Natural Resource Endowments, Subsistence Agriculture, and Poverty in the Chhotanagpur Plateau

Pabitra Banik and Christopher Edmonds and Nobuhiko Fuwa and Suan Pheng Kam and Lorena Villano and D.K. Bagchi

International Rice Research Institute

2004

Discussion Paper

2004 No. 47

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Mailing address: DAPO Box 7777, Metro Manila, Philippines
Phone: +63 (2) 580-5600
Fax: +63 (2) 580-5699
Email: irri@cgiar.org
Home page: www.cgiar.org.irri
Riceweb: www.riceweb.org
Rice Knowledge Bank: www.knowledgebank.irri.org
Courier address: Suite 1009, Pacific Bank Building
6776 Ayala Avenue, Makati City, Philippines
Tel. +63 (2) 891-1236, 891-1174, 891-1258, 891-1303

Suggested citation:
Banik P, Edmonds C, Fuwa N, Kam SP, Villano L, Bagchi DK. 2004. Natural resource endowments, subsistence agriculture, and poverty in the Chhotanagpur Plateau. IRRI Discussion Paper Series No. 47. Los Baños (Philippines): International Rice Research Institute. 32 p.

ISBN 971-22-0195-3
ISSN 0117-8180

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Glossary of non-English terms

Baad land	Medium uplands with low soil fertility status. Medium-duration (120 ± 5 days) rice is grown.
Barhi land	Homestead cultivable land with water resources. Mostly highly intensive cropping is done with high inputs.
Boro rice	Winter-season rice transplanted in December-January and harvested in April-May. Boro rice is photo-insensitive and grown under irrigated conditions.
Desi plow	Plow made of wood. Bullock-drawn shallow chisel. It makes a V-shaped furrow and does not turn over the soil.
Garha land	Lowland with high fertility status. The land is highly bunded with no drainage facilities. Long-duration traditional rice is grown with minimum inputs. Excess moisture is the main problem.
Gora rice	Upland direct-seeded traditional rice with low yield (below 1 t ha^{-1}) potential generally sown in June and harvested in October.
Gundli	A cultivated millet whose botanical name is *Panicum antidotale*.
Hatia star	Star that first appears in the sky over India from 27 September to 9 October that is traditionally used by farmers in the area to indicate likely postmonsoon rain and the availability of residual soil moisture enabling cultivation of winter crops.
Kharif season	Main monsoon season (June to October); the major crops grown are rice, sorghum, maize, cotton, etc.
Kodo	A minor millet (*Paspalum scrobiculatum*) generally grown in degraded uplands (tanr land).
Panchayat	The Indian codified system of local democracy and governance based on elections of local leaders from competing political parties.
Rabi season	Season during which winter crops such as wheat, barley, mustard, gram, etc., are cultivated; it usually extends from November to February.

Ragi	Also known as Marua. The English name is finger millet (*Eleusine coracana*) and it is also grown in uplands.
Rohan star	Star that first appears in the sky over India from 25 May to 7 June that is traditionally used by farmers in the area to time their cultivation of rice in anticipation of premonsoon rains.
Tanr land	Toposequentially, it is upland with light-textured, shallow sandy loam and noticeable amounts of gravel. It is highly permeable and has low water-retentive capacity.
Tolas	Cluster of houses in the village (artificial man-made boundaries). Each tola commonly represents a particular ethnic group.
Zamindar	An official in precolonial India assigned to collect the land taxes of his district. A landholder in British colonial India responsible for collecting and paying to the government the taxes on the land under his jurisdiction.

Natural resource endowments, subsistence agriculture, and poverty in the Chhotanagpur Plateau

P. Banik, C. Edmonds, N. Fuwa, S.P. Kam, L. Villano, and D.K. Bagchi

The Chhotanagpur Plateau in eastern India lies on the so-called "tribal belt" and is one of the poorest regions of India. In 1998, the Indian Statistical Institute in Kolkata and the International Rice Research Institute began research to examine the biophysical and socioeconomic factors constraining agricultural activity and household income in the region. This report provides an initial descriptive and quantitative analysis of the integrated biophysical and socioeconomic database constructed from this research. The report begins with a brief overview of the geography and history of the study area, followed by descriptions of the main biophysical characteristics of the area, such as climate, topography, soil, water availability, and the typology of land types in the area. The main cropping systems associated with each land type are identified. This research highlighted the importance of low-scale variations in topography in explaining cropping systems. The report then reviews the socioeconomic characteristics of the villages and the surveyed households. Key characteristics include the high incidence of poverty, the diversity of economic activities, and the small share of imputed household income derived from rice cultivation. The report concludes with a brief discussion of policy implications and avenues for future research.

Introduction

Among the rainfed lowland rice areas in Asia, the Chhotanagpur Plateau in India constitutes an area of particularly low agricultural productivity and a high incidence and severity of poverty. The incidence of poverty among rural households in the area is estimated to be among the highest in Asia. Most rural households practice subsistence farming under adverse and risky environmental conditions. The natural resource base can be characterized as poorly suited to agriculture because of climatic, water resource, and soil conditions. Because of several decades of nonsustainable land-use practices and highly erosive monsoon rains, deforestation and soil erosion are proceeding rapidly in many parts of the plateau. The families that live and work in the area often depend on nonagricultural income–generating activities to sustain the household—especially during the postmonsoon season. The majority of these nonfarming activities involve low-productivity and low-paying work. Trends with respect to the state of natural resources combined with the paucity of options for high-return nonagricultural employment make the prognosis for the future of the area, and of the families that live there, worrying.

Approach taken in this study

Beginning in 1998, this study has applied a multidisciplinary approach in seeking to identify the key determinants of poverty and welfare among farming households in adjacent districts (Giridih and Purulia) of the states of Bihar (located in the newly formed Jharkhand State) and West Bengal.[1] The approach combined geographic modeling relying upon geographic information systems (GIS) techniques and household agricultural and socioeconomic survey data collection and analysis typical of an economics approach in an effort to understand the main biophysical and socioeconomic factors driving farmers' livelihood strategies and use of the resources available to them in order to determine the key interventions—policy, technological, institutional, etc., aimed at improving livelihoods in a sustainable manner. Identification of the key constraints to improved agricultural productivity (particularly for rainfed rice, which represents the predominant crop and is the principal focus of agricultural activities of households in the study area) is a particular focus of this study. The research also seeks to determine what are the most promising exit paths from poverty and natural resource degradation in the eastern part of the Bihar plateau. Agronomic field work, including in-field experimentation carried out by the Indian Statistical Institute (ISI) in Kolkata, also provides useful insights regarding possible routes of crop diversification or other mechanisms for enhancing the value of the agricultural output of households in the study area.

The empirical data considered integrate biophysical and socioeconomic characteristics observed at various scales (household, village, and landscape). The biophysical environment is categorized according to hierarchical scales of what are identified to be important factors—climate, terrain, soils—that influence the hydrology and the suitability for different agricultural activities in the area. Interactions among these biophysical variables are considered at length as well, as is the relationship between biophysical and socioeconomic characteristics. Our analysis begins by discussing characteristics at the district level and subsequently considers the determinants of poverty and agricultural productivity at progressively lower scales (e.g., district, block, village, and household).

