd.

In West Bengal, 25% of rural households are cultivators, 33% are agricultural labourers while other occupations make up the remainder 42% of rural households (Business World

3. The foregoing %s in the text refer to the share of the state herd. The % in Table 5 reflect the state's share of the national herd.

2005, 92). The average farm size of 0.8 ha in West Bengal is low compared to the national average of 1.3 ha (MoA 2006), reflecting its high rural population density. Marginal farmers (<1 ha) constituted 77% of landholdings and another 15% are small farmers (1–2 ha, Table 6). The farm size distribution is the historical reflection of a high population density, ongoing subdivision of landholdings, traditional land tenure systems and the implementation of land reform. Land reform in West Bengal comprised both the provision of greater security of tenure to tenant cultivators (*'barga'*–permanent cultivation right given to cultivators) and redistribution of vested land (*'patta'*—transfer of ownership). Redistribution through land reforms peaked in the 1980s and slowed down in the 1990s (GoWB 2004; Sarkar 2006). The extent of land reform in West Bengal was such that it accounts for 20% of total land redistribution in India and for 47% of all India beneficiaries. Taken together, *barga* and *patta* have covered 41% of the rural population of West Bengal (GoWB 2004, 34).

Table 6. *Land size distribution in West Bengal State and India in 2000–01*

	State	Marginal (< 1 ha)	Small (1–2 ha)	Semi-medium (2–4 ha)	Medium (4–10 ha)	Large (>10 ha)	Total
% of landholdings	West Bengal	80.4	14.9	4.2	0.5	0.0	100
	All India	63.0	18.9	11.7	5.4	1.0	100
Land size (ha/ household)	West Bengal	0.51	1.59	2.77	5.12	279	0.82
	All India	0.40	1.41	2.72	5.80	17.18	1.32

Source: MoA (2006).

The success of the land reform in West Bengal was aided by the continuous rule by a leftist government for more than a quarter of a century (since 1977) with a vision of political, economic and social change (GoWB 2004, 3). Land reform was one of the two key strategies at the state level (see GoWB 2004, Chapter 2 for an overview). The second key strategy was decentralization and people's participation through Panchayat institutions (see GoWB 2004, Chapter 3).

The Panchayat system in West Bengal is a three tier system: Village level (*Gram Panchayat*), block-level (*Panchayat Samiti*) and district level (*Zila Parishad*) council. Members are responsible for the administration of local public goods (public buildings, water, roads) and identify targeted welfare recipients. Members are elected by the people and thereby directly accountable. The Panchayat system has existed formally in most of the major states of India since the early 1950s. However in many other states (including U.P. and Bihar) the Panchayat institution did not assume any active role and no elections were held. The first election in West Bengal took place in 1978 and elections have taken place at five-year intervals ever since. The Panchayat system provided the rural poor with representation, a share in the decision-making process and a kind of dignity and social prestige (Sarkar 2006). The Panchayat system enabled significant poverty alleviation, particularly where land was distributed more equally, the poor became more literate, there were fewer low caste households and local elections were more contested (Bardhan and Mookherjee 2004).

The combination of land reforms and the reorganization and greater emphasis on panchayats helped initiate agricultural growth (GoWB 2004). During 1983 to 1993–94, West Bengal achieved unprecedented growth in agricultural output and reduced the degree of inequality in the distribution of rural consumption (Banerjee et al. 2002; Chattopadhyay 2005) aided by rural employment generation. It has been suggested that the favourable equity implications were associated with having small farmers involved right from the very beginning of the agricultural transformation (Sarkar 2006). Consequently, *boro* rice remained a labour-intensive form of cultivation by small cultivators on small plots of land using mainly family labour (GoWB 2004, 90).

The indirect effects of agricultural growth created a wider market for mass consumption goods and stimulated significant diversification into non-agricultural activities, particularly up to the mid 1990s. Indeed, West Bengal witnessed a substantial growth in small-scale manufacturing and service activities in rural areas over the 1990s, whereby manufacturing output increased nearly 7% p.a. despite near stagnation in the organized sector (GoWB 2004, 37). This contributed to making West Bengal one of the fastest growing states in India with a per capita growth rate of 5.4% over the period 1993–94 to 2000–01 (GoWB 2004). However, agricultural growth itself slowed down significantly in the 1990s (Banerjee et al. 2002; Sarkar 2006). The rate of growth of rural employment and average earning of the agricultural labour households thereby decelerated with adverse effects for rural income distribution (Chattopadhyay 2005).

The overall stagnation of aggregate rural employment in the recent past has made employment generation the most pressing concern in West Bengal today. The state's experience thereby has become similar to the rest of the country. For India as a whole, the collapse in rural employment has been marked: with all forms of rural employment increasing by less than 0.6% p.a. over the period 1993–94 to 1999–2000, i.e. 1/3 the rate of rural population growth. This results from the increase in non-agricultural employment in rural areas generally not being fast enough to adequately compensate the decline in absolute employment in agriculture (GoWB 2004, 89). Another worrying sign is that West Bengal, along with Bihar and Uttar Pradesh, are the only major Indian states exhibiting negative industrial employment growth for the period 1980–81 to 1997–98 (Sarkar 2006). West Bengal thereby was subject to a relative industrial decline: in 1980–81 West Bengal produced 9.8% of the industrial output produced in India, as against only 5.1% in 1997–98 (Banerjee et al. 2002).

West Bengal's high population density exerts significant pressure on basic infrastructure as well as on the provision of health and education services. Tables 7 and 8 present selected indicators in relation to the Millennium Development Goals (MDGs) and overall development for the surveyed districts and for West Bengal as a whole. A striking contrast across the surveyed districts is the relative poverty level of Malda: nearly half the population below the poverty line and nearly a quarter going hungry. Malda tends to score low on most indicators, whereas Nadia and Medinipur tend to have more favourable indicators approximating the state average. The indicators also highlight significant gender differences in literacy and reported work participation. Low women participation thereby suggests a combination of greater restrictions on women's economic agency as well as social lack of recognition of women's unpaid work (GoWB 2004, 14). There also seems to have been limited support to women's concerns and empowerment in government programs, especially in skill enhancement and access to (financial) resources. Human development in West Bengal thus presents a mixed picture. Indeed, whereas the overall Human Development Index for West Bengal was 0.61, Malda district ranked lowest of all districts with an index of 0.44 whereas Nadia and Medinipur ranked in the middle (GoWB 2004, 13). Medinipur has split in 2002 into West and East, with W Medinipur ranking together with Malda amongst the seven West Bengal districts that were listed as India's 150 disadvantaged districts by the Planning Commission, Govt. of India (ICAR 2006).

Table 7. *Selected MDG related development indicators at district level*

	% of population below the poverty line	% of households going hungry	Infant mortality rate (per 1000 births)	% of children getting complete immunization	Literacy rate (%)	Gross enrolment ratio (elementary level, %)
Malda	47.8	22.9	62.0	38.9	50.7	73.5
Nadia	25.3	9.4	62.0	68.9	66.6	88.9
Medinipur *	23.8	5.9	60.0	46.0	75.2	88.9
Average all West Bengal[1]	31.7	9.7	56.0	53.3	66.7	83.1

Source: derived from Debroy and Bhandari (2003).
* Undivided Medinipur district (i.e. W and E combined).
1. Unweighted average across all districts.

The Rice–wheat Consortium (RWC) has recently tried to synthesize the biophysical and socio-economic drivers and modifiers of agricultural development in the IGP. Table 9 presents the RWC's summary description for the LGP, which corresponds with the West Bengal Plains. The table highlights the influences and interactions of natural, physical and human capital, and to which can be added the important elements of social and financial capital. These factors are key to our better understanding of the dynamics of agriculture, rural development and the underlying livelihood strategies within these densely populated plains with significant rural poverty. The summary serves as a useful complement to the livelihoods framework (Figure 2) when reviewing the responses from the village surveys.

Table 8. *Selected additional development indicators at district level*

	0–6 sex ratio (female per 1000 male)	% of 0–6 year olds in the population	Female:male literacy ratio	Pupil teacher ratio	Female work participation (%)	% of women receiving skilled attention during pregnancy
Malda	967	37.4	70.3	85.7	21.7	29.7
Nadia	975	25.1	82.6	102.7	13.3	77.5
Medinipur*	952	27.5	75.8	66.2	15.0	54.8
Average all West Bengal[1]	963	27.9	75.3	78.4	16.1	53.4

Source: derived from Debroy and Bhandari (2003).
* Undivided Medinipur district (i.e. W and E combined).
1. Unweighted average across all districts.

Table 9. *Characteristic biophysical and socio-economic features of the Lower-Gangetic Plain*

Biophysical		Socio-economic	
Climate	Hot subhumid, annual rainfall up to 1800 mm of which 70–78% received in monsoon season	Farmer characteristics	Middle level education and enterprising with less capacity to take risks; farmers generally poor and more risk prone. Agricultural holdings fragmented but relatively small sized. Farms highly diversified. Private sector agro-industries less conspicuous.
Physical features	Alluvial soils, medium fine textured calcareous and acidic soils, gently sloping, low-lying, flood prone; drainage congestion, ground water quality low due to fluorides and arsenic. Holdings fragmented and relatively small sized. Farms highly diversified and flood prone.	Infrastructure for inputs; technology and extension	Good infrastructure with good extension support
Irrigation	Irrigated agriculture mainly in winter season; life saving irrigation in monsoon season, intensive	Marketing of produce	More favourable to rice
Energy	ground water development.	Research support	Premier institutional network exist
Bio-climate	Favourable to Rice based systems; highly diversified	Policy support	Adequate

Source: unpublished background tables developed for RWC (2006).

4 Livelihood platforms

4.1 Livelihood assets

The income of a household largely depends upon utilization of available resources. These are the basic building blocks upon which households are able to undertake production, engage in labour markets and participate in reciprocal exchanges with other households (Ellis 2000, 31). The assets of the surveyed villages have been largely categorized into five asset categories: natural capital, physical capital, human capital, financial capital and social capital (Figure 2).

4.1.1 Natural capital

The main natural capital assets utilized by the people to generate means of survival in the surveyed villages comprise land, water and livestock. There is a high pressure on land: 93% of the village land area is reportedly cultivated, which is significantly higher than the reported state level data (61%—Annex 1). In each cluster, one or two out of the six surveyed villages were predominantly landless and implied an extremely high pressure on the limited land (e.g. in the Nadia cluster one village had 50% and another 80% landless; in Malda one village had 49% and another 67%; in Medinipur one village 60%). About 70% of households in all the surveyed villages have access to land, with an average landholding of 0.7 ha per farm household (Table 10). These figures compare reasonably well with aggregate state level data (landless rural population 33%; average farm size 0.82 ha—Annex 1). Although not significant, there was a tendency for farm size to be extremely low in Medinipur (0.4 ha per household).

Table 10. *Natural capital indicators*

Cluster	Altitude (m)[a]	Access to land (% of household)	Farm size (ha/farm household)	Herd size (# of cow equivalents per household)[b]
Malda	30 a	72	0.6	2.8 ab
Nadia	29 a	63	0.8	1.7 a
Medinipur	89 b	73	0.4	3.8 b
Mean (s.d., n, p.)	49 (44, 18, 0.01)	69 (23, 18, ns)	0.7 (0.5, 18, ns)	2.8 (1.6, 18, 0.06)

s.d.: standard deviation; n: number of observations; p.: Significance of group-effect. ns: non-significant (p > 0.10). Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.
a. Indicative value from GPS.
b. Using following weights: 1.2 for buffalo, crossbred cows and draught animals; 1 for *desi* cows and equines; 0.1 for sheep, goats and pigs; and 1.4 for camels.

The landscape in the Malda and Nadia clusters is primarily plain and of low altitude (30 m above sea level [asl], Table 10). The Medinipur cluster at an altitude of some 90 m asl has agricultural plains dissected with lateritic and forested uplands. The plains in the surveyed communities are highly suitable for crop agriculture although subject to the availability of water and with depressions subject to significant seasonal flooding during the monsoon season. The incidence and extent of seasonal flooding aggravates the land pressure in the communities. Particularly in the Lower Gangetic Plains (LGP) the importance of the topo-sequence (upland–midland–lowland) is readily apparent and determines land use and diversification opportunities and the corresponding value of the land. In the Nadia cluster, the highland is intensively used for horticulture and other upland crops whereas the lowlands are restricted to rice during the monsoon. In the Malda cluster, there was also a clear distinction between the potential use of upland and the flood prone lowland. In Medinipur, the upland often was forested, with single rainfed cropping in the midland (during rain season June–September) and with double cropping limited to the irrigated lowlands. The Medinipur cluster also seemed to have relatively poorer soils (laterite) of low/medium fertility.

Compared to the other IGP states, West Bengal has a relatively high rainfall. Although 76% still falls during the monsoon, the rains received in the pre-monsoon and post-monsoon period are significant and extend the growing season. Nonetheless, land use intensification and productivity increases imply the need for additional irrigation, an issue further elabourated below. Malda falls north of the Tropic of Cancer and has a relatively cool winter, whereas Nadia and Medinipur are tropical.

Groundwater is a key natural asset for irrigation development. However, in the Malda cluster the water table was reportedly deep (60–100 m), limiting its development and keeping agriculture predominantly rainfed. In the same cluster there were also reports of declining water tables. The use of groundwater for drinking and domestic purposes is widespread in the LGP as surface water is often mismanaged. High levels of arsenic in the groundwater are increasingly recognized as a serious threat to public health and already causing widespread poisoning in Bangladesh (Ahmed et al. 2006; Hossain 2006). In West Bengal, high levels of Arsenic have been detected in 64 blocks of 8 districts exposing a population of 5.9 million. In Nadia district 13 out of 15 districts and in Malda 5 out of 15 districts are affected. In one surveyed village each in the Malda and Nadia clusters, there were indeed specific reports of elevated arsenic levels in groundwater. The natural and manmade surface water bodies and inland fisheries provide additional natural resources. Particularly in the Malda cluster, fish ponds and fish farming were reported.

After land and water, livestock is the next main natural asset both in terms of value and prevalence. Livestock ownership is widespread with an average livestock herd of 2.8 cow equivalents per household (Table 10). However, the herd size varied significantly across clusters, with the Nadia cluster having 1.7 and the Medinipur cluster 3.8 cow equivalents per household.

There is occasional significant tree cover in and around the surveyed communities, with mango orchards in the Malda cluster, miscellaneous fruit trees in homesteads and uplands in the Nadia cluster and community forests in Medinipur. The trees and bamboo are important sources of construction material, fruits and fuel.

4.1.2 Physical capital

The physical capital asset base is relatively undeveloped and scarce. The surveyed villages typically had low coverage of utility services (electricity, piped water), a low penetration of telephones and about half availability of public transport (Table 11). A notable exception was the relative rural electrification in the Nadia cluster, probably linked to its proximity to Kolkata. Overall though, rural infrastructure was still relatively better than neighboring Bihar State and E U.P. The density and quality of the rural road network is reasonable, both in the surveyed villages and at the state level (road density of 56 km/km^2 — Annex 1). Travel times to the nearest urban centre were on average three-fourth of an hour and to the nearest agricultural market a little more than half an hour (Table 12). The Malda and Medinipur clusters were also relatively remote despite reasonable road infrastructure. The Malda cluster reported problems with drinking water.

