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Crop-Livestock Interactions and Livelihoods in the Gangetic Plains of West Bengal, India: Findings from a Scoping Study

O. Erenstein¹, A. Varma², W. Thorpe³ and J. Singh⁴

ABSTRACT

The research and development (R & D) 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 agriculture and resource-conserving technologies. The paper summarizes the findings from a scoping study to assess crop-livestock interactions and rural livelihoods in the Gangetic Plains of West Bengal, drawing from a village survey in three districts (Malda, Nadia and Paschim Medinipur) and secondary data. The rice-cattle based rural livelihoods are in stark contrast with those in the western IGP, whereas the state's high human and livestock pressure and high poverty pose particular challenges to sustainable intensification and poverty reducing agricultural growth; particularly in the more remote districts. Strengthening the client orientation and productivity of the agricultural R&D community will be central to improving livelihoods and more sustainably using natural resources; and research on crop-livestock interaction serves as a good entry point for that process.

Key words: Crop-livestock interactions, Indo-Gangetic Plains, Livelihoods, Mixed farming systems, Rice.

Introduction:

The Lower-Gangetic Plains (LGP) comprises most districts of West Bengal (W.B.) and neighboring western Bangladesh. Rural livelihoods in the LGP are based on rice-cattle farming systems – in stark contrast to the rural livelihoods in the western Indo-Gangetic Plains (IGP) which are based on wheat-buffalo farming systems (Erenstein et al., 2007a; and 2007b). W.B. is also India's most densely populated state.

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Nearly a third (32%) of the rural population are 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 LGP). W.B. is the most densely stocked state of India in terms of cattle, small ruminants and poultry. Equity and growth got 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.

The research & development (R&D) community now faces the challenge of sustaining crop productivity gains, improving rural livelihoods and securing environmental sustainability in the LGP. 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 i.e RCTs (Erenstein et al., 2007a).

This paper summarizes results from a scoping study to assess crop-livestock interactions and rural livelihoods in the Gangetic Plains of W.B., drawing from a village survey in three districts (Malda, Nadia and Paschim Medinipur) and secondary data. The comprehensive results of the scoping study were provided in Varma et al. (2007). These results along with those from three other sub-regional reports (Punjab and Haryana by Erenstein et al., 2007b; Uttar Pradesh (U.P.) by Singh et al., 2007; and Bihar by Thorpe et al., 2007) were also drawn together in a synthesis report (Erenstein et al., 2007a).

The present summary paper is structured as follows. The next section presents the methodology followed and details about the specific survey locations. The third section characterizes the agricultural economy in the state of W.B. as drawn primarily from secondary data and available literature. The fourth section summarizes the livelihoods and crop-livestock interactions in the surveyed communities. The final section first discusses the effects on livelihood security and environmental sustainability, subsequently dwells on the outlook for the surveyed communities and finally draws together an agenda for action.

Materials and Methods:

The present paper summarizes the more detailed companion study (Varma et al., 2007). The scoping study compiled secondary data for W.B. and collected primary data through a village survey of 18 randomly selected villages, from three different districts (one cluster of 6 villages each in Malda, Nadia and Paschim Medinipur) in 2005.

The communities were randomly selected using a stratified cluster approach. A representative district from each of the 3 main agro-ecological subzones within the LGP of W.B. (Kumar et al., 2002). At cluster level, 6 villages were randomly selected around a central point, typically the district headquarters. The villages were randomly selected by taking two villages off the main road along three different directions, one village typically relatively close (generally within 5 km) and the second further away (generally more than 15 km). It is important to flag the proximity of the Nadia cluster to the
major urban agglomeration of Kolkata, as this directly influences intensification and diversification incentives, particularly compared to the more remote the Malda and Medinipur clusters.

Within each village interaction was made with self-selected groups of key-informants using semi-structured interviews for about half-a-day. Members of a core team participated in each survey and were joined by local staff from the national agricultural research and extension system, particularly Uttar Banga Krishi Viswavidyalaya (U.B.K.V.) and its associated KVKs and staff (KVK, Malda; KVK, Coochbehar; KVK, Dinajpur), Bidhan Chandra Krishi Viswavidyalaya or B.C.K.V. (Mohanpur, Nadia) and the Seva Bharati KVK (Kapgari, Paschim Medinipur). The survey teams were also variously assisted and sometimes accompanied by members of the local level grassroots administration (Gram Panchayat).