Many of the socioeconomic analyses, on the other hand, are based on results from a detailed household survey. The survey was conducted with 541 households divided across 16 villages from two districts in the adjacent states of Jharkhand (formerly part of Bihar) and West Bengal. Both districts are located in the Chhotanagpur Plateau and share similar biophysical characteristics, but the governing institutions across the two districts differ markedly. In Purulia District (West Bengal), the *panchayat* system is well developed and land reform has been actively implemented, whereas, in Giridih District (Jharkhand), local democracy is largely absent and large landholders exercise considerable influence over local economic and political affairs. In each district, surveyed households were selected from two villages across four blocks (Fig. 1). Villages selected within each block were stratified according to the ease of access to the main transportation routes and markets. Within each village, household sample lists were drawn from census lists and approximately 34 households were selected for interviewing using stratified random sampling based on the size of the household landholding, with weights from each landholding category assigned in rough proportion to the class's representation in the population according to the latest census.

In rural economies in developing countries, the level of household welfare tends to be closely related to the size of landholding controlled by the household. Following the classification used by the Agricultural Census in India, we have thus classified our sample households into five categories according to the total size of land owned by the household: landless households (with landholding of less than 0.08 ha), marginal farm households (0.08–1 ha), small farm households (1–2 ha), medium farm households (2–4 ha), and large farm households (more than 4 ha). The data collected for each household included demographic characteristics, occupation and income of household members, plot-level information on agricultural inputs and outputs, crop disposal (e.g., how much of the produce is self-consumed and how much is sold), credit transactions, and capital and livestock holdings.

Report objectives

This report focuses on the descriptive and initial quantitative analysis of the integrated biophysical and socioeconomic database constructed for the project. It focuses on characterizing the study area and the farming households surveyed. The report starts with a brief introduction to the geography and history of the study area, followed by descriptions of the main biophysical characteristics of it, such as climate, topography, soil, and water availability. This section

[1]The state of Jharkhand was formed in 2000, but, during the initial phase of field work for this study, Giridih District was a part of Bihar State.

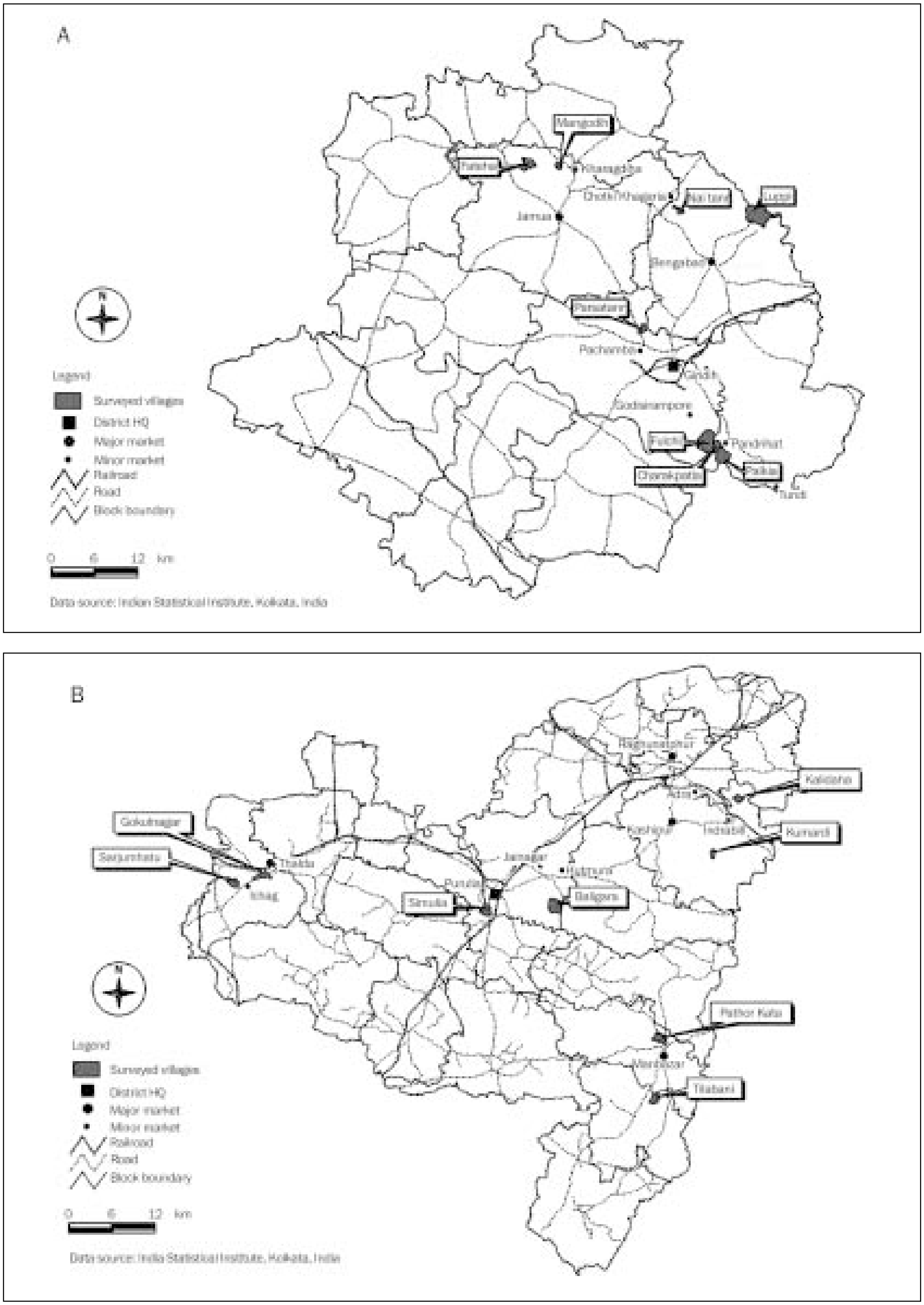


Fig. 1. Study area, sampled villages, and distance to urban centers and markets. (A) Giridih District, (B) Purulia District.

also introduces the typology of land types in the area and identifies the main cropping systems associated with each land type. The next section considers the main characteristics of agricultural production as revealed by the survey of farmers in the study area. The productivity, technology applied in production, and subsistence orientation in production are discussed. The next sections review the socioeconomic characteristics of villages and households in the study area. Key characteristics include the high incidence of poverty and the diversity of economic activities (both agricultural and nonagricultural) observed in the livelihood strategies of surveyed households. These sections also examine the relationship between important socio-cultural aspects found in the study area—caste, landholding size, and differences in systems of local governance—and observed economic outcomes. The report concludes by reviewing the findings that emerge from the review of descriptive data and discussing policy implications.

Description of the study area

Location and history

Physiographically, the study area is located at the eastern fringe of the Chhotanagpur Plateau, which rises in elevation south and west of the eastern Gangetic plain and the Ganges delta (Fig. 2). Before the British colonial era, this area was largely unsettled and was mostly covered with dense forest. Available oral history and limited documentation suggest that the small local population subsisted from the extraction of local forest products and carried out very little agricultural activity (Sen et al 1984), focusing on cultivating local rice, pulses, millets, and vegetables. Under British rule, the colonial administrators found the area to be an important source of timber for use in constructing national railways, leading to extensive deforestation. Settlers—particularly families from marginalized tribes—were permitted to move into the area to farm on the cleared lands. Although records are scarce, it seems that most immigrants into the area came from other parts of eastern India.