Table 11. *General physical capital indicators*

Cluster	Electricity supply (% of household)	Public water supply (% of household)	No. of phones (#/100 house-hold)	Availability public transport (% of villages)
Malda	47 b	0	9	50
Nadia	75 b	5	10	67
Medinipur	8 a	0	2	50
Mean (s.d., n, p.)	44 (44, 18, 0.02)	2 (7, 18, ns)	7 (8, 18, ns)	56 (42, 18, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Table 12. *Selected market access indicators*

Cluster	Good access road (% of villages)	Travel time to urban center (minutes)	Travel time to agricultural market (minutes)
Malda	67	53	40
Nadia	60	50	46
Medinipur	50	43	14
Mean (s.d., n, p.)	59 (51, 18, ns)	48 (32, 17, ns)	34 (28, 16, ns)

Compared to the other IGP states, the relative lack of irrigation development is particularly striking. Although irrigation was widespread in the Nadia cluster, only 43 and 31% of the village area was reportedly irrigated in the Malda and Medinipur clusters, respectively (Table 13), which compares to state level data (44%—Annex 1). All the three surveyed clusters also lacked access to canal irrigation. Rural electrification made electric tubewells the primary irrigation source in all surveyed villages in the Nadia cluster and in a quarter of villages in the Malda cluster. In contrast, diesel tubewells were the prevailing primary irrigation source in the Malda and Medinipur clusters. In the Medinipur cluster pumping from surface water bodies was the primary irrigation source in 2 out of 5 surveyed villages. Pumping from surface water bodies was also reported for the other clusters as secondary irrigation source. It typically implies irrigation with a diesel pump and loose hose. These figures compare with the relative irrigated area share by source at the state level: 53% tubewell irrigated, 11% canal irrigated and 36% from other sources (Annex 1).

Table 13. *Irrigation indicators*

Cluster	% of area irrigated	Primary irrigation source (% of villages, n=15)			
		Electric TW	Diesel TW	Canal	Pumped from surface water
Malda	43 a	25	75	0	0
Nadia	93 b	100	0	0	0
Medinipur	31 a	0	60	0	40
Mean (s.d., n, p.)	56 (43, 18, 0.02)	47	40	0	13

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Compared to the other IGP states, the relative lack of (4 wheel) tractors is another striking contrast. There is only one tractor for every 67 farm households. This reflects the overall low tractor density across West Bengal State (0.6 tractors/100 ha cultivated), which is low both compared to the remainder of the IGP and India as a whole (Annex 1). The low tractor numbers in part reflect a relative preference for power tillers (2-wheel tractors), of which there are about equal number as tractors in the surveyed communities. However, power tillers were primarily concentrated in the Nadia cluster. In terms of power tillers West Bengal reportedly ranks first in the country. For instance, the Economic Survey reports that out of a total of 16,018 power tillers sold nation wide in 2000–01, 5,161 were sold in West Bengal. No combiners or zero-tillage (ZT) drills were reported in the surveyed communities (Table 14). The Medinipur cluster particularly stood out for its relative lack of mechanization and heavy reliance on animal traction.

4.1.3 Human capital

Human capital comprises the labour and skills available to the household. The average family size is 6.5. The derived population density at the village level amounts to 1700 people/km^2 (Table 15), a figure nearly double the rural population density at the state level (900—Annex 1). Over a third of the household heads in the surveyed villages had no formal education.

Assuming no formal education to be synonymous with illiteracy, the implied literacy was substantially lower than the reported male literacy rates at the state level (78%—Annex 1). Illiteracy appeared to be particularly high in the Malda cluster (Table 15). The importance of education was widely acknowledged amongst the villagers, as illustrated by the investment of farm households in the education of the youth. The Medinipur cluster seemed to be relatively more affected by disease/health problems.

Table 14. *Mechanization indicators*

Cluster	No. of tractors (per 100 farm household)	No. of power tillers (per 100 farm household)	No. of combines (per 100 farm household)	No. of ZT drills (per 100 farm household)
Malda	1.9	0.5	0	0
Nadia	2.2	3.5	0	0
Medinipur	0.5	0.0	0	0
Mean (s.d., n, p.)	1.5 (2.8, 18, ns)	1.3 (4.0, 18, ns)	0 (0, 18, ns)	0 (0, 18, ns)

Table 15. *Human capital indicators*

Cluster	Village level population density (people/km^2)	Family size (#/household)	Household head with no formal education (% of household)
Malda	1400	6.7	47
Nadia	1800	6.8	31
Medinipur	1900	5.8	34
Mean (s.d., n, p.)	1700 (700, 17, ns)*	6.5 (2.5, 18, ns)	37 (33, 18, ns)

* One village of Medinipur excluded due to extreme value.

4.1.4 Financial and social capital

Specific indicators for financial and social capital were not collected in the surveyed communities, but from the village discussions it became clear that they played an important and varied role that merits closer attention in future studies. These assets and the underlying processes like the social relations that shape them were perceived to be too problematic and sensitive to collect and quantify reasonably within the surveyed communities, particularly in view of our rapid scoping study with outsiders spending only half a day in each community.

Financial capital comprises the stocks of money to which the households have access. Convertible assets and cash savings from the various productive activities are important sources of financial capital in the surveyed villages. Livestock often plays an important role as a productive convertible asset. From the discussions it became clear that financial constraints were common place and many households relied on the local credit market to alleviate these leaving a number significantly indebted. The scarcity of financial capital and the corresponding working capital constraints were readily apparent in the Malda and Medinipur clusters. In the Nadia and Medinipur clusters indebtedness was frequently observed. The importance of small ruminants in West Bengal (relative to the TGP and W U.P.; see section 5.2) may reflect its role as a reserve of financial capital that is more easily divisible than a cow or buffalo in households with scarce financial capital.

Social capital comprises the community and wider social claims on which individuals and households can draw by virtue of their belonging to social groups of varying degrees of inclusiveness in society at large (Ellis 2000, 36). On average, the surveyed communities comprised 1700 people and 280 households (Table 16), providing a rough indicator of social coherence. Social capital influenced some of the transactions within the community (e.g. mobilization of labour, credit, machinery, crop residues, and milk). Social capital most likely also plays an important role in times of crises. Rogaly and Rafique (2003) have illustrated the importance of maintaining supportive networks of kin for West Bengal rural women in nuclear families to cope with periods when men are absent for seasonal migration. At the same time group identities based on religion and ethnicity are strengthened through the experience of migration and deployed by some migrants to make this form of employment less degrading (Rogaly et al. 2002).

Table 16. *Village size*

Cluster	# of people	# of households
Malda	1800 ab	330 ab
Nadia	2700 b	410 b
Medinipur	500 a	100 a
Mean (s.d., n, p.)	1700 (1500, 18, 0.05)	280 (260, 18, 0.10)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

4.2 Access modifiers

The translation of a set of assets into a livelihood strategy composed of a portfolio of income earning activities is mediated by a great number of contextual social, economic and policy considerations. The key categories of factors that influence access to assets and their use in the pursuit of viable livelihoods are access modifiers on the one hand and the trends and shock factors on the other (Figure 3). Access modifiers include social relations, institutions and organizations and comprise the social factors that are predominantly endogenous to the social norms and structure of which the rural households are part. The trends and shock factors consist predominantly of the exogenous factors of economic trends and policies and unforeseen shocks (e.g. floods) with major consequences on livelihood viability (Ellis 2000, 37–8). The access modifiers as pertaining to the study sites are reviewed here, whereas the subsequent section reviews the trends and shocks.

4.2.1 Social relations

The social positioning of individuals and households within society play an important role in the communities. Social divisions existed in the communities surveyed in West Bengal, but compared to the other IGP states, there was less overt evidence of social exclusion of particular individuals or groups within the communities (e.g. based on caste, class/wealth, origin, gender). All the West Bengal clusters had significant numbers of scheduled tribes, and for instance the Malda and Medinipur clusters fall in tribal belts whereby tribal institutions play a prominent role. Still, as in the case of social capital, and exacerbated by the sensitivities involved (e.g. in the case of caste) specific indicators of social relations within the surveyed communities were difficult to collect through the approach followed.

Gender inequity still plays a key role, although relatively less explicit than in the upstream IGP states. Female literacy at the state level compares favorably with the national average, but at 60% is substantially lower than male literacy (78% — Annex 1). Nonetheless, compared to the other IGP subregions, more women participated in the village surveys and were relatively vocal. For instance, in the Malda cluster women, including landless, were frank and participated actively, with one village even being dominated by a lady. But women labourers in the Malda and Medinipur clusters were paid less than males (see labour market discussion below). Women in the cluster villages were typically involved in both crop and livestock activities (Table 17). Although women reportedly participated in all crop and all livestock activities, there often was a gender-based division of labour, and often there was less female participation in plowing and milking. The prevailingly Muslim population also implied that women generally cannot work in other people's fields and seasonal migration is male dominated. The reported levels of women having some say over the derived crop and livestock income are typically only half the level of their reported involvement (Table 17). Contrary to the other IGP subregions (Erenstein et al. 2007a), there was generally no marked difference between the crop and livestock sector in terms of women's involvement or say over income.

Table 17. *Gender issues*

Cluster	Women involved in		Women have say in	
	Crop activities (% of villages)	Livestock activities (% of villages)	Crop income (% of villages)	Livestock income (% of villages)
Malda	100	83	33	33
Nadia	83	83	50	50
Medinipur	100	100	50	50
Mean	94	89	44	44

4.2.2 Institutions

Land and credit market

Land is typically privately held. Previous land reforms at the state level have redistributed land and regulated share cropping arrangements. In the surveyed communities, the rental and sales market of private land were largely monetized, particularly in the Nadia cluster. Land prices are significantly higher in the Nadia cluster, with rental prices more than double the reported rates in the Malda and Medinipur clusters, and sales prices double those of the Medinipur cluster. The differences are largely a reflection of the Nadia cluster's proximity to the Kolkata metropolis and its agro-ecological potential (Table 18). The land rents however also vary significantly by type of land. For example, in the Nadia cluster the land rent for upland suitable for vegetable production is double that for lowland suitable for rice only, reflecting the importance of topography and incidence of seasonal flooding. Similarly, in the same cluster, reported sales prices for upland are typically 150–200% those of lowland. The ratio of rental to sales price averages 4%. This indicator of the average annual return to investment in land thereby is lower than the prevailing rate of interest. This suggests that despite the high pressure on land, capital remains the most limiting production factor.

Table 18. *Selected credit and land market indicators*

Cluster	Interest rate moneylenders (%/year)	Irrigated land rental price ($\times 10^3$ INR/ha)[a]	Irrigated land purchase price ($\times 10^3$ INR/ha)	Rental:purchase price (%)
Malda	92	10 a	310 ab	3.2
Nadia	95	21 b	420 b	5.1
Medinipur	120	8 a	210 a	3.8
Mean (s.d., n, p.)	98 (28, 10, ns)	14 (8, 15, 0.01)	320 (130, 15, 0.01)	4.2 (1.7, 13, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

a Based on combination of reported values and estimated values. Estimated values replace missing values using reported purchase price in village and 4.2% as average rental:purchase price ratio.

Compared to the other subregions in the IGP, credit markets are undeveloped in West Bengal, further compounding the scarcity of capital. Informal moneylenders meet the bulk of credit demand in the surveyed villages. Reported informal interest rates average 8% per month (Table 18), which was significantly higher than the rates charged in the other surveyed subregions of the IGP (Erenstein et al. 2007a). Two out of six villages in each of the clusters even reported rates of 11–12% per month. Other sources of credit include the provision of inputs on credit, credit from market traders and consumer credit from cooperative societies.

Labour market

There is an active rural labour market in each community. The average wage rate amounted to INR 42–43/day in the Malda and Nadia clusters (Table 19), but only INR 33/day in the Medinipur cluster. In the Nadia cluster, food was generally provided to the labourers, but in the Malda cluster this was not necessarily the case. In the Medinipur cluster the work day was reportedly relatively short (5 hr). Wage rates thereby are the lowest amongst all the clusters surveyed throughput the IGP (Erenstein et al. 2007a). These reported rates are in stark contrast with the official minimum wage for agricultural workers in West Bengal of INR 111.77/day without meals in 2003, which supposedly is the highest rate in the country as per Minimum Wage ACT. 1948.

Table 19. *Selected labour market indicators*

Cluster	Male wage rate (INR/day)	Female: male wage ratio	Peak: average wage ratio	Labour scarcity (% of villages)	Seasonal in-migration (% of villages)	Seasonal out-migration (% of villages)
Malda	42 b	0.7 a	1.2	17	17	100
Nadia	43 b	1.0 b	1.5	17	67	50
Medinipur	33 a	0.9 b	1.4	67	50	83
Mean (s.d., n, p.)	39 (8, 18, 0.09)	0.8 (0.2, 18, 0.00)	1.4 (0.3, 14, ns)	33 (49, 18, ns)	44 (51, 18, ns)	78 (43, 18, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Crop labour needs are highly seasonal. Still, in view of abundant labour and small farm size, only a third of the villages reported seasonal labour scarcity (Table 19). This is in stark contrast with the other IGP subregions (Erenstein et al. 2007a). Furthermore, seasonal labour scarcity tended to be limited to the Medinipur cluster. Wage rates typically still do increase with an average 40% during peak periods in the three surveyed clusters, such as rice harvesting and rice transplanting. In the Nadia cluster during peak periods, labourers tended to be paid by task.

The Nadia cluster stood out as having ungendered wage rates: male and female rates were reportedly the same—a unique feature amongst all surveyed clusters across the IGP (Erenstein et al. 2007b; Singh et al. 2007; Thorpe et al. 2007). At 70% of the prevailing wage rate, female wage rates were significantly lower than male wage rates in the Malda cluster, although this could partly reflect differences in working hours and the type of tasks implemented (Table 19). Women labourers tend to be local.

The Medinipur cluster and particularly the Malda cluster are labour surplus and net suppliers of agricultural labour. All villages in the Malda cluster and 5 out of 6 in Medinipur report seasonal out-migration, typically seasonal male migrants move to urban centers and rural areas for rice transplanting and harvest. The Malda cluster appeared to have a higher propensity for mobility to urban centers and other states, whereas labourers from the Medinipur cluster seemed more likely to move to other agricultural districts within the state. Compared to seasonal out-migration, seasonal in-migration to the villages is less common, particularly in the Malda cluster. The Nadia cluster presents the most balanced picture, reflecting inter alia its relatively intensive agriculture. Indeed, in the Nadia cluster villages with significant land tended to have year-round work (say 290+ days), a labour deficit and no need for out migration. This contrasted with the relatively landless villages in the same cluster which typically were labour surplus and needed to supplement their local work opportunities with seasonal and permanent out migration.

Rogaly and associates (Rogaly et al. 2001; Rogaly and Rafique 2003) have described the agricultural labour markets in West Bengal, where migrant rice labourers are recruited directly by individual employers at busy labour market places or in migrants' home villages. Hiring arrangements were entirely verbal, and the 'going rate' could vary substantially and with uncertainty for labourers about actual payment at the end of the job and the size and nature of the accompanying meals. Employment could be by the day, or by the task on piece rates and working hours were long and arduous, especially in the summer heat. An informal wage floor has been put into place and managed by the peasant union allied to the largest party in the Left Front regime (Rogaly et al. 2002).

Agricultural input and output markets

There is marked differentiation amongst surveyed communities in terms of external input use (Table 20). The Nadia cluster stood out as having the highest and near universal rates of improved seed purchase and use of chemical fertilizers and herbicides. This is a reflection of the intensive horticultural and rice crops grown there and suggests input availability is not an issue. The purchase of improved seeds is particularly associated with the horticultural crops, as for rice seed re-use is common. The Medinipur cluster stood out for having near negligible use of herbicides, a reflection of the prevailing low wage rates. Purchase of improved seed was also low, although chemical fertilizer was reportedly universal. The Malda cluster showed relatively intermediate levels of 50–70% for the three inputs. At a use rate of 68% of farmers, the chemical fertilizer use was however the lowest amongst all the surveyed clusters across the IGP (Erenstein et al. 2007b; Singh et al. 2007; Thorpe et al. 2007). The low use rates are a likely reflection of the risks inherent to flood plain cultivation with uncontrolled flooding. Indeed, despite widespread poverty, resource constraints are likely to play a lesser role as herbicide use was relatively widespread. Herbicide use may be attractive despite the low wage rates in view of enhanced timeliness of weeding. There are also active markets for tractor services (the Malda and Nadia clusters) and animal traction services (the Medinipur and Malda clusters), as reflected by ownership rates typically being lower than use rates (Tables 14, 30 and 45).