**Agricultural Economy in the State of West Bengal:**

W.B. is the most densely populated state of India with some 900 inhabitants 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). This reflects a great concentration of population over the centuries in the alluvial lands of the Gangetic plains of W.B., aggravated by historical and socio-economic factors. W.B. has witnessed significant internal migration from the neighboring states such as Bihar, Orissa and U.P. to Kolkata, Howrah and other industrial areas of the state, whereas partition led to an almost continuous stream of migrants into the state from across Indo-Bangladesh borders (Anon., 2004a). Over the last decade, W.B. now has a lower than average population growth, 1.8% per annum (p.a.). The population is predominantly rural (72%). Nearly one-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). Scheduled Castes, Scheduled Tribes and minorities together account for more than half the population, and are the three poorest groups in rural Bengal. Agricultural laborers 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 (Anon., 2004a).

The LGP in W. B. have a sub-humid climate with an annual rainfall ranging from 1450 to 1800 mm. The rains prevail during the warm monsoon season (with 76% falling in June-September), with the summer and cool winters being drier. The topography in Gangetic W. B. is generally gently sloping with deep alluvial soils with more lateritic soils proceeding westwards. The irrigated area in W. B. during 2000-01 was 44%, although relatively lower in the northern Barind plains.

W.B. still is heavily dependent on agricultural production. “For most of its post-independence history, W.B. 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” (Anon., 2004a). Over the last two decades, the net sown area has remained more or less the same (Anon., 2004a), implying intensification and
diversification of land use as the main pathways for agricultural growth.

W. B. is a major and traditional rice producer. With a rice area of 5.9 million hectares (m ha) in 2003-04, it provided 14% of the national area, equaled only by U.P. further upstream. Due to its slightly more favorable average yields of 2.5 t ha\(^{-1}\) in 2003-04 (against the national average of 2.1 t ha\(^{-1}\)), it was the main rice producer with 17% of national production, with only 42% of rice area being irrigated (Anon., 2005b). The prevalence of rice in the plains implies that at least two-third of the gross cropped area is devoted to rice cultivation. The state of W. B. dominates jute production in India, with its area of 0.6 m ha amounting to 63% of national area and 75% of production in 2003-04 (Anon., 2005b).

In comparison, the wheat area is relatively limited, with 0.43 m ha (1.6% of national area) in 2003-04 and below average yields of 2.3 t ha\(^{-1}\) (against the national average of 2.7 t ha\(^{-1}\)), with 79% of wheat area being irrigated (Anon., 2005b). With an estimated 0.3 m ha of rice-wheat system area, W. B. comprises only 2.7% of the rice-wheat system area of the IGP in India (Sharma et al., 2004). The surveyed village clusters fall in the Barind plains in northern W. B. and in the central alluvial plains. Wheat cultivation is largely confined to the northern plains with its cooler winters, and only the Malda village cluster in the Barind plains lies in north of the tropic of Cancer.

Rice production in W. B. 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 season and harvested in April-May. Though boro cultivation spread rapidly during the 1980s, it 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). 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.

There was substantial crop diversification in W. B. in the 1980s and 1990s. Potato production increased rapidly in the 1980s at nearly 9% p.a., making W. B. 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 (Anon., 2004a). 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 (Anon., 2004a).

The rice-based cropping systems are complemented by the livestock sector. Poultry
is the dominant stock with 3 fowls for every 4 humans in W. B. – in stark contrast to the low poultry numbers reported in Bihar and U.P. further upstream. Poultry includes significant numbers of ducks (28%) and offers particular pro-poor development prospects (Dhawan et al., 2009). 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 comprises 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. Overall the state of W. B. has witnessed an increase in livestock numbers over the last decade (+41%). 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 W.B. the most densely stocked state of India for a number of livestock types in addition to being the most densely human populated state. Whereas the state comprises only 2.7% of India’s 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 (Anon., 2004b).