With independence, state initiatives established a mining industry in Giridih District, which was rich in mineral resources (particularly mica and coal), as part of a broader development strategy highlighting industrial development. The mining industry flourished for about 30 years, attracting more immigrants, until the demand for mined mica declined because of the invention of a less costly artificial substitute, while other mineral resources became

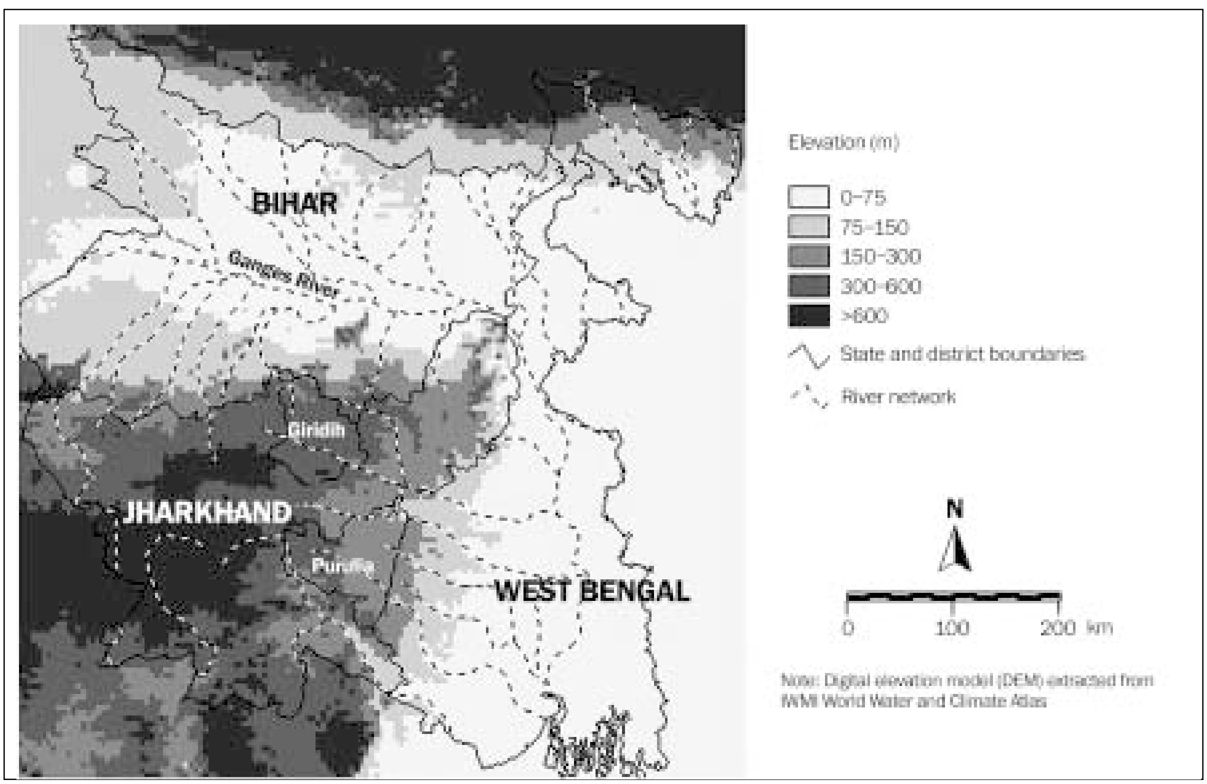


Fig. 2. Topography of Bihar and West Bengal, including study area.

depleted. With the decline of the mining industry, many of the immigrants turned to agriculture for their livelihoods.

On the other hand, Purulia District of West Bengal, serving as a buffer zone between the Damodar plains and Bihar plateau, came under British rule in the last decade of the19th century, with local zamindars governing natural resources, including forest, and peoples' livelihood. Except for a few coal areas, no important industries flourished. The main crops were more or less the same as those of Giridih District and tribals formed a significant part of the population. Postindependent reforms, particularly panchayat activities and land reforms, with an increase in small landowners, had major impacts in Purulia in the 1990s. For example, high-yielding varieties (HYVs) along with inputs such as fertilizer and pesticides were distributed among farmers through the panchayat under the scheme called "Manikit," which might explain the higher rate of HYV adoption in Purulia than in Giridih (as seen below). However, the topographical features and the predominance of rainfed cultivation are common between the two districts.

Natural resource degradation and unfavorable environmental conditions

Climate, rainfall, and the cropping calendar. Climatically, the study area is subtropical and subhumid, with hot wet summers and cool dry winters. During most of the year, temperatures in the study area do not constrain crop growth, although winter temperatures do fall below 10 °C in December and January. Low temperatures can affect establishment of *boro* (winter season) rice, which is transplanted in December-January and harvested in April-May.

Rainfall and water availability are more serious climatic factors constraining agriculture in the study area. Figure 3 shows the spatial distribution of mean annual rainfall for Bihar and West Bengal (in this study, availability of weather data from government meteorological stations was taken into consideration in the selection of blocks from which villages were sampled for farm household surveys). Annual rainfall generally decreases from the northwest to the southeast of the plateau. The mean annual rainfall in Purulia District is 1,334 mm, decreasing to 1,225 mm in Giridih District. While these annual amounts would generally be considered adequate for agriculture, the high seasonality of rainfall confines the cropping period to only part of the year. This rainfall seasonality is influenced by the southwest monsoon. About 82% of the annual rainfall occurs within the monsoon period, which lasts roughly from June to September (the black bars in Figure 4 show the 27-year average monthly rainfall in Giridih). There are, on average, about 80 rainy days (with daily rainfall exceeding 2.5 mm) in a year in Giridih and 83 in Purulia, but this can vary yearly, from 62 to 104 days. The monsoon rains can be very intensive and erosive, particularly in areas on higher ground bare of vegetation cover. Available moisture over the entire monsoon period determines the time window of opportunity for the various cropping systems practiced by farmers in the study area.

Normally the southwest monsoon starts in mid-June, that is, the 24th Standard Meteorological Week (SMW), and ceases at the end of September—SMW39 (Fig. 3B). Traditionally, farmers in the study area use the appearance of the Rohan star (Narahari Rao et al 1999, Banik 1996) in SMW20-21(mid-May) as an expectation of premonsoon precipitation for carrying out nursery planting and land preparation for rice. The average premonsoon precipitation (or Rohan rain) is 35.2 mm in Purulia and 26.9 mm in Giridih.

Similarly, the availability of postmonsoon precipitation (Hatia rain) during the period of appearance of the Hatia star in the last week of September to the first two weeks of October (SMW40-41) indicates the possibility of sowing winter crops and also using residual moisture to cultivate winter crops on medium land (Banik 1996). Our field experiments indicate that second cropping is possible on medium land with soil residual moisture provided that there is Hatia rain to germinate and establish the crop (Banik et al 1993, 1997, 1999, Banik and Bagchi 1996).

Variation is considerable in the onset and withdrawal of the southwest monsoon. The onset can occur as early as mid-May (SMW20) or as late as mid-July (SMW28). The withdrawal of the monsoon can vary from late August (SMW35) to late October (SWM43). This large variation in both the onset and withdrawal of monsoon causes much uncertainty for farmers in implementing their cropping calendar in the study area. For example, Figure 4 shows the monthly rainfall distribution for 1996 and 1998, compared with 27-year monthly average values, for Bengabad block in Giridih District, where one of the surveyed villages, Luppi, is located. The total rainfall for 1996 (1,299 mm) was just 1.8% higher than the 27-year average (1,276 mm), while the 1998 rainfall was 1,672 mm, or 31% more. Furthermore, the seasonal rainfall pattern for these two years is vastly different from each other and from the average 27-year pattern. In 1996, the June rainfall was 36% higher than normal, but declined drastically in July, to only 35% of the 27-year average. There was also an