Table 20. *External input use (% of household reportedly using)*

Cluster	Purchase improved seeds	Chemical fertilizers	Herbicides
Malda	57 b	68 a	47 b
Nadia	98 c	100 b	85 b
Medinipur	28 a	100 b	3 a
Mean (s.d., n, p.)	59 (37, 17, 0.00)	89 (29, 18, 0.07)	47 (48, 15, 0.01)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Despite being the largest rice producing state and having reached surplus in cereal production by 1999–2000 (GoWB 2004, 128), West Bengal is not an important source for rice procurement for the Food Corporation of India (FCI) and thereby does not figure amongst the actual beneficiaries of the Minimum Support Price (MSP) schemes for rice and wheat (World Bank 2005, 21). Rice is produced both for self-consumption and marketing, with surplus rice generally marketed through local markets and traders. Wheat is not widely produced and any surplus is marketed locally. As a result, farmer reported prices for paddy and wheat are more variable and less closely associated with the MSP (Table 21). Wheat prices are somewhat more favourable than the MSP for 2004–05 (INR 6.4/kg). Paddy prices were highest in the Nadia cluster and more favourable than the MSP for 2004–05 (INR 5.6/kg common grade), whereas they were low in both Malda and Medinipur cluster. The differential paddy price is likely associated with the development of rice value chains in response to rice marketable surplus and market access differences between the clusters. The domination of West Bengal in national jute production implies an active role for the Jute Corporation of India, which procures a tenth of production with a MSP of INR 8.9/kg for 2004–05.

Table 21. *Selected commodity prices (INR/kg, farm gate)*

Cluster	Wheat	Paddy
Malda	6.7	5.2 a
Nadia	7.2	6.9 b
Medinipur	6.6	4.9 a
Mean (s.d., n, p.)	6.8 (0.6, 9, ns)	5.7 (1.0, 15, 0.00)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

For comparative purposes selected livestock prices were compiled during the group discussions (Table 22). The reported purchase/sale prices for *desi* cattle were typically half those of cross-bred cattle. Buffalo are uncommon, so that few buffalo prices were reported, with a tendency to be similar to those reported for cross-breds. Goats/sheep fetched INR 500–800/head. Milk prices were relatively constant at INR 9–11/litre across the three surveyed clusters. Surprisingly, prices tended to be lowest in the Nadia cluster despite its proximity to Kolkata and milk marketing seemed to be an issue. Most milk was reportedly traded through local milk salesmen without industrial processing and/or consumed/sold locally within village/household.

Table 22. *Selected animal and produce prices (INR, farm gate)*

Cluster	Local cow (INR/head)	Crossbred cow (INR/head)	Buffalo (INR/head)	Milk (INR/liter)
Malda	3800	8200	11,000	9.8
Nadia	4600	9100	–	9.3
Medinipur	3100	7800	7800	11.0
Mean (s.d., n, p.)	3800 (1800, 17, ns)	8500 (4500, 11, ns)	8600 (2300, 4, ns)	10.0 (1.3, 15, ns)

In the Nadia cluster most markets tended to be monetized. In the Malda cluster, some interlinking of produce markets was reported (e.g. 1 kg pork = 10–15 kg rice, exchange after harvest). There is also an active market for rice residues, which will be dealt with in more detail when discussing crop–livestock interactions (section 6.1).

4.2.3 Organizations

In terms of organizations, the study focused the discussions on agricultural services. The use of artificial insemination (AI) provided the starkest contrast between the clusters, being widely used in the Nadia cluster and relatively unused in the Malda and Medinipur clusters (Table 23), thus mirroring the prevalence of *desi* cattle in the latter two clusters. However, AI seemed to be constrained by its availability. The reported increasing trend in AI use in the Nadia and Malda clusters was directly associated with enhanced availability. In the Malda cluster, AI was apparently available in some villages, but completely absent in others. Some villages with AI in the Malda cluster also reported having access to 3 different grades (exotic, upgrade, local). The Medinipur cluster reportedly lacked AI services. Veterinary services were reportedly used by three-fourth of households in surveyed communities, as against half reporting livestock extension and a third crop extension services (Table 23). Across the clusters the use of veterinary services was on the increase. The Medinipur cluster reported reliance on private veterinary services, which were reportedly more expensive (e.g. INR 50–100 vs. INR 5 charge) but more readily available and used. Input dealers/shops emerged as an important information source for farmers.

The Panchayat institution is one particularly prominent and functional organizational feature in rural West Bengal, with the village being the lowest of the three tiers. The village-level Gram Panchayat played an active role in village endeavors and allowed for decentralization and people's participation. The Gram Panchayat also played a role in agricultural extension and access to information. Some self help groups were also reported. In the Medinipur cluster the lack of access to hospitals and education emerged as problems. the Nadia cluster benefited from the proximity to various agricultural institutions, Nadia district hosting the State Agricultural University, the State Veterinary University, the Eastern Station of National Dairy Research Institute, and the Indian Veterinary Research Institute.

Table 23. *Use of selected agricultural services (% of household reportedly using)*

Cluster	Artificial insemination	Veterinary services	Livestock extension	Crop extension
Malda	6 a	83	41	36
Nadia	73 b	75	54	15
Medinipur	2 a	65	68	56
Mean (s.d., n, p.)	28 (40, 17, 0.00)	75 (34, 15, ns)	53 (41, 13, ns)	36 (42, 12, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

4.3 Trends and shocks

Rice is the traditional food crop in the surveyed communities of West Bengal. Wheat never was nor currently is a major crop in any of the surveyed clusters. In the Nadia cluster wheat reportedly dropped out of the cropping system around the turn of the century. Boro rice and its associated irrigation development have transformed large swathes of rural West Bengal. Of late though, the advent of these forces has been running out of steam, including increased difficulties to tap deep and/or declining groundwater tables. The boro rice—irrigation combination also has largely bypassed the Malda and Medinipur clusters, which seemed agriculturally stagnant and at significantly lower levels of agricultural development than the Nadia cluster. The most striking difference between the clusters was the prevalence of irrigation and year round cropping in Nadia as compared to the primarily rainfed and single cropped the Medinipur cluster, with an intermediate position for the Malda cluster. In the Nadia cluster cash crops grown for the market were on the increase, including vegetables and floriculture. In the Malda cluster, the crops on the increase presented a more mixed picture, but included a shift towards more rice–wheat in some villages. Crops that have dropped out generally included sugarcane and aus rice. The decline of sugarcane, particularly in the Malda cluster, was often associated with market issues (including low price) and its long duration. The decline of aus rice was associated with its low productivity and pest and weed problems. In the Malda cluster, some of the crop changes were driven by the incidence of flooding, including a shift from aus rice to jute and tobacco to potato. There were various other crops that were on the decline in some of the communities, often due to a range of both market and technical constraints.

In terms of livestock, the perceived trend for *desi* cattle in the surveyed communities was downwards or stagnant, whereby declines were attributed to the low yield and grazing constraints. Buffalo numbers were either stagnant or downwards. In contrast, particularly in the Nadia cluster, cross-breds were on the increase, driven by their higher yield and profit and facilitated by the increased availability of AI services. In the Medinipur cluster crossbred trends presented a more mixed picture. In terms of small ruminants the picture was varied across the surveyed clusters. In the Nadia cluster, goats were on the increase driven by their profitability. In contrast, goat trends in the Malda and Medinipur clusters tended to be stagnant or downwards. Whereas sheep trends were stagnant in the Malda cluster, they were reportedly downwards in the Medinipur cluster driven by their unfavourable smell and grazing constraints. Perceived trends in poultry were upwards for the Nadia cluster, and more mixed for the other clusters. In the Medinipur cluster, Newcastle disease was reported as a major constraint that occasionally decimated the poultry population.

In terms of crop production practices, the use of external inputs like improved seed, chemical fertilizer and herbicides were on the increase, driven by the inherent productivity/yield gains. In the Medinipur cluster the use of high yielding rice varieties was increasing, whereas these varieties had already made significant inroads in the other clusters. Another striking contrast between the surveyed clusters was the relative lack of mechanization in the Medinipur cluster (Table 24), which still primarily relied on animal traction. In contrast, in the Malda cluster and particularly the Nadia cluster, tractor use (4-wheel and 2-wheel) was widespread and on the increase, driven by enhanced timeliness and wider availability (owned or rented). No combiner use was reported in any of the surveyed communities. Mechanical wheat threshers, common in the upstream subregions, were not observed, whereas some manual paddy threshers were. In the other IGP states zero tillage wheat using a tractor drawn zero tillage seed drill has been spreading recently. In none of the surveyed communities in West Bengal was there any knowledge or use of the zero tillage seed drill (Table 24). In part, this reflects the limited wheat area and the only very recent efforts to accelerate the diffusion of zero tillage in West Bengal. Some of the surveyed communities did report the use of manual no-till practices, like the direct seeding of lathyrus as a relay into a standing rice crop.

The high population density and still positive population growth (1.8% p.a. at for West Bengal) exert considerable and increasing pressure on the already intensively used natural resource base. Above (section 4.1.1) we have already reported the increased incidence of Arsenic poisoning afflicting rural communities of West Bengal. Malda district stands out as having the second largest population growth rates of the state (2.5% p.a. GoWB 2004, 10). In part, this is associated with the reportedly increasing Bangladeshi population. The proximity of the border also adversely affected the Malda cluster villages through reportedly higher insecurity levels. Some communities reported the potential theft of animals which reduced investment incentives in livestock. Some border villages thereby reportedly kept the animals for safekeeping within the house during nighttime whereas the people slept outside.

Table 24. *Mechanization and zero tillage (ZT) indicators*

Cluster	Use of tractor (% of farm household)	Use of combiner (% of farm household)	Knowledge of ZT (% of villages)	Use of ZT (% of farm household)
Malda	72 b	0	0	0
Nadia	95 b	0	0	0
Medinipur	20 a	0	0	0
Mean (s.d., n, p.)	66 (40, 15, 0.01)	0 (0, 5, ns)	0 (0, 18, ns)	0 (0, 0, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Natural calamities (flooding, drought, disease) presented occasional shocks with widespread impact in the communities surveyed. In addition, individual households were also subjected to the range of individual and social shocks that typically affect the rural poor (e.g. accidents, sudden illness, loss of access rights, etc), with immediate effects on the livelihood viability of the individuals and households concerned.

5 Livelihoods strategies

The asset status of households, mediated by social factors and exogenous trends and shocks, results in adoption and adaptation over time of livelihood strategies. Livelihood strategies are dynamic and are composed of activities that generate the means of household survival (Ellis 2000, 40). The present chapter reviews the main livelihood activities in the surveyed communities: crop production, livestock and non-farm based activities.

5.1 Crop production

Crop production is the major activity for households with access to land (owned or hired, i.e. farm households). With irrigation there are two main crop seasons/year, each season with its distinct set of crops.

In the *kharif*/monsoon season, the average village cropped area is primarily allocated to rice (71%) and a lesser extent horticulture (19%, primarily vegetables, but also some fruit orchards) and fallow (7%, due to flooding), with marginal areas under pulses/oilseeds, other cereals (typically maize), fodder crops and sugarcane (0–1% each — Table 25). Rice is the dominant monsoon crop across the clusters and grown in all surveyed communities. Still, the Medinipur cluster stands out by its near sole cropping of rice during the monsoon, whereas in the Nadia and Malda clusters there are also significant areas under horticulture. This reflects both a wider occurrence of horticulture (reported in 5 out 6 villages in the Nadia and Malda clusters, as against 2 out of 6 for the Medinipur cluster) and stronger specialization. The relative horticulture area in the Malda cluster is somewhat inflated by one village having most of its cultivable area as mango orchard. Summer maize cultivation was reported in half the surveyed villages in the Malda cluster, albeit on relatively limited areas. Compared to the other IGP subregions, the lack of *kharif* fodder crops is particularly striking, and was only reported in 2 out of 6 villages in the Nadia cluster.

Table 25. *Crop share of* kharif *area (% village cultivable area)*

Cluster	Rice	Other cereal	Sugarcane	Horticulture	Pulses/ oilseeds	Other crops	Fodder crops
Malda	58 a	3 b	1	21	0	0	0
Nadia	53 a	0 a	0	33	2	0	1
Medinipur	102 b[1]	0 a	0	2	3	0	0
Mean (s.d., p.) [n=18]	71 (38, 0.03)	1 (3, 0.07)	0 (1, ns)	19 (27, ns)	1 (3, ns)	0 (0, ns)	0 (1, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.
1. Includes some double cropping during *kharif*—aus and aman.

In *rabi*/winter season, the village cropped area is relatively diverse and allocated to horticulture (23%, including potato and vegetables), non-wheat cereals (16%, particularly boro rice), pulses/oilseeds (14%, including gram, lathyrus, lentil, rape, mustard), wheat (5%), and other crops (4%, particularly jute—Table 26). Due to irrigation constraints, boro rice is primarily limited to the Nadia cluster (4 out of 6 villages reporting, with only one village in the Malda cluster). Horticulture area is quite variable, with a tendency to be highest in the Nadia cluster and lowest in the Medinipur cluster. This primarily reflects stronger specialization (with horticulture being the main non-monsoon crop in half the villages in the Nadia cluster) as winter horticulture was reported across the clusters (reported in all villages in the Nadia cluster and 4 out of 6 villages in the Malda and Medinipur clusters). The extent of horticulture is limited by irrigation and market access. Compared to the other IGP subregions, the limited wheat area and the absence of winter fodder crops are particularly striking. Still, wheat was reportedly cultivated in 5 out of 6 villages in the Malda cluster and 4 out of 6 villages in the Nadia and Medinipur clusters. Winter maize was reported in only one village in the Nadia cluster. Irrigation constraints implied more fallow land which was used for grazing (reported in three villages in Malda and four villages in Medinipur, as against only one village in Nadia).

Table 26. *Crop share of* rabi *area (% of village cultivable area)*

Cluster	Wheat	Other cereal	Sugarcane	Horti-culture	Pulses/ oilseeds	Other crops	Fodder crops
Malda	7	12 ab	0.3	22	15	6	0
Nadia	6	37 b	0.0	41	12	4	0
Medinipur	2	0 a	0.0	7	14	0	0
Mean (s.d., p.) [n=18]	5 (5, ns)	16 (29, 0.07)	0.1 (0.5, ns)	23 (28, ns)	14 (20, ns)	4 (8, ns)	0 (0, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Rice-based cropping systems thereby prevail across the three clusters (78% overall, Table 27). The main rice-based cropping systems included rice–fallow (39%, prevailing in the Medinipur cluster), rice (aman)–rice (boro) (22%, mainly the Nadia cluster), rice–pulses/ oilseeds (11%) and rice–horticulture (6%). Only 6% of the cropping systems were wheat based (fallow–wheat) and were limited to the Malda cluster. The remaining 17% had horticulture based systems. The dominance of rice in the cropping pattern (all the clusters) is thereby prominent. In neither season were major differences in cropping patterns reported for large- and small-scale farmers.