In W.B., 25% of rural households are cultivators and 33% are agricultural laborers while other occupations make up the remainder 42% of rural households (Anon., 2005a). The average farm size of 0.8 ha in W. B. is low compared to the national average of 1.3 ha (Anon., 2006b), reflecting its high rural population density. Marginal farmers (<1 ha) constituted 77% of land holdings and another 15% are small farmers (1-2 ha). 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 W.B. 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 (Anon., 2004a; Sarkar, 2006). The extent of land reform in W.B. was such that it accounted 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 the state (Anon., 2004a).

The success of land reform in W.B. was aided by the continuous rule by a Left Front Government for more than a quarter of a century (since 1977) with a vision of political, economic and social change. Land reform was one of the two key strategies at the state level, the other being decentralization and people’s participation through Panchayat institutions (Anon., 2004a).

The Panchayat system in W.B. is a three-tier system: village-level (Gram Panchayat), block-level (Panchayat Samiti) and district-level (Zilla Parishad) council. Members are responsible for the administration of local public goods (public buildings, water and 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 the country 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 W.B. 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 (Anon., 2004a). During 1983 to 1993-94, W. B. 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 favorable 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 labor-intensive form of cultivation by small cultivators on small plots of land using mainly family labor (Anon., 2004a).

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, W. B. 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. This contributed to making W.B. one of the fastest growing states in India with capita growth rate of 5.4% over the period from 1993-94 to 2000-01 (Anon., 2004a).

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 labor 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 W. B. 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 from 1993-94 to 1999-2000, i.e. one-third 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 (Anon., 2004a). Another worrying sign is that W.B. along with Bihar and U.P. are the only major Indian states exhibiting negative industrial employment growth during the period from 1980-81 to 1997-98 (Sarkar, 2006). W. B. thereby was subjected to a relative industrial decline: in 1980-81, the state produced 9.8% of the industrial output produced in the country as against only 5.1% in 1997-98 (Banerjee et al., 2002).

High population density in W.B. exerts significant pressure on basic infrastructure as well as on the provision of health and education services. Human development indicators in W.B. present a mixed picture by district (e.g. poverty) and gender, with significant gender differences in literacy and reported work participation (Debroy and Bhandari, 2003). 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 (Anon., 2004a). 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.

A striking contrast across the three surveyed districts is the relative poverty level of Malda: nearly half the population below the poverty line and nearly a quarter going hungry (Debroy and Bhandari, 2003). Malda tends to score low on most development indicators, whereas Nadia and Medinipur tend to have more favorable indicators approximating the state average (Debroy and Bhandari, 2003). The overall Human Development Index for W.B. was 0.61, but Malda district ranked lowest of all districts with an index of 0.44 whereas Nadia and Medinipur ranked in the middle (Anon., 2004a). Medinipur has split in 2002 into Paschim and Purba, with Paschim Medinipur ranking together with Malda amongst the seven W. B. districts of W.B. that were listed as India's 150 disadvantaged districts by the Planning Commission, Government of India (Anon., 2006a).

Livelihoods and Crop-Livestock Interactions:

The present section summarizes the livelihood platforms, livelihood strategies and crop-livestock interactions in the surveyed communities. The comprehensive results of the village surveys are provided in Varma et al., (2007).

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 in each 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 (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% month⁻¹. Daily wage rates were low (Rs. 42-43/- in the Malda and Nadia clusters, Rs. 33/- in the Medinipur cluster) and were the lowest amongst all the clusters surveyed throughout the IGP. In view of abundant labor and small farm size, the Medinipur cluster and particularly the Malda cluster are labor surplus and net-suppliers of agricultural labor. 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 labor. Compared to the upstream IGP states, wheat largely disappears from the agricultural system in the W. B. 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 household \(^1\) in the Nadia cluster to a high of 3.8 in the Medinipur cluster. Compared to the other IGP states upstream, the W. B. 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 landless households, the crop component generally was more important than the livestock component for household income, whereas landless depended primarily on farm labor. 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 laborers worked locally and when migrating seasonally, tended to remain within the state and did so during the times of rice harvesting and rice transplanting.

Crop-livestock interactions: W. B. 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 used as feed, and the labor-intensive residue management and use practices. There is some grading of rice straw for feed associated with seasonal and varietal differences. W. B. 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 (Rs. 0.8 kg \(^{-1}\)).