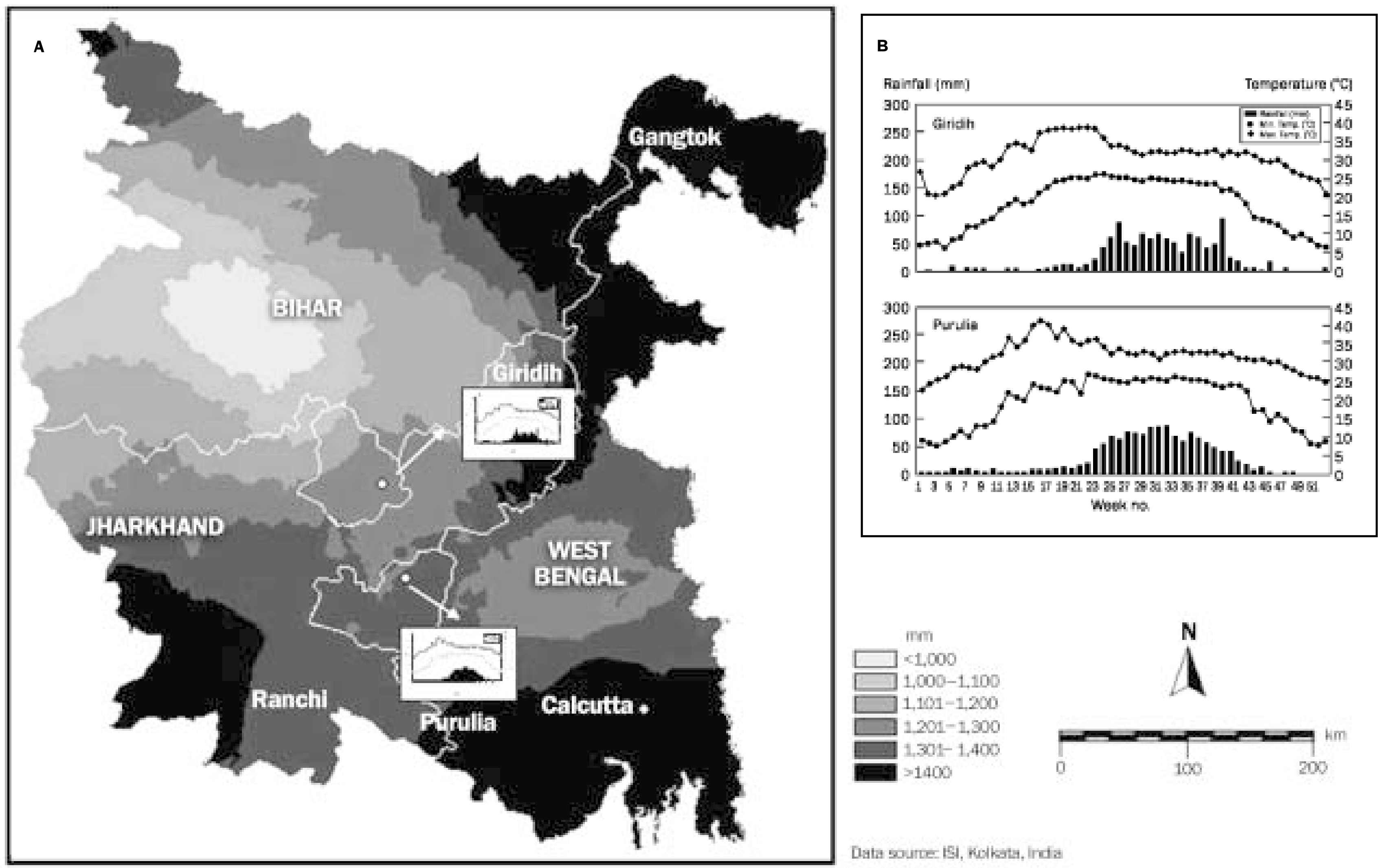


Fig. 3. Rainfall and temperatures in the study area. (A) Annual mean rainfall in Bihar and West Bengal, (B) annual mean rainfall in Giridih and Purulia districts.

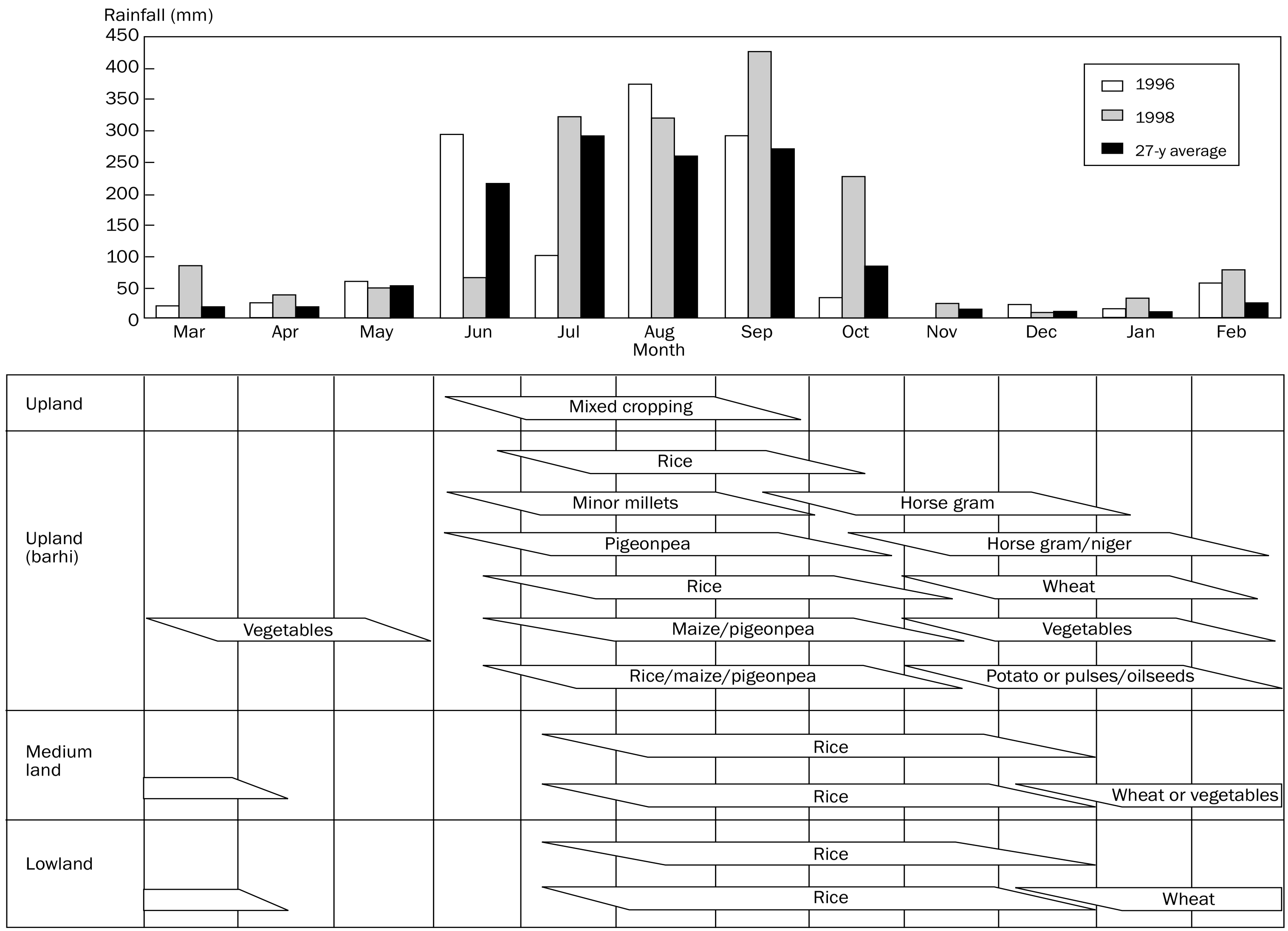


Fig. 4. Temporal rainfall patterns in Giridih (Bengabad block) in relation to cropping calendars.

early withdrawal of the monsoon; the October rainfall in 1996 was 60% below the 27-year average (83 mm) and no rainfall was recorded for November. In 1998, the off-monsoon months of January to April were distinctly wetter and the onset of the monsoon was delayed—the June rainfall was 70% below the 27-year average. However, the monsoon lasted longer and the September and October rainfalls were 56% and 174% higher than normal. A delay in the onset of the monsoon means that farmers who take advantage of the Rohan rain to start their crops would encounter early-season drought. An early withdrawal and/or lack of Hatia rain would affect the ability to grow winter crops in a multiple cropping system. Hatia rain (over a 2-week period in late September to early October) can vary from 0 to 334 mm, and may fail completely in one out of four years. On average, only about 10% of the total annual rainfall occurs outside the monsoon (pre- and post-) period. Although this constitutes a small amount of rainfall, it is nevertheless important in giving reasonable yields for winter crops such as barley and oilseeds.