Table 27. *Main cropping system (% of villages)*

Cluster	Rice based	Wheat based	Other
Malda	67	17	17
Nadia	67	0	33
Medinipur	100	0	0
Mean [n=18]	78	6	17

The seasonal cropping intensity in the surveyed villages averages 93% in *kharif* and 62% in *rabi*, resulting in an annual cropping intensity over two seasons of 155% (Table 28). However, there is a marked gradient in cropping intensity across sites, with a low of 130% in the Medinipur cluster and a high of 188% in the Nadia cluster. In the *rabi* season the gradient is even more marked, reiterating the underlying irrigation gradient and the intensive land use in the Nadia cluster. In fact, Nadia district is the most intensively cultivated district in West Bengal and government statistics estimate only six districts to have a cropping intensity above 200% (Nadia—250, Hoogly—220, 24 Parganas North—209, Murshidabad—210 and Howrah—206). The official district level estimate thereby is substantially higher than our cluster level estimate, an issue related to the downward bias of our estimate being based on the two main cropping seasons only. Another issue to note is that the cropping intensity and the underlying area shares are relative to the village cultivable area. It should be noted though that the Medinipur cluster is primarily rainfed, so that the monsoon area and village cultivable area largely correspond, explaining the 100% *kharif* cropping intensity. In the two other clusters though, irrigation facilities and incidence of flooding implies that *kharif* cultivated area and *rabi* cultivated area do not necessarily correspond. The figures are for indicative purposes and do highlight the main points. That is, the Medinipur cluster has a low cropping intensity, with widespread winter fallow due to irrigation constraints. The Nadia cluster has an intensive cropping year-round, whereas the Malda cluster takes an intermediate position.

Table 28. *Cropping intensity indicators (% of cultivable land)*

Cluster	*Kharif*	*Rabi*	Annual
Malda	83	62 b	145 ab
Nadia	88	100 c	188 b
Medinipur	100	30 a	130 a
Mean (s.d., n, p.)	93 (29, 18, ns)	62 (44, 18, 0.00)	155 (48, 18, 0.09)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

The reported paddy yields (4.4 t/ha) are relatively favourable compared to those reported in U.P. and Bihar, but still lower than those reported in Punjab and Haryana. In contrast, the reported wheat yields (2.5 t/ha) are relatively low and comparable to those reported in Bihar, a reflection of the relatively marginal environment for wheat (short growing season). There were no marked productivity differentials between the clusters for paddy or wheat (Table 29).

On average half the rice produced is marketed, but there is tendency for rice to be primarily produced for the market in the Nadia cluster and primarily for home consumption in the Malda and Medinipur clusters (Table 29). The marketed share compares well against the average marketed surplus ratio of 55% for the triennium 1999–2002 for rice at the State level (Annex 1; MoA 2004a). In the Medinipur cluster there generally appeared to be limited surplus, a reflection of the limited farm size and single cropping. Still, there were reports of forced selling of produce in the Medinipur cluster to liquidate debts. In the Malda cluster there was a consumer preference for aman rice over boro rice. In the Nadia cluster parboiling of rice was common practice. Wheat is primarily produced for own consumption, reflecting the generally limited wheat area and low yields (Table 29).

Table 29. *Rice and wheat: Yields and marketed surplus*

Cluster	Wheat (t/ha)	Paddy (t/ha)	Marketed share wheat (%)	Marketed share paddy (%)
Malda	2.5	3.9	22	45
Nadia	2.3	4.4	0	63
Medinipur	2.5	4.8	40	35
Mean (s.d., n, p.)	2.5 (.6, 7, ns)	4.4 (1.0, 15, ns)	21 (22, 5, ns)	50 (27, 15, ns)

Compared to the upstream IGP subregions, wheat largely disappears from the agricultural system in the West Bengal clusters, reflecting productivity constraints and its generally limited human consumption. Instead, rice asserts itself as the dominant crop in terms of food, feed and income, aided by the limited agricultural alternatives for the flood-prone lowlands during the monsoon.

5.2 Livestock production

The village surveys confirmed widespread ownership of livestock to complement the rice-based cropping systems as the basis of rural livelihoods (Table 30). The widespread ownership of backyard poultry (57% of households, including duckery) is particularly striking compared to the relative absence of poultry in the upstream IGP subregions (Erenstein et al. 2007a). Furthermore, there is a tendency for poultry ownership to increase from a third of households in the Malda cluster in the North to 85% of households in the Medinipur cluster in the South. Backyard poultry prevails: none of the surveyed villages reported commercial (broiler and layer) chickens, the development of which has been limited to peri-urban areas of West Bengal. Poultry was owned by both landless and landed households.

Table 30. *Livestock ownership (% of household)*

Cluster	Buffalo	Local Cow	Crossbred cow	Draught	Caprine and ovine	Pigs	Poultry	Equine and camel
Malda	3	90 b	3 a	29 a	72 b	2	33	0
Nadia	1	11 a	63 b	6 a	23 a	1	52	2
Medinipur	5	76 b	2 a	64 b	63 b	2	85	0
Mean (s.d., p.) [n=18]	3 (6, ns)	58 (40, 0.00)	23 (34, 0.00)	33 (34, 0.00)	53 (34, 0.02)	2 (3, ns)	57 (45, ns)	0.6 (2, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Desi cattle are the prevailing stock across the three clusters, but show a marked concentration in the Malda and Medinipur clusters: respectively 90 and 76% of households owning *desi* cattle (Table 30) and an average of 2.1 and 1.8 heads per village household (Table 31). *Desi* cattle are relatively absent from the Nadia cluster. Instead, crossbreds show a marked concentration in the Nadia cluster: 63% of households owning crossbred cattle (Table 30) and an average of 1.3 heads per village household (Table 31), but being relatively absent from the other two clusters. Milk yields of *desi* cattle are low and milk in Malda and Medinipur cluster is thus primarily used for domestic consumption (Table 32). In contrast in the Nadia cluster, the prevalence of the higher yielding crossbreds implies that the milk is primarily marketed (Table 32). As indicated earlier (Table 22) and reflecting the productivity differential, the reported prices for cross-bred cattle were typically more than double those of *desi* cattle and there was a trend towards cross-breds where AI facilities were available. Crossbreds also seemed to be constrained by the lack of feed resources to maintain the animals, particularly in the Malda and Medinipur clusters.

Table 31. *Livestock numbers (heads/household)*

Cluster	Buffalo	Local cow	Crossbred cow	Draught	Caprine and ovine	Pigs	Poultry	Equine and camel
Malda	0.0	2.1 b	0.0 a	0.3 a	2.3	0.0	0.2 a	0.0
Nadia	0.0	0.1 a	1.3 b	0.1 a	1.2	0.0	1.9 a	0.0
Medinipur	0.1	1.8 b	0.0 a	1.0 b	3.7	0.1	8.2 b	0.0
Mean (s.d., p.) [n=18]	0.1 (0.1, ns)	1.4 (1.0, 0.00)	0.4 (0.7, 0.00)	0.4 (0.6, 0.01)	2.4 (2.2, ns)	0.0 (0.1, ns)	3.4 (4.2,. 00)	0.0 (0, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Table 32. *Livestock and milk sales*

Cluster	Herd size (# of cow equivalents per household)	Regular livestock sales (% of villages)	Non-local livestock sales (% of villages)	Marketed share milk (% of output)
Malda	2.8 ab	17	0 a	42 a
Nadia	1.7 a	0	0 a	84 b
Medinipur	3.8 b	0	50 b	24 a
Mean (s.d., n, p.)	2.8 (1.6, 18, 0.06)	6 (25, 16, ns)	13 (34, 16, 0.03)	52 (37, 14, 0.03)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Small ruminants (goats and sheep) showed a similar contrast between the Nadia cluster and the Malda and Medinipur clusters, with respectively 23 and 63–72% of households owning small ruminants. Compared to cattle, small ruminants were often preferred by the smallholders and landless due to their relative divisibility (i.e. smaller units providing more transaction flexibility) and regularity (i.e. short gestation period). This is consistent with other studies (Rangnekar–2006) and reiterates the prevailing resource constraints.

Draught animals showed a marked concentration in Medinipur: 64% of households owning (Table 30) and an average of 1.0 heads per village household (Table 31). As expected, this is inversely related to tractor use (Table 24). Draught animals are primarily bullocks, with occasionally a few male buffalos.

Particularly striking is the relative absence of buffalo in the West Bengal clusters, compared to the upstream IGP subregions (Erenstein et al. 2007a). Some of the respondents related this to cattle being easier to manage and the lack of labour for supervision. In fact, labour constraints seemed to affect overall livestock management and grazing prospects in the surveyed communities.

The divergences between the clusters imply that the Medinipur cluster has the highest average livestock herd: 3.8 cow equivalents per household. The corresponding figure for the Nadia cluster is only 1.7, with an intermediate value of 2.8 for Malda (Table 32).

The important role of livestock again extends to the landless, with 10–100% of landless households keeping livestock. The types of stock owned by the landless were generally mixed, including goats, cows and poultry. The few instances with pigs were typically landless.

Sales and purchases were not regular occurrences (Table 32). Livestock transactions tended to be local, except for the Medinipur cluster where half of the villages reported sales outside the locality (Table 32). There were also some livestock health issues, particularly in the Medinipur cluster, linked to feeding practices and the incidence of Newcastle disease.

In summary, and compared to the other IGP subregions upstream, the West Bengal clusters thereby show: (i) a relatively limited role and income from dairy; (ii) near complete substitution of cattle for buffalo; (iii) a spatial heterogeneity in terms of the prevalence of *desi* cattle (the Malda and Medinipur clusters) and cross-breds (the Nadia cluster); and (iv) the importance of backyard poultry. The more limited dairy role is likely associated with marketing constraints, lower milk consumption and the increased reliance on rice–fish diets.

5.3 Non-farm based activities

As well as crop and livestock production, rural households in the surveyed communities were variously engaged in different types of off-farm activities. Such activities typically included farm labour on other farms, self employment and employment/service elsewhere. The Nadia cluster benefited from its proximity to the Kolkata metropolis and the related non-farm labour opportunities (e.g. masonry, industry, trading). In the Malda cluster, some cottage industries like rope making were reported (reportedly sold @ Rs4/kg rope, generating approximately INR 10/day).

Particularly the engagement in farm labour can be seen as an indicator of relative poverty due to its low wages, low status and seasonality, and is often associated with landlessness or a very small holding. Indeed, working as a farm labourer was the main employment for the landless in the three clusters. Most farm labourers worked locally and, when migrating seasonally, tended to remain within the state and did so during the times of rice harvesting and rice transplanting. More than three-fourth of the surveyed villages mentioned members of some households seasonally migrating out of the village (Table 19), mainly to work as farm labour in other villages.

Rogaly and associates have documented the plight of the landless and role of seasonal migration for agricultural work from densely peopled regions in West Bengal. They report that seasonal migration can involve practical welfare gains, but the costs and risks of migration remain high (Rogaly et al. 2002). Seasonal migration, of mainly Muslim men traveling without their wives, is reportedly from 10 days to about a month. It gives the migrants the opportunity to acquire lump sums for the equivalent of 10 to 25 US dollars (Rogaly and Rafique 2003).

5.4 Relative importance of livelihood activities

Across all the surveyed villages in West Bengal, the main livelihood activities were crop farming (60%), farm labour (23%), employed outside district (11%), livestock rearing (4%) and self employed (2%) (Table 33). The importance of livestock rearing was thereby relatively low compared to the other IGP subregions surveyed (Erenstein et al. 2007a). Although not significant, there is a tendency for employment on other farms to be relatively higher in the Malda cluster. Similarly, there is a tendency for employment outside the district to be relatively higher in the Nadia cluster, a likely reflection of the opportunities offered by its proximity to the Kolkata metropolis. Overall though, there was only limited variation over the clusters, despite the differential asset base available to the households, as reviewed in the previous chapter.

Across surveyed villages, smallholders predominated (61%) followed by landless poor (35%). Large farmers (2%) are uncommon. Wealth is closely associated with access to land in these rural communities, and consequently landless rich households are uncommon (2%), and largely limited to the Nadia cluster with its more significant non-agricultural opportunities. There is relatively little variation over the clusters (Table 34). Despite the reportedly widespread land reforms in West Bengal (see chapter 3), the share of landless poor is still relatively high and comparable to that reported across the surveyed clusters of neighbouring Bihar (Thorpe et al. 2007). Elsewhere in West Bengal, it has been reported that rural inequality had increased as the control over land and water, and hence wealth, had become more highly concentrated. Increasing land prices, conflicts over land titles and high dowry costs had led many to lose land (Rogaly and Rafique 2003).

Table 33. *Main livelihood activity (% of household)*

Cluster	Crop farming	Livestock rearing	Employed on other farms	Self employed	Employed outside district
Malda	57	0	30	2	11
Nadia	59	2	20	4	15
Medinipur	65	8	18	1	8
Mean (s.d., p.) [n=18]	60 (27, ns)	4 (7, ns)	23 (21, ns)	2 (4, ns)	11 (12, ns)

Access to land thus provides a key indicator for differentiating amongst household livelihood strategies. For the larger landed households, crop production appeared as the main livelihood source. In the case of the Malda cluster, fruit orchards were particularly important. For small-holders crop and livestock are typically complementary. Their relatively small land holdings however generally limit the income from crop production. In the Malda cluster some small-holders reportedly leased out their limited land to a larger landlord and subsequently hired out their own labour. Landless households depend primarily on their labour asset used both locally and through seasonal migration, with livestock providing an important contribution.

Table 34. *Categorization of village households (% of household)*

Cluster	Landless rich	Landless poor	Small farmers (<4 ha)	Large farmers (>4 ha)
Malda	0	38	59	3
Nadia	4	29	65	2
Medinipur	1	33	67	0
Mean (s.d., p.) [n=18]	2 (5, ns)	35 (27, ns)	61 (28, ns)	2 (3, ns)

Labour plays another key role in shaping the household livelihood strategies. Family labour provides the lion's share of the labour needs for crop and livestock production. Half the farm households used casual labour to supplement family labour in crop production. This tended to be substantially higher in the Nadia cluster, reflecting the more intensive cropping systems. Other uses of non-family labour are virtually absent (Table 35).

In sum, the rural livelihoods in the West Bengal clusters revolved around rice–livestock systems. For landed households, the crop component thereby generally was more important than the livestock component for household income whereas landless depended primarily on farm labour. Only in the Nadia cluster were the agricultural systems relatively intensive. The combination of resource constraints and the relatively low productivity levels prevailing in the Malda and particularly in the Medinipur cluster strengthened risk aversion and made the systems subsistence oriented that sometimes resorted to distress sales.

Table 35. *Labour use by enterprise*

Cluster	Crop		Livestock	
	Use of casual labour (% of farm household)	Use of permanent labour (% of farm household)	Use of casual labour (% of household)	Use of permanent labour (% of household)
Malda	45	1	0	0
Nadia	70	0	2	0
Medinipur	40	0	0	0
Mean (s.d.,p.) [n=18]	52 (40, ns)	0 (1, ns)	1 (2, ns)	0 (0, ns)

6 Crop–livestock interactions

The previous two chapters presented the livelihood platforms and livelihood strategies pursued by the surveyed communities. Within this context, the present chapter specifically looks into the crop–livestock interactions. We start by reviewing the flows of the crop activities into the livestock activities. Particular emphasis is put on understanding crop residue management and livestock feeding practices. We subsequently address the reverse flows from livestock into crop activities, particularly in terms of manure and traction services. The chapter ends with an assessment of crop–livestock interactions.