In terms of livestock feeding practices, W. B. had a number of marked differences compared to the other IGP states. First, the prevalence of rice residues as the main basal feed. Use of crop residues other than rice 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 in the IGP. 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 W. B. Third, 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 the state. A number of factors explain the observed divergences, not least the prevalence of lowly productive desi cattle in two of the W. B. clusters and the rice food/feed tradition. The relatively limited extent of irrigation constrains overall fodder availability in the W. B. clusters, particularly in Malda and Medinipur.

W. B. combines relatively low mechanization with a high reliance on animal traction. Half of the manure is reportedly used as household fuel in the W. B. 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, farm yard manure) 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 W. B. 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 draft, 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.

**Discussion and Recommendations:**

Livelihood security and environmental sustainability: The surveyed communities show significant diversity in terms of livelihood security and 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 favorable, 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 labor-surplus households. Labor-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 laborers. 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 as 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 laborers. In this respect, the land reforms in W.B. 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 labor for able-bodied poor people is thereby still an important livelihood strategy and a means of getting hold of lump sum of cash in rural W.B., in general (Rogaly and Rafique, 2003) and the surveyed clusters, in particular. However, instead of serving as a way 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, over-development and over-exploitation of ground water has undermined the prospects of secured irrigation in others. Ground water 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 northwestern IGP (Abrol, 1999), the extent of over-exploitation of ground water still seems less severe, probably aided by the higher annual rainfall and more significant recharge. The threat of consuming arsenic contaminated ground-water 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 W.B. 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 W.B. implies few organic residues that 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 farm yard manure. This implies 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 W.B. clusters compared to the other IGP sub-regions (Erenstein et al., 2007a) was the predominance of rice as the prevailing food and feed crop. Over time there only seems to have some changes in the margin. In this respect, the similarities with some of the prevailing food consumption and production practices in Bangladesh are 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.

Outlook and Constraints:

Outlook and constraints: The situation of the Nadia cluster appeared relatively favorable 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, 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 labor 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 labor-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 W. B. clusters was the prevalence of 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 in the Medinipur and Malda clusters) and the prevalence of scheduled tribes (predominant in 2 of the 3 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% month⁻¹, constraining investment possibilities and working capital alike. The communities are increasingly labor 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.

**Agenda for Action:**

As in the other three sub-region scoping studies, the W. B. study 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 W.B.'s crop and livestock sub-sectors. 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 study on the Trans-Gangetic Plain, Erenstein et al. (2007b) highlighted the need for India’s “breadbasket” and the heartland of the green revolution to have a more enabling environment for economic and human development. They highlighted 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 labor from the primary sector and the rural landless. As has been outlined in the previous sections of this paper, these priorities for action equally apply to W.B., where low productivity and poverty are endemic in some districts. Excess labor 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 Trans-Gangetic Plain, a more enabling environment for agricultural development, also needs to be urgently addressed in W.B. 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; Anon., 2007). Despite the lessons from rapid agricultural growth in some districts, there are, however, still immense challenges to agricultural and poverty-reducing growth in W.B. 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 R & D; enabling agricultural intensification and high-value and labor-intensive diversification; enhancing access to affordable rural credit (micro-credit); and promotion of agro-based industries.

The present 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 capitals particular attention. Agricultural produce markets appeared particularly underdeveloped in the Malda and Medinipur clusters, a reflection of the prevailing subsistence orientation of small holdings, 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 labor-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 W.B. may benefit from the lessons and success of the Grameen Bank and similar institutions in Bangladesh (e.g. Goldberg, 2005; Schreiner, 2003).

The 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" in order to reduce the "yield gap" for most crops. Similarly, the limited use of livestock services and recommendations (like artificial insemination, 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 IGP sub-regions. 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 appropriate RCTs, while factoring in any trade-off effects on the feeding of crop residues to livestock; and, related to that;
- investigate whether variation in rice, wheat and maize varieties for fodder quality (nutritional value) as an avenue for increasing the available quantity and quality of crop residues for feeding goats, cattle and buffalo; and,
- investigate organic matter 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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