On the whole, differences in rainfall characteristics between Purulia and Giridih are only slight, with Purulia experiencing marginally higher rainfall and more rainy days, and slightly higher frequency of early monsoon onset (5 out of 20 years compared with 2 out of 20 years for Giridih). These minor differences across space are overshadowed by the considerably greater interannual variations at any location in the plateau.

Surface water and groundwater resources. During the dry season, many of the smaller streams/rivulets in the study area typically dry out; as a result, surface water is not readily available. The main sources of water for agricultural use are dug wells, supplemented with water stored in reservoirs and ponds. The study area is poorly endowed with underground water resources because of its crystalline (granitic) bedrock and insufficient recharge from rainfall during the monsoon season because of excessive surface runoff. The water-table depth varies from shallower than 3 m to more than 12 m during the summer months, and many of the shallow wells retain scanty water or dry up completely. Hence, irrigation potential during the dry season is relatively low (Bhattacharya et al 1985, Maiti and Bagchi 1993).

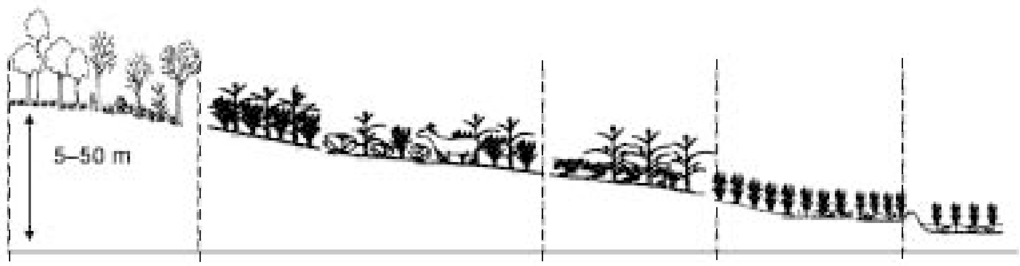
Influence of topography and soils on land use. Topographically, the study area is undulating, with elevation ranging from 250 to 500 m. The undulating topography and highly dissected landscape give rise to short-range variations in terrain and soil and water conditions, which influence the kinds of crops that can be grown, the time windows for cropping, and the possible cropping systems in different parts of the toposequence. Topographically, three main landscape types are identified:

- The upper terraces, or uplands, are associated with light-textured soils.
- The middle terraces, or medium land, have slightly more heavily textured soils (e.g., loamy sands and sandy loams).
- The lower terraces, or lowlands, have even more heavily textured soils (e.g., sandy clay loam).

Soil texture influences soil moisture storage capacity, which, together with water-table depth, largely determines the period of moisture availability for cropping at these landscape positions. Water availability outside the monsoon season (including pre- and postmonsoon periods) is particularly crucial for cultivation in the upland and medium land, whereas, in the lowlands, the accumulation of excessive surface runoff coupled with a high water table causes flooding, which could keep the land submerged after the monsoon period until as late as February. Farmers further distinguish different levels among the upland, medium land, and lowland, planting different rice varieties according to their perception of soil moisture gradient across the toposequence (Fig. 5). (The percentage distribution of different land types among our sample households is shown in Table 1.)

The uplands, locally known as *tanr*, are subjected to various intensities of use.

1. The gravelly uplands are generally not suitable for cultivation because of the harsh soil and water conditions. Where the natural forests are degraded, these uncultivated areas undergo severe erosion, causing further land degradation and increasing the extent of uncultivable area.
2. In the cultivable uplands, cropping of *gora* rice (short duration, 85–90 days, drought-tolerant, low-yielding upland rice) and traditional minor millets (finger millet, *kodo*, *gundli*) is done solely or in association with other crops as mixed crops during the monsoon season. Across all the sample villages, the most common cropping pattern for uplands was rice (*kharif* or monsoon-season)-fallow (*rabi* or winter-season), which was practiced on 41% of the total upland plots (in terms of the number of plots), as illustrated in Table 2. Seventy-four percent of the upland plots are left fallow during the winter season (see Table 3).
3. The uplands close to the homesteads, called *barhi*, are supplied with water from dug wells. The *barhi* land is intensively used to cultivate vegetables, high-yielding varieties of potato,



System	**Degraded uplands**	**Upland** (tanr)	**Upland (barhi)**	**Mid-upland (Baad)**	**Medium land (ajan/kanali)**	**Lowland (garha)**
Soil texture	Rocky; loamy sand	Sandy loam with gravel	Sandy loam; sandy clay loam	Sandy loam	Sandy clay loam	Clay loam
Soil depth	Shallow	Shallow	Shallow to moderate	Moderate	Moderate	Moderate to deep
Available soil moisture	150–175 mm	200–225 mm	200–250 mm	225–250 mm	250–275 mm	300–375 mm
Fertility status	Low	Low	Medium	Low	Low to medium	Medium to high
Cropping system	Forest Degraded forest Not cultivated	Fallow Gora paddy, minor millets such as finger millet; *kodo*; gundli Mixed cropping	Double-/triple-cropped cereal-based systems: rice/maize-wheat/pulse-potato/vegetables (medium-duration traditional rice varieties)	Monocrop rice (medium-duration traditional variety—locally called *Badhia dhan*)	Monocrop rice Rice-wheat (long-duration traditional varieties such as *Ajan dhan*)	Monocrop rice (long-duration traditional varieties)
Problems	Drought Low fertility Shallow soil depth Erosion	Water scarcity Low fertility Shallow soil depth Erosion	Small plots Unavailability of HYVs Unbalanced application of manure and fertilizer	Lack of water Unavailablity of suitable high-yielding medium-duration variety	Lack of water Unavailablity of inputs such as HYVs, etc. Unbalanced nutrient application	Excess water Poor drainage Lack of proper nutrient manage-ment

Fig. 5. Land types defined by low-scale differences in topography.

Table 1. Percentage share of different land types by village (sampled plots only).