6.1 Crop residue management

Crop residues (straw) constitute an important by-product of crop production and all the surveyed communities reported their use as animal feed. There is however significant variation over crops. Crop residue use as animal feed amongst the rural households is near universal for rice. In the Malda cluster, there is also some reported use of maize residues, whereas in the Medinipur cluster some potato residue was reportedly used. However, and in marked contrast with the other IGP subregions (Erenstein et al. 2007a), the share of households using wheat residues as feed was marginal (Table 36). The already marginal use of wheat straw had a tendency to decrease further along the North–South gradient. Two factors largely explain this marked contrast in the use of rice and wheat straw. First, rice has long been the traditional and prevailing food crop in West Bengal resulting in a tradition of rice straw use as livestock feed that extends into Bangladesh. In contrast, wheat is a relatively recent arrival and its cultivation relatively limited. Second, wheat straw is relatively sturdy and its use as animal feed elsewhere has benefited from the mechanical threshing that prevails in the traditional wheat growing areas. This mechanical threshing chops the wheat straw into more palatable pieces. However, in West Bengal, mechanized threshing has yet to make significant inroads.

Table 36. *Crop residue collection for* ex situ *livestock feed (% of household)*

Cluster	Wheat	Rice	Maize
Malda	6	96	33
Nadia	3	100	0
Medinipur	1	100	–
Mean (s.d., n, p.)	4 (6, 14, ns)	99 (6, 18, ns)	25 (50, 4, ns)

There appears to be considerable variation in the livestock pressure on the crop residues over the clusters (Table 37). Particularly the pressure on generic crop residues shows a marked difference: the Medinipur cluster reported levels more than triple those reported in the Malda and Nadia clusters. This is the combined result of the Medinipur cluster having the largest herd size (in cow equivalents), the lowest cropping intensity and a tendency to have the smallest farm size. The limited wheat area inflates the nominal pressure on wheat residues, although this is of limited practical interest in view of the limited feed-use of wheat residues. Though there is a tendency for divergences over the clusters in terms of pressure on rice and cereal residues in general, these differences are not statistically significant, reflecting considerable variability and our limited sample size. The pressure on crop and cereal residues in West Bengal is markedly higher than that reported in the other IGP subregions for this study (Erenstein et al. 2007a), reflecting West Bengal having the lowest farm size with intermediate herd size (in cow equivalents) and relatively low cropping intensity (particularly due to the Medinipur and Malda clusters).

Table 37. *Indicators of livestock pressure on crop residues*

Cluster	On crop residue (cow eq./ha)	On cereal residue (cow eq./ha)	On wheat residue (cow eq./ha)	On rice residue (cow eq./ha)
Malda	4.7 a	10.8	95 a	22
Nadia	2.6 a	6.6	61 a	7.5
Medinipur	14.2 b	16.3	641 b	17
Mean (s.d., p.) [n=18]	7.2 (10, 18, 0.10)	11.3 (11 ,18, ns)	253 (431, 13, 0.08)	15 (19, 18, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

The rice crop is harvested manually, whereby the rice plants are cut just above the soil surface (see Annex 5:2). The crop bundles are subsequently brought to a central place in the field or elsewhere for threshing, thereby facilitating the collection and use of crop residues. The threshing of paddy is generally done manually or with a paddle thresher, keeping the rice residue relatively intact. The remaining rice residue bundles are kept in the open in heaps or stacks, often protected from the elements by an inclined thatch roof of rice residues (see pictures in Annex 5). To further reduce spoilage, the stacks are slightly elevated above the ground level so as not to be in direct contact with the soil surface or water (e.g. some villages in the Medinipur cluster used a bamboo base). A tenth of the residues are reportedly lost due to rain spoilage and rodents. Rice residue use as livestock feed is year-round and storage is therefore typically 12 months (Table 39). Prior to feeding, rice residues are chaffed, typically manually using a knife or sickle. In the Medinipur cluster this was done with a specially designed chaffing knife (see Annex 5:15). In stark contrast with the other IGP subregions (Erenstein et al. 2007a), there was a general lack of mechanical chaff cutters in West Bengal. Wheat is also harvested and threshed manually. Wheat straw is only sparingly used or stored as feed, and in cases when stored, only stored seasonally for 4 months. One village in the Medinipur cluster reportedly soaked the wheat straw in water prior to feeding to make it softer (less stiff).

Crop residue use as livestock feed primarily relies on harvesting and storing the residues for *ex situ* use (stall feeding). *In situ* stubble grazing complements the residue collection from the same cereal field and is reported in 2/3 of the surveyed villages (Table 38). The practice of stubble grazing in West Bengal thereby is markedly more common than in the other subregions of the IGP (Erenstein et al., 2007a). This is driven by the high livestock pressure on the crop residues and relative feed shortages, and in part facilitated by the prevalence of *desi* cattle and the limited irrigated area in the Medinipur and Malda clusters (i.e. more winter fallow). Grazing *in situ* was more common in rice fields than after the wheat crop (Table 40), reiterating the preference for rice straw as feed. Stubble grazing varied from a few days in between crops to half a year in fallow rainfed fields.

Table 38. *Crop residue management practices (% of villages)*

Cluster	*Ex situ* feed use	*In situ* grazing	Non-feed use	*In situ* burning
Malda	100	67	83	17
Nadia	100	67	100	17
Medinipur	100	67	100	0
Mean (s.d., n, p.)	100 (0, 18, ns)	67 (49, 18, ns)	94 (24, 18, ns)	11 (32, 18, ns)

Table 39. *Duration of crop residues storage (months)*

Cluster	Wheat	Rice
Malda	4	11
Nadia	4	13
Medinipur	–	11
Mean Mean (s.d., n, p.)	4 (1, 3, ns)	12 (2, 18, ns)

Table 40. *Crop residue grazed* in situ *(% of households)*

Cluster	Wheat	Rice
Malda	24	67
Nadia	40	67
Medinipur	0	67
Mean Mean (s.d., n, p.)	23 (42, 14, ns)	67 (49, 18, ns)

In addition to the use of crop residues as livestock feed, West Bengal also has a near universal use of crop residues for non-feed uses (Table 38), including the use for fuel and construction material. Rice straw was used for thatching/construction, rope, fuel and occasionally for mulching vegetables (reported in one village each in the Nadia and Medinipur clusters). Wheat straw and other crop residues were primarily used as fuel and for thatching/construction. Non-feed use extends to non-cereal crop residues (e.g. mustard, sesame, jute).

In view of the intensive residue utilization limited residues remain in the field at the time of land preparation (see Annex 5:2). As a result, the practice of *in situ* burning of crop residues as a land preparation measure is uncommon (Table 38). *In situ* burning is a traditional practice for cleaning fields, removing weeds and fertilizing by adding ash before the onset of rains. Only in one out six villages in the Malda and Nadia clusters did some farmers reportedly resort to this practice. In the Malda village this was reportedly associated with termite infestation on wheat residues, whereas in the Nadia village this was associated with the limited turn-around time after aman rice.

Crop residue sales were the universal crop residue transaction between households in the surveyed clusters (Table 41). In contrast with the other IGP subregions (Erenstein et al. 2007a), none of the surveyed villages in West Bengal reported the use of crop residues as in-kind payment nor were crop residues given away, likely a reflection of the limited farm size and pressure on the crop residues (Table 41).

Table 41. *Crop residue transaction practices (% of villages)*

Cluster	Sales	In-kind payment	Given away
Malda	100	0	0
Nadia	100	0	0
Medinipur	100	0	0
Mean (s.d., n, p.)	100 (0, 18, ns)	0 (0, 18, ns)	0 (0, 18, ns)

Crop residue transactions were limited to rice residues and were not reported for wheat residues. About 1 out of 5 households in the surveyed communities is engaged in the rice residue market as net seller and 1 out of 4 as net buyers (Table 42). Net sellers outnumber net buyers in the Nadia cluster, whereas the reverse is true in the Malda and Medinipur clusters. This is associated with the tendency for the pressure of livestock on the crop residues to be somewhat lower in the Nadia cluster (Table 37). In the Nadia cluster, rice residue sales were reportedly an important additional cash income.

Table 42. *Categorization of households as deficit or surplus in crop residue (% of household)*

Cluster	Surplus (net seller)		Deficit (net buyer)	
	Wheat	Rice	Wheat	Rice
Malda	0	11	0	35
Nadia	0	40	0	15
Medinipur	0	12	0	24
Mean (s.d., n, p.)	0 (0, 13, ns)	21 (28, 18, ns)	0 (0, 18, ns)	25 (31, 18, ns)

Rice residue trading is based both on quantity (e.g. 'kahan') and area. Residue sales tend to be local with some purchases from outside. Transactions are both directly between buyer and seller and through traders (e.g. the Medinipur cluster). Within the surveyed communities, carting of significant amounts of rice residue was regularly observed (see Annex 5). Residue transactions over larger distances also occur, particularly from significant rice residue surplus areas to rice residue deficit areas like Kolkata, as illustrated by the occasional rice residue stacks/marketing points along the highway. However, compared to the wheat straw (*bhusa*) market in upstream subregions, the rice residues trade in West Bengal seems to be less widespread. This seems to be a reflection of a number of associated factors that reduce the incentives to trade residues. For one, there is a higher and more spread out supply of residues. Whereas wheat is always limited to a single winter season, rice in West Bengal is grown in up to three seasons (aman, boro, aus). Rice residue prices are also relatively lower than wheat prices in the upstream areas (Erenstein et al. 2007a). Finally, relatively high local demand also limits the extent of rice residue surplus, whereas purchasing power limitations may constrain demand.

The price of rice residue showed seasonal variation, whereby the overall average across sites of INR 0.8/kg varied from a seasonal low of INR 0.6 after the rice harvest to a seasonal high of INR 1.2 (Table 43). There was a tendency for rice residue prices to be relatively high in the Malda cluster compared to the two other clusters. Rice residue prices were also affected by varieties and cropping season. One village in the Nadia cluster reported a 33% price premium for rice residues from fine grained varieties over coarse grained. Although both aman and boro rice residues are widely used in the Nadia cluster, one village reported rice straw from the aman season to fetch INR 0.5/kg, double the corresponding price for boro season (INR 0.25/kg). A village in Medinipur also reported higher prices for aman over boro rice, although relatively less pronounced (INR 1/kg and 0.8/kg, respectively). The cropping season effect is associated with varieties as rice varieties between the seasons can differ, and particularly in the boro season the use of high yielding varieties is widespread.

Table 43. *Rice residue prices (INR/kg)*

Cluster	Average	Peak	Trough
Malda	1.2	1.8	0.8
Nadia	0.6	0.8	0.5
Medinipur	0.7	0.9	0.5
Mean (s.d., n, p.)	0.8 (0.6, 17, ns)	1.2 (1.1, 15, ns)	0.6 (0.3, 15, ns)

Varietal choice for rice and wheat mainly reflected grain yield considerations. Some villages reported that, in addition to grain yield, they considered market demand/quality of the rice variety and its pest resistance. One village reiterated the importance of topo-sequence resulting in upland, mid-land and lowland varieties. Only five villages (spread across the three clusters) considered rice residue in their varietal choice, typically in terms of residue quantity and quality. In the Medinipur cluster one village reported the preference for paddy straw of local (*desi*) varieties, which was perceived to be more palatable, durable and not subject to spoilage. The same *desi* rice was also preferred for making country beer.

The prevalence of rice in West Bengal as the traditional food and feed crop thereby has a marked effect on crop residue management. Particularly striking are the general lack of wheat residue use as feed and the labour intensive residue management and use practices. A particular feature of West Bengal was the more readily perceivable grading of rice straw for feed and its association with seasonal and varietal differences.

6.2 Livestock feed inputs and availability

As discussed in section 5.2, livestock production in the West Bengal clusters is dominated by *desi* cattle and small ruminants in the Malda and Medinipur clusters and cross-bred cattle in the Nadia cluster. Both *desi* and crossbred cattle are fed through the year (Table 39) on a basal diet mainly of rice straw (Tables 36, 38 and 44). For landowning households the rice straw is mainly home-produced, but purchases are important sources of basal feed especially for marginalized and landless households (Tables 41 and 42). The basal diet of rice straw is supplemented with grazing, collected grasses/forage and other crop by-products (Table 44).

Grazing was near universal in the Malda and Medinipur clusters, but markedly less common in the Nadia cluster (Table 44). This reflects the prevalence of *desi* cattle and small ruminants and the lesser extent of irrigation and correspondingly lower cropping intensity in the *rabi* season in the first two clusters. Grazing includes rice stubbles (Table 40) and common property resources. In the Malda cluster fruit orchards provided further grazing land whereas in the Medinipur cluster there were more common properties, including the forested uplands. As a result, the cattle in the Nadia cluster were predominantly stallfed, whereas in the Malda and Medinipur clusters the stock was generally fed through a combination of stall feeding and grazing. Only one village in the Medinipur cluster reported feeding the cattle primarily through grazing only. However, there was a generally negative trend in terms of the prevalence of grazing across the surveyed communities due to increasing (grazing) land constraints.

Table 44. *Use of feed sources (% of household)*

Cluster	Other crop by-product	Compound feed	Grazing	Collected grasses/ forage	Green fodder
Malda	86	18	95 b	74	1
Nadia	73	22	58 a	79	2
Medinipur	63	0	100 b	100	2
Mean	74	13	84	84	1
(s.d., n, p.)	(40, 18, ns)	(32, 18, ns)	(33, 18, 0.05)	(32, 18, ns)	(3, 18, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

Collected grasses/forage (e.g. from roadsides/bunds, undergrowth in orchards/forests and tree leaves/prunings) are an important component for the diet, particularly for the *desi* cattle and small ruminants. In West Bengal, farmers' forage scarcity eases starting from late May to early October, coinciding with the monsoon. Pre-monsoon rains are a boon for perennial and indigenous grasses, edible weeds and shrubs whose roots are already present in the soils of common property and waste lands. These start contributing forage just after the onset of pre-monsoon rain and provide an economical supplement. The relative importance of natural grasses/forage is aided by the relatively high rainfall in West Bengal compared to the other IGP subregions.

About three-fourth of the households in the surveyed communities used other crop by-products to further complement the rice straw basal diet, albeit that quantities actually fed appeared to be limited. Such by-products were used primarily for lactating milch animals and included oilseed cake (mustard, linseed, groundnut, sesame), broken grains (rice, wheat, maize, pulses), bran (rice, wheat) and occasionally vegetable waste. These by-products were generally produced on the farm or bought (e.g. oilseed cake INR 7–7.5/kg, bran INR 1/kg). Bought compound feed was uncommon except for the Nadia cluster (INR 6–7/kg). In the Malda cluster the use of paddy husk mixed with broken rice was reported which was obtained from custom hiring rice mills (INR 0.25/kg). In the Medinipur cluster rice husks and broken rice were ground together as feed (INR 4/kg). The use of other crop by-products and compound feed was reportedly on the increase in the Nadia cluster (and associated with its prevalence of crossbreds and proximity to Kolkata), but stagnant in the other two clusters.

Cultivation of green fodder was relatively insignificant across the surveyed clusters. This seems associated with stringent land and water constraints and the lack of a fodder growing tradition. The lack of green fodder crops is particularly striking for the Nadia cluster in view of its reliance on crossbreds and dairy market orientation. In the same way, there were limited reports of mineral mixture purchases, despite known links between poor reproductive performance and mineral deficiencies.

When reviewing these various sources of feed supply, the villages reported a consistent gradient. The Medinipur cluster had the most marked feed deficits, whereas the Malda cluster oscillated between communities that were self-sufficient and deficit. Only the Nadia cluster was generally self-sufficient, with some communities reporting surplus. Underlying this assessment are two important factors in favour of the Nadia cluster: a lower livestock pressure and the prevalence of irrigation. The more limited extent of irrigation constrains overall fodder availability in the West Bengal clusters, particularly in the Malda and Medinipur clusters.