Village	All villages	Giridih villages							
		Charak Patla	Fateha	Fulchi	Luppi	Mangodih	Naitanr	Palkia	Parsatanr
Upland	22	36.8	8.0	26.9	16.6	12.3	34.2	32.0	23.3
Barhi	13	11.8	14.9	18.7	15.6	20.6	17.1	20.1	35.5
Mid-upland	34	21.8	51.7	21.7	39.2	36.3	27.7	19.9	20.2
Medium	10	1.0	0.5	0.0	15.3	0.0	4.3	4.1	7.4
Lowland	22	28.6	24.9	32.7	13.4	30.8	16.8	23.8	13.6
Total area (ha)	3,473	202	326	296	236	259	168	272	92

Village	Purulia villages							
	Simulia	Baligara	Kalidaha	Kumardi	Patharkata	Tilabani	Gokulnagar	Sarjumhato
Upland	19.3	30.8	30.8	13.7	10.7	26.6	10.4	26.6
Barhi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Mid-upland	39.8	27.8	31.2	39.6	60.2	40.3	69.2	30.5
Medium	17.6	21.3	14.3	20.8	12.9	11.4	14.1	18.3
Lowland	23.3	20.0	23.7	25.9	16.2	21.6	6.2	24.1
Total area (ha)	116	293	210	254	155	162	209	157

and wheat and rice, and for rice seedbeds. The relatively higher level of inputs (including labor) in these *barhi* lands compensates for the low natural fertility of the soils and enables these areas to support crop diversification and intensification. In contrast with other land types, the rice-fallow cropping pattern is found on only 4% of the *barhi* plots, and only 36% of the *barhi* plots are left fallow during winter (see Table 3). Cropping patterns practiced on *barhi* lands are quite diverse, but the more commonly observed ones during the *kharif-rabi* seasons on *barhi* plots were fallow-potato (16%), maize-fallow (15%), *ragi* (finger millet—*Eleusine coracana*)-fallow (7%), maize-potato (7%), rice-fallow (4%), *ragi*-potato (4%), and fallow-wheat (4%). See Table 2 for complete details.

4. The lower portions of the uplands (mid-uplands) and the medium lands are distinguished by the rice varieties that are grown, as influenced by soil moisture availability. In the mid-uplands (or *baad*), medium-duration rice varieties are grown, whereas, lower down the toposequence in the medium land where soil moisture is available for a longer period, long-duration rice varieties are grown. These medium lands are known as *ajan* in Giridih and *kanali* in Purulia. Winter crops such as rapeseed, linseed, barley, lentil, and gram can be cultivated successfully following the monsoon-season rice crop, using residual soil moisture, particularly in the mid-uplands. In the medium lands, the most common cropping pattern is still rice-fallow, which covers 87% of the total medium land plots (see Table 2).
5. Although the lowlands are the most fertile, excessive moisture and poor drainage limit cropping to only rice, and constrain growing winter crops after the main rice season. Presently, most farmers grow traditional long-duration rice varieties with low inputs of manure. The rice-fallow cropping pattern is practiced on as much as 91% of lowland plots (see Table 2).

In general, the plateau soils are low in organic matter as well as available phosphorus, and have medium levels of potassium (150 to 300 kg ha^{-1}). The soil is slightly acidic in some areas. The soil fertility characteristics also vary with landscape position and with intensity of cultivation. Table 4 summarizes the main soil chemical properties for samples taken from rice fields at different landscape positions in Luppi village in Giridih District. There is a marked difference in the soil fertility level of the *barhi* and *tanr* in the uplands because of the higher inputs applied to the *barhi* lands, which are the most intensively cultivated. Apart from the *barhi* land, there is a systematic trend of increasing soil fertility from the uplands to the lowlands.

Because of the risky environment and the relative difficulty in gaining access to markets, food security is a primary concern of households in the study area. As a result, large amounts of the resources of farm households (especially family labor) are

Table 2. Crops planted in *kharif* (monsoon) and *rabi* (winter) seasons by land type.

Upper terrace		Bari		Mid-upland		Medium land		Lower terrace	
Crops (kharif-rabi)	% of plots	Crops (kharif-rabi)	% of plots	Crops (kharif-rabi)	% of plots	Crops (kharif-rabi)	% of plots	Crops (kharif-rabi)	% of plots
Rice-fallow	41	Fallow-potato	16	Rice-fallow	78	Rice-fallow	87	Rice-fallow	91
Fallow-nonrice	18	Maize-fallow	15	Rice-wheat	10	Rice-wheat	6	Rice-rice	3
Pulses-fallow	10	Marua-fallow	7	Rice-potato	4	Other	7	Rice-potato	1
Fallow-fallow	7	Maize-potato	7	Other	8			Other	6
Other	24	Rice-fallow	4						
		Fallow-wheat	4						
		Other	46						
Total	100	Total	100	Total	100	Total	100	Total	100

Table 3. Percentage share of plots left fallow by season and by land type.

Season	Land type				
	Upper terrace	Bari	Mid-upland	Medium land	Lower terrace
Kharif	25	28	2	1	3
Rabi	74	36	79	88	92

typically applied to rice production, particularly in the rainy season, for their own consumption. Various surveys show that, except for the case of *barhi* lands, most of the other plots are left fallow during the nonmonsoon season. However, this does not mean that the household labor force is left idle; many members are engaged in a wide variety of nonagricultural income–earning activities during the agricultural off-season, as will be described in the section on "High incidence of poverty."

Agricultural production

Low productivity and limited use of modern technologies

Agriculture in our sample villages is largely rice-based, with a very strong subsistence orientation. The average yield of paddy across all land types, seasons, and villages during the survey years was 2.8 t ha^{-1} (see Table 5). This yield level, however, appears to compare favorably with eastern Indian standards based on aggregate data. The average rice yield during 1990-97 across seven eastern Indian states was 2.0 t ha^{-1} (Pandey et al 2003). The average paddy yield within the eastern Indian plateau (covering the plateau area of Bihar, Orissa, West Bengal, and eastern Madhya Pradesh states) during 1995-97 was 1.6 t ha^{-1}.

The average rice yield also observed across surveyed villages ranged from 2.3 t ha^{-1} (Kumardi village in Purulia District) to 3.2 t ha^{-1} (Fateha village in Giridih District) (see Table 6). Because of the higher intensity of input use as well as differences in soil fertility and production systems in lowland plots and land on the higher levels of the toposequence, rice yields are highest in plots on the lower terraces or lowlands. Average rice yields in upland, barhi land, mid-upland, medium land, and lowland were 2.1, 2.5, 2.5, 3.0, and 3.3 t ha^{-1}, respectively (see Table 7). The average yield of high-yielding rice varieties is higher than that of traditional varieties by 20% to 40% depending on land type and this yield differential tends to be larger on upper terraces than on lower terraces (see Table 7).

Table 4. Chemical properties of soils across predominant land types.

Ecosystem	No. of samples	pH	Org. C (%)	Av P (kg ha^{-1})	Av K (kg ha^{-1})	Total N (%)	C/N ratio
Upland (barhi)	6	6.6	0.75	23	249	0.07	10
Upland (tanr)	3	5.5	0.38	12	84	0.03	11
Mid-upland	6	5.5	0.53	18	82	0.05	12
Medium	6	6.3	0.56	21	267	0.05	12
Lowland	21	6.4	0.77	24	185	0.07	11

Source: Soil chemical analysis completed at ISI Kolkata.

Table 5. Average paddy yield by season.

Season	Number of plots	Average yield (kg ha^{-1})
Kharif	1,161	2,743
Rabi	14	4,483
Summer	1	2,808
All-season average	1,176	2,764

Table 6. Average paddy yield by village (kharif season).

Village	District	Number of plots	Average yield (kg ha^{-1})
Charak Patla	Giridih	69	3,118
Fateha	Giridih	63	3,218
Fulchi	Giridih	66	3,013
Luppi	Giridih	74	2,540
Mangodih	Giridih	63	2,577
Naitanr	Giridih	87	2,911
Palkia	Giridih	94	2,375
Parsatanr	Giridih	65	3,044
Simulia	Purulia	72	2,747
Baligara	Purulia	130	2,659
Kalidaha	Purulia	68	2,655
Kumardi	Purulia	64	2,344
Patharkata	Purulia	70	2,705
Tilaboni	Purulia	61	2,905
Gokulnagar	Purulia	51	2,641
Sarjumhato	Purulia	64	2,642
Giridih average		581	2,824
Purulia average		580	2,663

Table 7. Average paddy yield by land type and by rice variety (kharif season).