The prevalence of *desi* cattle with low milk yields in the Malda and Medinipur clusters suggests that most bovine keeping households did not have as a primary objective the regular sale of milk, but rather satisfying immediate household needs. For these clusters one can conclude from the reported feed management practices that while bovines represented an integral part of the livelihood strategies of most landed households, their role was not perceived as primary income earners, but more as converters of available rice residues into: (i) milk primarily for household consumption with any surplus being sold; (ii) dung for use as manure (Table 46); (iii) traction power used for draught and transport; and, (iv) herd growth as a means of capital accumulation and security. In contrast, the crossbreds in the Nadia cluster played a more significant role in terms of dairy income and herd growth, aided by the proximity to Kolkata. The production function of the small ruminants and poultry was presumably mainly as a means of capital accumulation and security.

It is also important to point out that livestock also fulfilled these same roles for some landless households (having a mix of goats, cows and poultry), with feed sources for the ruminants coming mainly from grazing (rice stubble and common property resources), the collection of free resources (grasses from bunds, weeds in fields, tree leaves, rice stubbles) and occasional purchases of rice straw. In the Medinipur cluster, the landless in one community reported resorting to feed their animal with leaves of jack fruit, mango and ber during severe fodder scarcity.

Compared to the other IGP subregions (Erenstein et al. 2007a), there are a number of marked differences. First, the prevalence of rice residues as main basal feed. Second, both grazing and the reliance on collected grasses were markedly more common in West Bengal. Third, the use of produced green fodder was virtually absent. Similarly, chaff cutters which are generally used for chopping the green fodders and crop residues elsewhere in the IGP, are markedly absent in West Bengal. A number of factors explain the observed divergences, not least the prevalence of *desi* cattle in two of the West Bengal clusters with their low productivity.

Besides the non-use of wheat straw, it is interesting to note the diametrically opposed farmer opinions in West Bengal and the Trans-Gangetic Plains (TGP, Haryana and Punjab). In West Bengal, wheat straw is generally not perceived to have any feed use, whereas in the TGP farmers tend to have the same opinion of rice straw. TGP farmers generally believe long-term feeding with rice residues to be detrimental amongst others due to perceived silica content and to reduce milk yield (Erenstein et al. 2007b). Different crop varieties and livestock species could contribute to these diverging views. However, long-term experiments conducted at C.C.S. Agricultural University Hisar found wheat and rice straws to have good palatability, nutritive value and bailing and densification properties, with similar results for cattle and buffaloes (Yadav et al. 1990; Yadav et al. 1994). The same studies report crude protein content of wheat straw to be somewhat better than for rice straw, although both being far below that of green fodders.

6.3 Livestock input to crop production

Farm yard manure (FYM) and traction services are the two main potential flows from livestock into crop activities. Both of these traditional crop–livestock interactions now have imperfect substitutes in the form of chemical fertilizer and tractors.

Chemical fertilizer use was reportedly universal amongst farm households in the Nadia and Medinipur clusters, and markedly less common in the Malda cluster (Table 45). FYM use was near universal in the Medinipur cluster, whereas less than 2 out of 5 households reportedly used in the Malda and Nadia clusters (Table 45). The Malda cluster thereby combines the lowest and the Medinipur cluster the highest chemical fertilizer and FYM use. The combination of chemical fertilizer and FYM use suggests they are used as complements and not necessarily as substitutes. These aggregate use rates however say little about the regularity and intensity of fertilizer and FYM application. The livestock density in the surveyed villages averaged 7 cow equivalents per cultivated ha (Table 37), a multiple of the densities reported in the other IGP subregions (Erenstein et al. 2007a). However, this high density does not automatically translate into more available manure. Indeed, whereas stall feeding practices prevail in the other subregions, West Bengal clusters had an increased reliance on grazing. The practice of grazing inherently limits the recovery of the manure produced. It also implies that the manure when used as FYM is mainly a source of organic matter with limited nutrients. Dung is typically collected in open heaps on or near the homestead within the village perimeter. No use of composting was reported.

Table 45. *Comparative indicators of external and livestock input use for crop production (% of farm household reportedly using)*

Cluster	Tractors use	Draught animals use	Chemical fertilizers use	FYM use
Malda	72 b	73 b	68 a	36 a
Nadia	95 b	7 a	100 b	39 a
Medinipur	20 a	90 b	100 b	98 b
Mean (s.d., n, p.)	66 (40, 15, 0.01)	60 (43, 17, 0.00)	89 (29, 18, 0.07)	59 (43, 17, 0.01)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

For the three surveyed clusters combined, the use of the annually collected dung was about equally split between its use as FYM and fuel (Table 45). This however masks significant differences amongst the clusters. Particularly striking is the contrast between the Nadia and Medinipur clusters. In the Nadia cluster dung is primarily used as fuel, whereas in Medinipur as FYM. The intensity of FYM use is such that Medinipur reported the highest FYM allocation across all the surveyed clusters across the IGP (Erenstein et al. 2007b; Singh et al. 2007; Thorpe et al. 2007). The Malda cluster provides an intermediate picture. Significantly contributing to the observed divergence within West Bengal is the availability of alternative fuel sources in the Medinipur cluster, particularly the forested uplands that dissect the cultivated plains.

Table 46. *Dung use (% of dung allocated to use)*

Cluster	As fuel	As FYM	Other
Malda	52 ab	48 ab	0
Nadia	68 b	32 a	0
Medinipur	20 a	79 b	0
Mean (s.d., p.) [n=18]	47 (36, 0.05)	53 (36, 0.06)	0 (0, ns)

Data followed by different letters differ significantly—Duncan multiple range test (significance level: 0.10), within column comparison.

The fuel use of dung primarily revolves around its use in dried form as household fuel. In marked contrast to the other IGP subregions (Erenstein et al. 2007a), Bengal farmers have the tradition of using ‘dung-sticks’: manure balls pressed around jute sticks thereby facilitating drying, transport and subsequent use (see Annex 5:4). The use of dung-sticks is a traditional Bengal practice that extends across the border into Bangladesh, but is increasingly constrained by the availability of jute sticks. As a result, the use of dung-cakes (i.e. without the stick) is increasingly widespread (see Annex 5:9). However, compared to the large and voluminous dung cakes in the other IGP subregions, the size and shape of the West Bengal dung cakes has more resemblance to fist-sized 'dung balls'. Dung sticks/balls are produced manually mainly during the dry season so as to dry properly in the open. Dung cakes are typically produced by women and used for both own household use and sale—the latter being an additional source of income for small farmers and landless households (e.g. INR 1/kg in the Malda cluster). Household ashes were again applied to the fields. Use of dung for biogas plants was uncommon, although in one village in the Medinipur cluster, three out of five biogas plants were still operational.

Compared to the other IGP subregions (Erenstein et al. 2007a), West Bengal combines the lowest mechanization with the highest reliance on animal traction. This is associated with the small average farm size in the West Bengal clusters, in addition to a socio-political climate that has not been very supportive of mechanization in view of its perceived labour-saving nature. For the three surveyed clusters combined, the number of farm households using tractors (4-wheel tractors or 2-wheel power-tillers, own or rented) approximate those using draught animals for crop operations (including hauling) (Table 45). This however masks significant differences amongst the clusters. Particularly striking is the contrast between the Nadia and Medinipur clusters (Table 45). In the Nadia cluster there has been widespread substitution of machinery (2 and 4-wheel tractors) for traditional animal traction services for crop operations. In contrast, mechanization still has to make significant inroads in the Medinipur cluster with animal traction for crop cultivation and hauling still prevailing. The Malda cluster provides an intermediate picture, with a combined reliance on both tractors (primarily for tillage) and draught animals (both for hauling and tillage). The mechanization of the Nadia cluster is associated with its intensive year round land use and commercial orientation, both facilitating access to mechanization and making animal traction more cumbersome, particularly in terms of feeding and management constraints. The contrast between the Nadia and Medinipur clusters extends to the share of households reportedly keeping draught animals (Table 30). However, draught animal ownership figures tend to be lower than use rates, particularly in the Malda and Medinipur clusters, suggesting a significant share of households rely on the use of animal draught services.

6.4 Assessing crop–livestock interactions

The aforementioned interactions have highlighted the dependence of livestock (particularly large ruminants) on rice straw across the West Bengal clusters. The livestock services to crop production (traction, FYM) vary across the clusters, from being very significant in the Medinipur cluster to a more limited role in the Nadia cluster. The surveyed communities in West Bengal thus presented a range of crop–livestock integration. The most integrated systems were observed in the Medinipur cluster, with the most pronounced complementarities between crop (rice) and livestock (*desi* cattle for dairy and draught, small ruminants) production. The crop–livestock interactions thereby underpinned livelihood security, but did not really drive any system change and seemed more a reflection of subsistence and status quo. In the Nadia cluster the systems were most commercially oriented, both in terms of crops and livestock produced, but integration between the two was relatively limited. Our findings thereby suggest that the extent and importance of crop–livestock interactions decreases with further intensification and commercialization of agricultural systems.

Combining crop and livestock production implies a more diverse livelihood portfolio and reduces risk. The two enterprises also have different resource use patterns (particularly labour and cash flow) which imply complementarities and potential resource savings at the household level by allowing more efficient resource use. Farm income also becomes more regular. Proceeds from crop sales are highly seasonal and often realized once or twice a year, whereas proceeds from the sale of milk, poultry, meat, young stock etc. can be more regular and more flexible. Financial interactions between the livestock and crop enterprise are reportedly important in the surveyed communities. In all surveyed villages it was reported that financial proceeds from livestock production are used to meet crop production expenses and vice versa (except for two villages in the Nadia cluster). Livestock also provides an investment and accumulation opportunity. One village in the Medinipur cluster specifically reported the use of a goat as a fixed deposit against a credit line during the cropping season.

The group meetings discussed the advantages and disadvantages of crop–livestock interactions. These tended to highlight the importance of the crop and livestock enterprises in terms of contributing to household income and household consumption (rice, milk, fuel) and internal services (use crop by-products, manure, traction) and their complementarities in terms of labour use and more regular income. In terms of disadvantages, mention was made of free roaming animals damaging crops (including goats, sheep and pigs, e.g. the Malda cluster), that keeping livestock was labourious and needed supervision during grazing, and competition for land (and decrease in available grazing land). One village in the Medinipur cluster reported the inability to grow sugarcane due to free roaming livestock.

In sum, and compared to the other IGP subregions (Erenstein et al. 2007a), crop–livestock interactions currently played a more prominent role in the West Bengal clusters, particularly the Medinipur and Malda clusters.

7 Discussion and recommendations

7.1 Livelihood security and environmental sustainability

The surveyed communities show significant diversity in terms of livelihood security. They thereby aptly illustrate that poverty is the result of low levels of assets, combined with low and uncertain returns. In the Nadia cluster the asset base and returns are relatively favourable, aided by the proximity to Kolkata. The livelihoods of landed households appear relatively comfortable, particularly when farm size is reasonable, with ample market opportunities and intensive land use. The extension of irrigation facilities and advent of boro rice increased the marketable rice surplus. Dairy crossbreds and vegetable cultivation provide significant complementary income sources with an ample market to tap into. The proximity to the state's capital facilitated rural electrification, inflates land value and provides employment opportunities to the labour-surplus households. Labour intensive crops, dairying and off-farm diversification all contribute to a relatively broad-based growth.

On the other hand, the Malda cluster in the north of the state and the Medinipur cluster in the West present a comparatively dismal picture. Remoteness exacerbated by costly and scarce irrigation and small and fragmented farm holdings all make farming less profitable, particularly for small farmers. Overall economic growth is slow providing few employment and diversification opportunities and poverty is widespread, particularly amongst agricultural labourers. Population growth is positive and leads to further fragmentation and keeps wage rates low. High dependence on rains for crop production, lack of institutional finance and veterinary and extension services add to the uncertainties of rural livelihoods. Resource constraints encourage rearing of small ruminants and poultry as a supplementary income source for small farmers and landless households.

The orientation and management of the agricultural systems in the Malda and Medinipur clusters also stands in stark contrast with the Nadia cluster and its intensified crop and livestock production, external input use, productivity and market integration. This suggests different roles for livestock as a livelihood diversification opportunity. In the Nadia cluster, livestock complements crop production in the portfolio of productive enterprises. In the Malda and Medinipur clusters, livestock provides important non-market functions that complement crop production, including household consumption (milk, fuel), internal services (dung, traction) and a means of capital accumulation and security. The latter role is particularly important in the Malda and Medinipur clusters in view of the high cost of capital, the limited income generating alternatives and as a means to reduce overall risk exposure.

Access to land is central to the security of rural livelihoods across the clusters. Indeed, poverty is highest and concentrated amongst agricultural labourers. In this respect the West

Bengal land reforms are praiseworthy, although the increasing monetization of land markets and extent of landless and marginal holdings in the surveyed communities questions their extent and impact. Seasonal migration for agricultural wage labour for able-bodied poor people is thereby still an important livelihood strategy and a means of getting hold of lump sums of cash in rural West Bengal in general (Rogaly and Rafique 2003) and the surveyed clusters in particular. However, instead of serving as a mean of escaping poverty, it seems to be no more than a survival strategy (Rogaly and Rafique 2003).

Whereas the agro-ecological environment clearly shaped the current livelihoods, the implications for the environment were less obvious. Whereas deep water tables and resource constraints prevented irrigation development in some communities, overdevelopment and overexploitation of groundwater has undermined the prospects of secured irrigation in others. Groundwater use in the Central Alluvial Plain and coastal saline plain reportedly already exceeds natural recharge and leads to declining water tables. However, compared to the NW IGP (Abrol 1999), the extent of over-exploitation of groundwater still seems less severe, probably aided by the higher annual rainfall and more significant recharge. The threat of consuming arsenic contaminated groundwater is increasingly recognized and is not limited to some of the surveyed clusters. In other districts heavy metal concentrations in ground water beyond the safe limit have also been reported.

The high population density and still positive population growth exert considerable and increasing pressure on the already intensively used natural resource base. Household fuel sources, including dung cakes, seemed to be in short supply across the West Bengal clusters, suggesting an impending household fuel crisis. Another significant threat to the current livelihoods is soil fertility and organic matter mining. The intensive use of rice and other crop residues in West Bengal implies that few organic residues remain in the field at the time of land preparation. The prevailing crop residue extraction is insufficiently compensated by the droppings of grazing animals and application of FYM. This implies that a continuous mining of soil organic matter. Soil fertility is further undermined by unbalanced fertilizer use. On the positive side, this implies that there is limited *in situ* burning of crop residues at land preparation time, and therefore agriculture does not impose seasonal atmospheric pollution.

A final observation relates to the importance of human food habits/traditions in shaping rural livelihoods. Indeed, a striking feature of the West Bengal clusters compared to the other IGP subregions (Erenstein et al. 2007a) was the predominance of rice as the prevailing food and feed crop. Over time there only seem to have been some changes in the margin. In this respect the similarities with some of the prevailing food consumption and production practices in Bangladesh is also striking, including a preference for parboiled rice and the use of 'dung-sticks' and power-tillers. This suggests that there is considerable potential for cross-border lessons.

7.2 Outlook and constraints

The situation of the Nadia cluster appeared relatively favourable and dynamic, aided by the proximity to Kolkata and its market opportunities for intensification and diversification (agricultural and non-agricultural). Population pressure and ongoing urban sprawl are likely to give further impetus to the intensification and diversification of the already intensive and diversified agricultural production systems over the coming decades. Increasing production costs particularly affected the landed, whereas securing employment was the priority for the landless. A constraint for all was the high informal interest rates, which constrained investment possibilities.