Land type	Aggregated yield (traditional and modern varieties)			Yield differentiated by modern and traditional varieties		
	Number of plots (% share)	Average yield (kg ha^{-1})	Average yield: modern varieties (kg ha^{-1})	Share of area planted with MVs (%)	Average yield: traditional varieties (kg ha^{-1})	Share of area planted with TVs (%)
Upland	109 (11)	2,115	2,915	6	2,075	94
Barhi	39 (4)	2,539	3,404	13	2,409	87
Mid-upland	462 (45)	2,459	3,210	9	2,372	91
Medium	148 (14)	3,028	3,631	24	2,796	76
Lowland	268 (26)	3,282	3,764	21	3,132	79

Pair-wise tests of the difference in means (t test) further reveal that per hectare cash expenses are significantly lower on upland than on medium land and lowland, and cash expenses on mid-upland are lower than those on lowland. The average per hectare value of rice produced is significantly lower on upland and mid-upland than on other land types. The net rice income (before subtracting the shadow value of the cost of family labor) is higher on lowland and medium land and lowest on upland. With family labor costs (valued at observed market wage rates) included, however, the average net income (after subtracting both cash and family labor) turns negative for the upland, barhi, and mid-upland, while remaining positive for medium land and lowland. This is a result of the high shadow value of the labor cost that, in turn, is due to the high labor intensity of the production system, especially on barhi plots (Table 8).

The use of modern technology in agricultural production was relatively limited among the sampled households. The rate of adoption of improved crop varieties (HYVs), measured by the share of the households adopting HYVs, ranged from 3% (among wheat-cultivating households) for wheat to 51% for rice, on average, across all the sampled villages. This compared unfavorably to the estimated 70% HYV adoption rate for rice in eastern India as a whole (Pandey et al 2003). Furthermore, based on our plot-level data, only 21% of the rice planted area during the kharif season was planted with HYVs. The HYV adoption rate, however, differs somewhat across land types; the HYV adoption rate is roughly twice as high on medium land and lowland as on upper terraces.

The main reasons provided by interviewed households for why they did not use HYVs were the higher risk and higher seed cost involved. The adoption of other rice production practices associated with more modern cultivation practices, such as the practice of intercropping, use of purchased chemical inputs (e.g., fertilizer, pesticides, or herbicides), and use of irrigation, further suggests the traditional nature of agriculture carried out by the surveyed farms. Intercropping was reportedly practiced by only 24% of our sampled households, but the adoption rates contrasted sharply across surveyed households in Giridih (42%) and Purulia (7%) districts. In response to a question about why intercropping was not practiced, the predominant reason was “lack of know-how.” Application of pesticides in rice crops was relatively low (42%)—with the main reasons for

Table 8. Production costs and returns across land types.

	Rice production (kg ha^{-1})	Total cash expenses (Rs. ha^{-1})	Total value family labor applied (Rs. ha^{-1})	Value of rice produced (Rs. ha^{-1})	Net returns (cash and family labor costs subtracted) (Rs. ha^{-1})	Net returns (only cash of expenditures subtracted) (Rs. ha^{-1})
Averages (all)						
All kharif rice	2,733	4,781	5,772	10,642	146	5,873
Land type = upland	2,160	3,645	5,770	8,248	–734	4,611
Land type = barhi	2,646	6,279	13,613	12,375	–7,517	6,096
Land type = mid-upland	2,392	4,480	5,550	9,229	–801	4,749
Land type = medium	3,202	5,360	4,776	12,167	2,031	6,808
Land type = lowland	3,262	5,201	5,673	12,802	1,997	7,648
Difference of means t-test results						
Upland vs barhi land						
P-value: upland>barhi	0.08	0.01	0.05	0.00	0.11	0.28
Upland vs mid-upland						
P-value: mid-upland>upland	0.04	0.16	0.02	0.02	0.07	0.15
Upland vs medium land						
P-value: medium>upland	0.00	0.00	0.26	0.00	0.01	0.01
Upland vs lowland						
P-value: lowland>upland	0.00	0.00	0.91	0.00	0.00	0.00
Barhi vs mid-upland						
P-value: mid-upland>barhi	0.29	0.06	0.04	0.01	0.11	0.30
Barhi vs medium						
P-value: medium>barhi	0.04	0.36	0.02	0.86	0.03	0.61
Barhi vs lowland						
P-value: lowland>barhi	0.02	0.26	0.04	0.71	0.03	0.24
Mid-upland vs medium						
P-value: mid-upland>medium	0.00	0.05	0.19	0.00	0.00	0.00
Mid-upland vs lowland						
P-value: mid-upland>lowland	0.00	0.03	0.81	0.00	0.00	0.00
Medium vs lowland						
P-value: lowland>medium	0.67	0.74	0.16	0.29	0.97	0.23

nonuse (as provided by survey respondents) being lack of funds or lack of know-how.[2] Less than one-third (31%) of the surveyed farms reported applying urea. Less than a third (roughly 30%) of the households reported using irrigation and the main reason for not using irrigation is reportedly "lack of resources" (i.e., money for pumping equipment, inaccessibility of water) (Table 9).

Table 9. Agricultural practices of surveyed households.

Type of practice	Share (%) of households adopting		
	Overall	Giridih	Purulia
Use of improved crop varieties			
Paddy	51	38	66
Maize	5		
Wheat	3		
Potato	24	36	10
Reason for nonadoption of improved rice varieties			
Seed too costly	24	100	13
Risky	23	0	23
Method used to sow rice and reason for adoption			
Transplanting	89	81	76
Cost-effective	9	0	18
Proper management	16	3	31
Good yield	43	4	87
Behind plow	9	15	11
Proper management	17	32	0
Good yield	23	32	13
Broadcasting (direct seeding)	2	4	14
Lack of know-how	6	3	11
Traditional practices	28	47	5
Mixed cropping/intercropping practices	24	42	7
Reason for adoption			
More stability	17	29	2
Avoid risk	13	19	4
Increase total production	11	18	4
Reason for nonadoption			
Sole crop has higher yield	10	–	–
Lack of know-how	48	25	77
Seed proportion unknown	9	5	15
Farmyard manure/chemical fertilizer application	86	–	–
Adoption			
FYM only	30	24	36
FYM + fertilizer	60	55	66
Reason for nonadoption			
High price	1	1	2
Lack of funds	6	3	8
Fertilizer damages soil	1	–	–
Use of insecticides/pesticides on rice	42	37	47
Reason for adoption			
Higher yield	37	37	39
Reduce riskiness	12	0	27
Reason for nonadoption			
Lack of funds	33	35	31
Lack of know-how	19	26	11
Irrigation on rice crop	29	29	30
Reason for adoption			
Better-quality grain or straw	14	–	–
Good yield	27	–	–
Reason for nonadoption			
Lack of sources	46	27	67
Lack of funds	8	13	2

Subsistence orientation

Food security appears to be the prime objective of the surveyed farms, resulting in their strong orientation toward subsistence in production. Anecdotal evidence and oral histories suggest past vulnerability of the sampled households to years of hunger and starvation, which would explain the fixation on satisfying food security. While 90% of the households are reportedly engaged in rice production, for example, only 21% reported selling of rice during the year covered by the survey. Similarly, 22% of the households produce potato, but only 2% reported selling potato, and 21% produce but none reported selling maize (see Table 10).