The comparatively dismal picture and prospects in the Malda and Medinipur clusters resulted in what appeared to be a relatively stagnant poverty stricken situation and without any clear future direction. Whereas here change was most needed, it was least obvious in view of the remoteness (geographical isolation from main urban markets, particularly Kolkata) and miscellaneous constraints hampering agricultural intensification and further diversification into agricultural and non-agricultural activities. The limited human capital, poverty and sheer population pressure further undermine these options. This was further aggravated by the lack of financial capital and scarcity of land and irrigation water and in the case of the Malda cluster, fuel. Lack of irrigation water seemed to be the most pressing constraint to agricultural development. With an alleviation of these constraints, the Malda cluster promises significant agricultural potential for increasing cropping intensity and high value crops. Its proximity to the border and the reportedly related insecurity dampens the prospects for livestock development for now. In the Medinipur cluster, irrigation also appeared crucial to increase cropping intensity in *rabi* season, boost agricultural income and enhance the prospects of diversification. There seemed to be some prospects for water harvesting and a check dam in some communities. For now, the Medinipur cluster seemed to be stuck on a low input–low output platform. High market transaction costs reflecting its remoteness and the generally small surpluses marketed thereby proved to be a significant additional barrier. So were the lack of technical knowledge and support services, limited prospects for value addition and income generation and severe credit constraints.

The communities in the three surveyed clusters reported a range of problems that curtailed their prospects. Most prominent across communities were access to and/or quality off: irrigation, road infrastructure, marketing, utilities (electricity, water), education, health services (human and animal), finance, technical knowledge, agricultural support services, floods and quality inputs.

When the surveyed communities were probed about their future outlook, farming households generally wanted to expand their crop production activities, particularly various vegetables (including potato) and sometimes more (boro) rice. Crop expansion prospects were primarily curtailed by the lack of irrigation facilities and financial, market, knowledge and production cost constraints. The surveyed communities also saw prospects in increasing livestock production, although preferences were mixed and included dairy, goats and backyard poultry, and involved both number expansion and improved breeds. These prospects were however hampered by financial constraints and milk marketing. One village in the Nadia cluster specifically reported that livestock implied a high investment whereas profit was low. Surprisingly, feeding constraints were only occasionally flagged as a constraint. Indeed, with increased availability of irrigation water farmers' preference generally was to shift towards more vegetable growing, not to grow fodder crops.

The prospects for the landless are particularly meager in the Malda and Medinipur clusters. Unskilled labour is their basic asset, but the prevailing wage rate is low and the value of that asset will continue to be eroded in view of continued population growth and limited growth in labour intensive sectors. Indeed, unemployment was typically the most pressing problem throughout for the landless. The landless mentioned a range of additional problems, including finance, access to land/space for cropping and housing, access to knowledge/education, health and fodder.

A striking feature of the West Bengal clusters was the prevalent poverty. In part, this is associated with the state's sheer population density/growth, the limited extent of irrigation (i.e. increased reliance on rainfed rice–fallow systems, particularly the Medinipur and Malda clusters) and the prevalence of scheduled tribes (predominant in two of the three clusters). Numerous rural households appeared significantly indebted and stuck in a poverty trap/spiral. Land was scarce and becoming scarcer, yet the limited returns to agriculture decreased the incentives to invest. Financial capital was particularly scarce, as reflected by the high informal interest rates of 8% per month, constraining investment possibilities and working capital alike. The communities are increasingly labour surplus, yet there is limited out-migration and seasonal mobility was typically confined to within the state due to language and cultural restrictions. Health/education constraints limited the possibilities to climb out of poverty. Therefore, despite reported progress in recent decades, many households still lived on the edge, hand to mouth.

7.3 Agenda for action

As in the other three subregion reports, the scoping study for West Bengal has set out to present primary information from village-level surveys, to relate the information to secondary sources, and to draw some broad conclusions that address the interface of West Bengal's crop and livestock subsectors. Specifically, it has focused on the management of crop residues because of their importance as ruminant livestock feeds and their role in natural resource management. The intention was not to provide any definitive answers or recommendations, but rather to flag issues for research.

In the parallel report on the TGP (Trans-Gangetic Plain), Erenstein et al. (2007) highlight the need in the TGP—India's 'breadbasket' and the heartland of the Green Revolution—for a more enabling environment for economic and human development with two specific objectives: to enhance the human capital base and skills through basic education; and to stimulate the economic growth of the secondary and tertiary sectors to absorb surplus labour from the primary sector and the rural landless. As has been outlined in the previous section of this report, these priorities for action equally apply to West Bengal, where low productivity and poverty are endemic in some districts. Excess labour and low wages undermine the livelihoods of the rural poor. The bulk of farms are fragmented and too small to make a decent living from farming alone.

The second intervention identified for the TGP, a more enabling environment for agricultural development, also needs to be urgently addressed in West Bengal. Agriculture has an important role in driving pro-poor economic growth, largely by default, as there are few other candidates with the same potential for supporting broad-based pro-poor growth (Kydd et al. 2004; World Bank 2007). Despite the lessons from rapid agricultural growth in some districts, there are, however, still immense challenges to agricultural and poverty-reducing growth in West Bengal. Policy needs to recognize and address the diversity of infrastructural, technological and institutional challenges to enable broad-based growth and provide the poor both the means and viable options to escape poverty across all districts. Proposed policy interventions thereby include some of the usual suspects: increased irrigation; building up rural infrastructure; increased expenditure and relevance of agricultural research and development; enabling agricultural intensification and high-value and labour intensive diversification; enhancing access to affordable rural credit (micro-credit); and promotion of agro-based industries.

Our study highlights the need for such interventions. Water management is an area needing concerted attention to improve the prospects of farming livelihoods in the Malda and Medinipur clusters. Similarly, their remoteness from Kolkata is one of the major hindrances to the intensification and diversification of agriculture, even in relative proximity to their district capitals. The development of agricultural value chains merits particular attention. Agricultural produce markets appeared particularly underdeveloped in the Malda and Medinipur clusters, a reflection of the prevailing subsistence orientation of smallholdings, high transaction costs (due to limited surplus and remoteness) and limited margins for farmers. Emphasis thereby should be on marketing chain development for high value and labour intensive commodities with particular attention to risk management, market information and infrastructure. Despite the potential of dairy in the Nadia cluster, the sector seemed to be held back by the prevailing and underdeveloped milk marketing system. Across the clusters there was also an important role for enhancing education and agricultural support services. The credit sector merits particular attention, and West Bengal may benefit from the lessons and success of the Grameen Bank and similar institutions in Bangladesh (e.g. Schreiner 2003; Goldberg 2005).

Our study also flags the need to ground agricultural development interventions on a better understanding of livelihood systems and the need to strengthen such capacity in the research and extension services. Indeed, there is an on-going need to better understand the rationale for farmers' practices and reluctance to adopt certain 'recommendations' if we are to reduce the 'yield gap' for most crops. Similarly the limited use of livestock services and recommendations (like AI, balanced feed) in some districts seemed to be the combined result of both the limited institutional capacity and limited relevance of some of the technologies. Yet there seems considerable potential and pay-off to enhancing dairy productivity through better feeding practices. This calls for a better understanding of the constraints faced by farmers to develop viable enhancement options. The potential to increase fodder yield and quality through improved varieties is one field that merits follow-up, i.e. the need to move from a purely grain to complete biomass focus in varietal improvement. The livestock improvement and development efforts also seem biased towards the dairy sector, neglecting the poverty-alleviation potential of enhancing small ruminants and poultry.

Cross-cutting action research needs for the IGP

The present study and its companion studies also highlight a set of specific research needs that cut across the subregions. These specific needs relate to the land use systems of the IGP and their crop, livestock and crop–livestock interaction components and include action-research to:

- Understand and address local variation in land use systems and the resulting constraints and opportunities for diversification and intensification;
- Address key issues including community-action for improved management of land, water and livestock resources and ways to increase market access for inputs (including knowledge) and outputs;

- Improve the productivity of the staple crops, including through identifying resource-conserving technologies (RCTs), while factoring in any trade-off effects on the feeding of crop residues to livestock; and, related to that:
  i. Investigate whether variation in rice, wheat and maize varieties for fodder quality (nutritional value) is an avenue for increasing the available quantity and quality of crop residues for feeding goats, cattle and buffalo; and,
  ii. Investigate organic matter (OM) management and particularly crop biomass management issues impacting on the prevalent crop–livestock livelihood strategies of landed and landless households, taking account of the multiple functions of the crop residues and of the various livestock species within a household and community.

Central to achieving the overall goals of improving livelihoods and more sustainably using natural resources in the IGP will be strengthening the client orientation and productivity of the agricultural R&D community. Research on crop–livestock interaction can serve as a good entry point for that process.

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Annex 1. Socio-economic and development indicators in IGP states

Indicators		Year/source	Punjab	Haryana	Uttar Pradesh	Bihar	W. Bengal	All India
Population (× 10^6)		2001 (1)	24.4	21.1	166.2	83.0	80.2	1029
Increase (%)		1991–2001(1)	20.1	28.4	25.9	28.6	17.8	21.6
Population density (per km^2)		2001 (3)	484	478	690	881	903	325
Rural population (%)		2001 (3)	66.1	71.1	79.2	89.5	72.0	72.2
Farming population (%)		2001 (3)	32	46	48	31	25	
Landless population (%)		2001 (2)	22	19	29	51	33	
Literacy	Male (%)	2001 (4)	76	79	70	60	78	76
	Female (%)	2001 (4)	64	56	43	34	60	54
Rural population below poverty line (%)		1999–2000 (1:9–10)	6.4	8.3	31.2	44.3	31.9	27.1
Share of agri. in GSDP at 1993–94 prices (%)		2001–02 (1)	39	31	33	35	23	24
Per cap income at current prices		2002–03 (2)	26,000	26,600	10,300	6,000	18,800	18,900
% of household in income classes (INR/month)	< INR 3000	2002–03 (2)	52.4	64.2	80.7	85.1	77.8	
	INR 3001–6000		38.7	26.5	14.9	10.6	16.4	
	INR 6001–10,000		6.5	6.8	3.4	3.3	4.4	
	INR 10,001–20,000		2.2	2.5	0.9	1.0	1.4	
	> INR 20,000		0.1	neg.	neg.	neg.	0.1	
Geographical area (× 10^3 ha)		2000–01 (3)	5036	4421	24093	9416	8875	328724
Cultivated area (× 10^3 ha)		2000–01 (3)	4250	3526	17612	7437	5417	141087
Area irrigated (%)		2000–01 (3)	95	83.9	72.8	48.7	43.5	39.1
% of area irrigated by source	Canal	2000–01 (3)	24	50	24	31	11	30
	TW		76	50	69	55	53	40
	Others		0	0	7	14	36	30
Cropping intensity %		2000–01 (3)	187	173	154	147	168	137
Average farm size (ha)		2000–01 (5)	4.03	2.32	0.83	0.58	0.82	1.32
# of tractors (× 10^3)		2001–02 (3)	442	331	677	107	35	3084

# of pumpsets energized (× 10^3)		2002 (4)	811	427	815	276	112	13044
Expenditure by SAU's (× 10^6 INR)		2004–05 (4)	1410	1025	738	708	594	
Foodgrains	Area (× 10^6 ha)	2002–03 (1)	6.13	3.98	17.90	6.88	6.54	111.50
	%		5.5	3.6	16.1	6.2	5.9	100
	Production (× 10^6 t)		23.49	12.34	36.30	10.27	15.52	174.19
	%		13.5	7.1	20.8	5.9	8.9	100
Marketed	Rice	1999–2002(1)	96	91	74	68	55	70
Share (%)	Wheat	1999–2002(1)	80	78	58	67	–	67
Fruits	Area (× 10^3 ha)	2002–03 (4)	40.5	31.9	280.3	294.8	152.2	3787.9
	Production (× 10^3 t)		578	237	4314	3038	1786	45203
Vegetables	Area (10^6 ha)	2002–03 (4)	0.14	0.16	0.85	0.61	1.21	6.1
	Production (× 10^3 t)		2.3	2.1	15.8	8.3	17.4	84.8
Milk production (× 10^6 t)		2002–03 (1)	8.7	5.1	15.3	2.6	3.6	87.3
Egg production (× 10^9)		2002–03 (1)	3.5	1.2	0.8	0.7	2.8	40.2
Fish production (× 10^3 t)		2002–03 (1)	66	35	250	166	1120	6200
Dry fodder (× 10^6 t)		2002–03 (4)	29.4	18.9	80.8	15.6	21.6	377.7
Green fodder (× 10^6 t)		2002–03 (4)	25.5	19.0	35.8	1.3	1.9	503.1
Wet dung production (× 10^6 t)		1987 (4)	33.2	34.5	24.2	22.4	21.7	615.5
Electricity consumption for agriculture (%)		2001–02 (1)	27	42	20	23	7	25
Road length (km/100 km^2)		2000 (3)	104	59	53	19	56	45
Fertilizer use (kg/ha)		2003–04 (4)	184	167	127	81	122	90

Sources: (1) MoA (2004a); (2) Business World (2005); (3) ESO (2004); (4) IASRI (2005); (5) MoA (2006).

Annex 2. Area, yield and production of major crops in IGP states

Crop	State	1974–75			2003–04		
		Area (× 10^3 ha)	Production (× 10^3 t)	Yield (kg/ha)	Area (× 10^3 ha)	Production (× 10^3 t)	Yield (kg/ha)
Wheat	Punjab	2213	5300	2395	3444	14489	4207
	Haryana	1117	1954	1749	2303	9134	3966
	U.P.	6152	7176	1164	9150	25567	2794
	Bihar	1478	2000	1353	2119	3778	1783
	W. Bengal	422	837	1984	426	986	2315
	All-India	18010	24104	1338	26581	72108	2713
Rice	Punjab	569	1179	2072	2614	9656	3694
	Haryana	276	393	1426	1016	2793	2749
	U.P.	4530	3523	778	5952	13012	2187
	Bihar	5228	4540	868	3557	5393	1516
	W. Bengal	5420	6543	1207	5857	14662	2504
	All-India	37889	39579	1045	42496	88284	2077
Maize	Punjab	522	898	1720	154	459	2981
	Haryana	124	125	1010	15	38	2573
	U.P.	1394	827	593	947	1319	1392
	Bihar	881	572	650	607	1440	2374
	W. Bengal	46	52	1137	41	97	2359
	All-India	5863	5559	948	7322	14929	2039
Sugarcane	Punjab	123	6150	50,000	123	7870	64,000
	Haryana	161	5910	37,000	161	9340	58,000
	U.P.	1492	61479	41,000	2030	112754	56,000
	Bihar	141	5568	40,000	103	4222	41,000
	W. Bengal	29	1682	58,000	17	1268	Na
	All-India	2894	144289	50,000	3995	236176	59,000
Total Pulses	Punjab	328	245	746	48	48	824
	Haryana	781	374	479	196	149	740
	U.P.	3154	2185	694	2708	2339	886
	Bihar	1554	867	558	684	562	824
	W. Bengal	682	376	550	252	30	840
	All-India	22024	10020	455	23440	14940	637
Total Oilseeds	Punjab	368	290	790	87	102	1167
	Haryana	214	149	694	640	990	1547
	U.P.	3784	1927	509	1140	928	814
	Bihar	296	132	446	149	125	842
	W. Bengal	204	75	369	684	651	952
	All-India	17313	9152	529	23700	25290	1067
Cotton	Punjab	547		373	452		414
	Haryana	246		311	526		372
	U.P.	35		118			150
	Bihar	–		–	–		–
	W. Bengal	–		–	–		–
	All-India				7630		370

Source: MoA (2005b).

Annex 3 Survey team members

Name	Institution	Participation in cluster (team)		
		Malda	Nadia	Medinipur
Dr Joginder Singh	PAU (Ludhiana)	A	A	A
Dr Bill Thorpe	ILRI-India (Delhi)	A	A	A
Shyamal K Sahoo	TA (P.Prot.), KVK Malda	A		
Dr Tanmay Samajdar	TA (An.Sc.), KVK Cooch Bihar	A		
Madhu Sudan De	BCKV Mohanpur		A	
Sushantai Das	BCKV Mohanpur		A	
Dr S Mukherjee	TO, KVK Kapgari			A
Dr SN Singh	TA(Eng.), KVK Kapgari			A
Dr N K Bej	TA (Agr.), KVK Kapgari			A
Dr Arun Varma	Retired (Ex ADG ICAR)	B	B	B
Dr Bhabani Das	TA (Agr), KVK Malda	B		
Dr Biswajit Goswami	TA (Fish), KVK Majhian	B		
Dr PK Bandopadhyaya	BCKV Mohanpur		B	
Pulen Bihari Sahu	BCKV Mohanpur		B	
Smt. Rita Sarkar	BCKV Mohanpur		B	
Dr TK Chowdhury	TA (Hort.), KVK Kapgari			B
Dr (Mrs) Raba Das	Homesc., KVK Kapgari			B
Dr Olaf Erenstein	CIMMYT-India (Delhi)	C	C	C
Manjinder Singh	Research associate	C	C	C
Biplab Nlihaa	TA (Agr), KVK Cooch Bihar	C		
Adwaita Mondal	TA (Fish), KVK Malda	C		
Amit Kumar Roy	Ext., BCKV Mohanpur		C	
Suhrita Chakrabarty	Horti., BCKV Mohanpur		C	
Dr PK Bandyopadkyay	Soils, BCKV Mohanpur		C	
PK Guin	TA (Liv.), KVK Kapgari			C

Crop-livestock interactions scoping study
Farmers group discussion

State: …………District: …………………….. Village: ……………………………..
Date: ………… Team members: ……………………………..…………………
…………...……………………………...…………...……………………………..

GPS code: …………… X- Coord: …..…………. Y-Coord…………………
(Decide on a code you will use on the GPS unit and on the checklist. Make sure it's a unique identifier. Take reading in village – probably place of meeting)

0 Village characteristics (from key informant)

Number of people in village: ……	**Number of households: ……**
	Number of farm hh: ……
	Number of landless hh: ……

Prevailing cropping system: ……………………………………

Overall assessment of the road infrastructures in the area:

Availability of public transport:	1. high, 2. low, 3. non existent
Type of public transport:	1. bus, 2. jeep/van, 3. train, 4 ….
Travel time by public transport:	
• to nearest urban centre (70% ag; more than 500)	…
• to nearest agricultural market centre	…
Distance to all weather road	… km
Quality of all weather road:	1. Good, 2. Bad

Access to basic facilities:

% of hh with **electricity** : ….	
% of hh **piped public water**: …	
Number of phones in village: …	

Education level of the household heads

Education level	% households in the location
No formal education	
Primary level	
Secondary level	
Higher level	

Introduction

Start by setting the scene – create common understanding for whole group.
Focus: Crop residue mgt – linkage between crop and livestock mgt. Changes and implications. Problems and solutions. Questions typically assess indicators of change - try to understand why. Write down any related information on additional space/sheets.

When estimating % shares of population, ask "out of 10 farmers in this location, how many…". You don't have to get a consensus. If this is the case, indicate range of answers.
The exercise does not have to be "linear"- for example, if the participants give answer for subsequent questions at the same time, note the answer down and don't ask again! Write down any additional related discussion. Try to involve all participants in discussion.

Number of **farmer participants**: ……	# of **women** among participants: ……

1 Land resource

Total village land area (ha): ………

	Private irrigated *(specify main source …………………)*[a]	Private rainfed	Communal	
Divide village area by land type				*(check total = 100% or village area)*
Prevalent number of crops per year				
Rental price (Rs per year per ha)				
Purchase price (Rs per ha)				

[a]*e.g. 1. Canal; 2. Electric tubewell; 3. Diesel tubewell; 4. Other……*

2 Main types of crops grown

First assess the types and aggregate area of crops and fodder that are grown in the area (first column).

Season	Type *(use large categories, eg pulses, vegetables)*	Indicative aggregate area (ha)	% of farmers growing crop
Kharif	Rice		
	Basmati rice		
	Sugarcane		
	Vegetables		
	Forage (specify …………….)		
	Others………		
	Others………		
	Others………		
	Fallow		
	Communal land		
		(check seasonal total = 100% or village area)	
Rabi	Wheat		
	Vegetables		
	Pulses		
	Forage (specify …………….)		
	Others………		
	Others………		
	Others………		
	Fallow		
	Communal land		
		(check seasonal total = 100% or village area)	

List any significant **changes in crops** over last decade:

	Crops area decreased	Crops dropped out	Crops area increased
Crop(s)			
Why			

Do small and large landholdings grow different types of crops?: 1. Yes; 0. No

Crops mainly grown by small holders (<4 ha)	Crops mainly grown by large holders (?4 ha)

3 Livestock population

Type	% of households keeping livestock	Total number of animals in village *(to nearest 10)*	Trend over last decade *(1-Up; 2-Down; 3-Same)*	Why *(reason for up or down trend)*	Who owns *(0-Landless, 1-Small, 2- Large, 3-All)*	Main feeding system *(1-Only grazing, 2-Stall feeding, 3-Both)*
Buffalo milch						
Dairy cattle (indigenous)						
Dairy cattle (cross bred)						
Draft animals (main purpose 1. transport; 2. crop production) Type ……………						
Sheep						
Goat						
Pigs						
Poultry						
Others…						
Others…						

Of all livestock dung produced in the village, how much is…

Use of dung	% of total
Used as fuel	
Used as manure	
Other …	
Not used/wasted	

4 Livelihood types

Main livelihood activity

Assess the main sources of livelihood in the area. Start by asking the type of activity (crop, livestock etc…). Only after, try to assess the importance of each activity (%). To do this, ask "out of 10 farmers in the area, how many are mainly crop farmers " If you cannot get a consensus, indicate range of answer.

Activity	**% households in the location who derive a main part of their living from the activity**
Crop farming	
Livestock rearing	
Employment on other farms	
Self employment (e.g. business)	
Employment outside the district	
Other, specify	

Breakdown of main livelihood activity by landholding

Subdivide the households by their landholding. Assess corresponding main sources of livelihood using previous categories.

Landholding	% households in the location	Predominant income source
Landless but "rich"		
Landless and "poor"		
Small (< 4 ha)		
Large (?4 ha)		

Note: Landless do not cultivate land. Check with first page for total number of landless and farmers.

5 Non-feed inputs and services for livestock activities

	% households using	Any significant change in use over last decade	Why *(reason for change, e.g. availability)*
AI services			
Bull services			
Veterinary services			
Extension messages			
Other inputs, specify: ……..			
Other services, specify: ……			

6 Inputs and services for crop activities

	% farmers using	Changes in use over last decade	Why (reason for change)
Purchased improved seed			
Chemical fertilizer			
Manure			
Herbicides			
Tractors			
Combine harvester			
Draft animals (specify main use: 1. tillage; 2. weeding; 3. marketing)			
Extension messages			
Other inputs, specify:……			
Other services, specify: ……			

Number of **tractors** in village: ……	Number of **combiners** in village: ……

7 Marketing of farm products

7.1 Sales of main crops and livestock products

Produce	% of average production sold or exchanged	Main market outlet	Price [1]
Wheat			
Rice			
Basmati rice			
Other crops…..			
Other crops…..			
Other crops…..			
Other crops……			

Milk			
Dung as manure			
Dung as fuel			

[1] *Indicate if price is seasonal and provide corresponding range.*

7.2 Sales of animals

Where are surplus animals mainly sold?	1. Local; 2. Outside community, ….
How regular is the sale of surplus animals as source of income?	1. Regular; 2. Irregular *(sporadic sales, as needed, etc.)*

Types of animals	Price [1]
Local cattle	
Crossbred cattle	
Buffalo	

[1] *Use Heifer price (36 months animal) for buffalo and cattle. Indicate if price is seasonal and provide corresponding range.*

8 Crop residue use

In this section we look at crop residues only – i.e. the dry fodder/straw as byproduct from crop production. Next section includes green fodder and other byproducts.

Are crop residues **collected** to be used as livestock feed *ex situ*? 1. Yes; 0. No

	Wheat	Rice	Other … ………
% of farms using			
Main livestock types for which used			
How are residues collected from field?			
Changes in use *(if any)*			

Are crop residues **processed** (e.g. chopped) before use as feed? 1. Yes; 0. No

	Wheat	Rice	Other … ………
How are residues processed?			
Problems with processing *(if any)*			
Number of choppers in village			

Are crop residues **stored** for later use? 1. Yes; 0. No

	Wheat	Rice	Other … ………
Duration			
How are residues stored?			
Problems with storage *(e.g. spoilage, fire, rodents, etc…)*			

Are crop residues used for **other uses** than livestock feed? 1. Yes; 0. No

	Wheat	Rice	Other … ………
List types of uses *(e.g. fuel, construction, other…)*			

Are crop residue stubbles **grazed** *in situ*? 1. Yes; 0. No

	Wheat	Rice	Other … ………
% of farmers using			
When & where			
Type of animals			
If not own animals, grazing fees			

Are crop residues **sold**? 1. Yes; 0. No

	Wheat	Rice	Other … ………
% of farms with residue surplus (selling more than buying)			
% of farms with residue deficit (buying more than selling)			
What is main outlet for those selling	1. Local; 2. Outside ……....	1. Local; 2. Outside ……....	1. Local; 2. Outside ……....
What is main source for those buying	1. Local; 2. Outside ……....	1. Local; 2. Outside ……....	1. Local; 2. Outside ……....
Describe crop residue marketing chain if sold outside *(e.g. form, intermediaries, time and regularity transactions; storage location)*			

Crop residue **prices**

	Wheat	Rice	Other ……
Average grain yield			
Average residue price			
Are residue prices seasonal? • At peak • At trough	0. No; 1. Yes Month: … Price: … Month: … Price: …	0. No; 1. Yes Month: … Price: … Month: … Price: …	0. No; 1. Yes Month: … Price: … Month: … Price: …
What other factors affect prices? (non-seasonal - e.g. variety, quality, etc)			

Are crop residues used as **payment in kind**? 1. Yes; 0. No

For which crops	1. Wheat, 2. Rice, 3 …
Specify (for what; to whom; why; when)	

Are crop residues also **given away** for free? 1. Yes; 0. No

For which crops	1. Wheat, 2. Rice, 3 …
Specify (to whom; why; when)	

Are crop residues **burned in the field**? 1. Yes; 0. No

	Wheat	Rice	Other ……
% of farms burning			
Why			
Trend in use (if any)			

Criteria determining which **crop variety** to cultivate

	Wheat	Rice	Other ……
What is the main criterion determining which variety to grow?			
Is crop residue use an important criterion?	0. No; 1. Yes	0. No; 1. Yes	0. No; 1. Yes
If yes, explain (e.g. quantity, quality, etc)			

Of all above crop residue uses, **which use** of crop residues is the **largest** by volume? Second and third largest? *(tick column)*

	Wheat			Rice		
	1	2	3	1	2	3
Used as stall feed						
Used as stubble feed						
Used for non-feed						
Burned in field						
Left in field						
Other …						

Of all above crop residue uses, **which users** of crop residues are the **largest** by volume? Second and third largest? *(tick column)*

	Wheat			Rice		
	1	2	3	1	2	3
Used on own farms						
Sold/exchanged within village						
Sold outside village						
Other …						
Not used						

Notes:

9 Other feed inputs for livestock activities

Feed source	Main source (1.own, 2-purchased)	% of house-holds using	Main livestock types for which used	Specify season (when)	Price (Rs/Kg)	Changes in use over last decade	Why (reason for change)
Crop byproducts ………………… ………………… ………………… …………………							
Compound feed (dairy meal)							
Grazing							
Collected grasses/forage							
Produced green forage ……							
Other, specify:							

Other practices using normal crops for green fodder (e.g. wheat, barley, etc)

Practice	% of farmers practicing it
Grazing of green crop (before grain) *in situ*	
Selling of green crop (as forage)	

10 Overall fodder/feed availability

How would you categorize the village in terms of **self-sufficiency** on an annual basis for the following **feed sources** *(tick one column)*

	Deficient (importing)	Self-sufficient	Surplus (exporting)
Crop residues			
Other crop byproducts			
Grazing			
Collected grasses/forage			
Produced green forage			
Other, specify: ________			

Fodder/feed availability

Which are the critical months when fodder/feed is not available?	
Suggestions to improve upon problem of fodder/feed availability	

11 Other system issues

Use of hired labour

Activities	% of farmers hiring casual labour	% of farmers hiring permanent labour
Crop-related activities		
Livestock-related activities (specify activities….)		
For other agricultural activities, specify: ……..		

Casual wage rate

Male: Rs …… per day	Female: Rs …… per day

Is there occasionally **shortage** of casual labour? 1. Yes; 0. No

Peak period	
Casual wage rate during peak	Rs …… per day
Does casual labor from elsewhere migrate to the village during those times?	0. No; 1. Yes, from …

Does casual labor from the village also seasonally migrate to other places?	0. No; 1. Yes, to …

Role of women

	Crop related activities	Livestock- related activities
Are women in the village involved in?	0. No; 1. Yes	0. No; 1. Yes
Which are their main tasks?		
Have women more say over income from crop or livestock? *(tick)*		

Crop-livestock interactions

	In same farm household	In same village
What are the main **advantages** of having simultaneously crop and livestock…		
What are the main **disadvantages** of having simultaneously crop and livestock…		

(e.g. soil/land health, water use, pest control, water use, labor use, income, etc…)

Financial crop-livestock interactions

How significant is the use of income from crops for buying livestock or livestock inputs?	0. Not significant; 1. Significant.
How significant is the use of income from livestock for buying crop inputs?	0. Not significant; 1. Significant.

Local interest rate with village money lenders

Seasonal loan ………	Investment loan ………

Have you heard of zero-tillage? 1. Yes; 0. No

What % of farmers use zero-till drill?	
How many zero till drills are there in community?	
What is your perception of zero-tillage technology?	

Future outlook

	Crop production	Livestock production
Do farmers want to expand crop or livestock production?	0. No; 1.Yes	0. No; 1.Yes
How/which activities?		
What are the hindrances? (e.g. credit, market, land resources, water…)		
Any other constraints?		

What is the main problem affecting the village?

Comments:

Close group discussion and thank participants. Take a tour of village and surrounding fields to observe first hand. Please note any observations, discussions and general perception of crop-livestock issues if not covered before.

Crop-livestock interactions scoping study
Landless group discussion

After completing group discussion with farmers, request to meet a small group (5-10) of landless households from the village. Try hard to include some women. Discuss with them below and related issues.

Number of **participants**: ……	# of **women** among participants: ……

What share of landless households have livestock?:

Main types of animals:

How do they procure the livestock feed? (types, seasons, prices):

Describe importance of livestock to them (e.g. relative to other sources):

What problems do you face?

Annex 5. Selected photographic impressions from study area

Malda cluster

1. Milking *desi* cow

2. Rice stubble grazing

3. Rice straw stack

4. Farm compound with dung sticks & rice residue stack

5. Survey scene

6. Transport of rice residue

Nadia cluster

7. Crossbred pen

8. Farm compound drying sesame

9. Dung cakes

10. Loose & stacked rice residues & dung cakes

11. Survey scene

12. Rice straw stack

W Mednipur cluster

13. Farm compound with *desi* cattle

14. Village scene with roadside cattle shed

15. Manual chaffing of rice residue

16. Farm compound with rice residue stacks

17. Survey scene

18. Transport of rice residue