The subsistence orientation of surveyed farm households is further demonstrated by the fact that, across all crops, only 23% of the surveyed households reported the sale of any farm output. The sale of farm outputs provided only 3% of the total household gross income, on average, whereas the imputed value of home-consumed farm outputs equaled 34% of the total household gross income (Table 11).

The surveyed farms' activities in agricultural output markets predominantly involved transactions in the rice market. Among the total number of reported incidences of crop sales among surveyed farms, 49% involved rice, 12% potato, 11% maize, 9% millet, 7% horsegram, and 7% wheat (see Table 12). The concentration of product sales on nonperishable grains indicates that transportation costs (i.e., poor transportation infrastructure makes it costly and time consuming to transport goods to market) may constrain commercial agricultural activities in the study area, and the focus on rice suggests that commercial markets for crops aside from rice are quite limited.

Subsistence orientation also dominates the surveyed farms' animal husbandry activities. The

Table 10. Production and sale of farm output.

Output	% of households
Rice	
Reported rice production	90
Reported sale of rice	21
Potato	
Reported potato production	22
Reported sale of potato	2
Maize	
Reported maize production	21
Reported sale of maize	0

[2] In addition, pest pressure and yield loss may be low because of the relatively low adoption rate of modern varieties.

imputed value of home consumption of livestock and poultry (including both "main products" such as milk and eggs and "by-products" such as animal dung) averaged Rs. 3,565 (about US$90 at the 40 Rs. = $1 exchange rate that prevailed in 1997), while the average income from livestock sales was only Rs. 570 (roughly US$14) across all households. The sale of livestock/poultry was reported by only 19% of the households and income from such sales made up only 2% of the total gross income on average. The total imputed value of home consumption of livestock and poultry equaled 13% of the total gross income (Table 11).

The participation of surveyed households in markets for agricultural inputs was also low. Farmers generally appear reluctant to use purchased inputs or to make investments because of the high risk of crop failure—which threatens loss of costs of purchased inputs and investments—, because of the high transactions costs (i.e., inaccessibility to markets makes it costly to purchase inputs in markets) and because of the low adoption of HYVs. The rates of application of purchased chemical inputs were reviewed above. The share of the households reporting hiring of paid labor across the principal tasks required for rice cultivation was 14% (for weeding), 36% (for threshing), and 40% (for transplanting). The rental of capital equipment or draft animals among surveyed farms was also infrequent; the shares of households reporting having rented or leased land, draft animals, or various machinery were 0%, 13%, and 6%, respectively (Table 13).

High incidence of poverty

Income and wealth

A defining characteristic of the households in our study area is their predominantly low standard of living and high incidence of poverty. According to official poverty estimates of the Indian government, the incidence of poverty in our study area was among the highest in the country. Statewide headcount poverty ratios in Bihar and West Bengal were the second and third highest in 1987-88, first and fifth highest in 1993-94, and second and fifth highest in 1999, respectively (Deaton 2001). The standard of living among our sampled households can be measured using estimated household incomes (per capita), the value of assets/wealth held by surveyed households, and the ease of access to public services providing basic needs such as education and potable water.

Among all 16 sampled villages, the estimated average annual household gross income was Rs. 27,269 (equivalent to about $680 at the exchange rate prevailing at the time of the survey), while the

Table 11. Income composition, poverty, and inequality among surveyed households.

Income source	Overall	Giridih	Purulia
Income from nonagricultural work (Rs.)	11,952	11,155	12,723
Share of households reporting (%)	83	91	75
Share from gross income (%)	39	39	39
Income from off-farm agricultural work (Rs.)	1,042	485	1,582
Share of households reporting (%)	41	45	37
Share from gross income (%)	6	4	8
Income from miscellaneous sources (Rs.)	1,018	1,140	900
Share of households reporting (%)	17	24	10
Share from gross income (%)	3	3	2
Total value of crop output (both sold and home-consumed) (Rs.)	9,144	11,306	7,053
Share of households reporting (%)	91	93	88
Share from gross income (%)	38	42	33
(Sale of crop output from selling crop output) (Rs.)	(753)	(712)	(793)
(Share of households reporting) (%)	(23)	(13)	(32)
(Share from gross income) (%)	(2)	(1)	(3)
Total value of livestock (both sold and home-consumed) (Rs.)	4,112	3,765	4,449
Share of households reporting (%)	66	67	64
Share from gross income (%)	15	12	18
(Sale of livestock and livestock main products and by-products) (Rs.)	(548)	(159)	(923)
(Share of households reporting) (%)	(19)	(12)	(26)
(Share from gross income) (%)	(3)	(1)	(4)
(Total cash income) (Rs.)	(15,651)	(13,050)	(18,167)
(Share of income from rice production) (%)	(35)	(37)	(33)
Gross income	27,269	27,850	26,707
Per capita gross income	4,018	4,026	4,010
Poverty incidence (%)	60	57	63
Gini coefficient of per capita income	0.380	0.376	0.382
Gini coefficient of land distribution	0.48	0.48	0.47

average per capita annual gross income was only Rs. 4,018 (about $100) (Table 11). The village average per capita gross income among surveyed households ranged from a low of Rs. 3,003 (in Naitanr village in Giridih District) to a high of Rs. 6,474 (in Charak Patla village, also in Giridih District) (Table 14). The planning commission's official poverty line for 1999 (Deaton 2001) and the estimated per capita gross income indicated that 60% of the sampled households were poor (Table 11). Across the surveyed villages, the estimated headcount poverty ratio ranged widely, but all had a substantial portion of their population considered poor. Poverty incidence was lowest in Charak Patla village (24%) and highest in Patharkata village (82%) (see Table 14). Average per capita gross income is the same for Giridih (Rs. 4,026) and Purulia (Rs. 4,010); however, because of the higher cost of living—thus, higher local rural poverty line—in West Bengal, the estimated headcount poverty ratio is higher in Purulia (63%) than in Giridih (57%) (Table 11).

Another basis upon which to draw conclusions about the standard of living enjoyed by surveyed

Table 12. Crop sales reported by surveyed households (no. and % share of instances crop sold across households).

Crop	Number	Percent
Rice	488	49
Potato	119	12
Maize	113	11
Millet	87	9
Horsegram	66	7
Wheat	64	7
Small millet	9	1
Sorghum	7	1
Sugarcane	4	0
Other crops[a]	31	3
Total[b]	988	1

[a]Includes vegetable crops, lentils, oilseeds, and other crops sold very infrequently.
[b]Excludes eight instances in which a farm reported selling a crop with an unidentified code.

Table 13. Market participation by the sampled households.

Market	% of households active in market
Labor	
Land preparation	
Male	33
Female	17
Transplanting	
Male	25
Female	40
Weeding	
Male	14
Female	28
Harvesting	
Male	26
Female	37
Threshing	
Male	36
Female	14
Capital equipment and draft animal rental	
Land rental	0
Draft power	13
Machine	6
Irrigation	4
Fertilizer	
FYM (for rice)	34
Urea (for rice)	31
DAP (for rice)	27
Plant protection (insecticide, etc.) for rice	5

Table 14. Average per capita income and poverty incidence by village.

Village	District	Average per capita gross income (Rs.)	Poverty incidence (%)	Percentage of nonagricultural income
Charak Patla	Giridih	6,474	24	19
Fateha	Giridih	4,203	49	43
Fulchi	Giridih	4,240	65	35
Luppi	Giridih	3,790	57	45
Mangodih	Giridih	3,588	63	39
Naitanr	Giridih	3,003	71	33
Palkia	Giridih	3,556	62	36
Parsatanr	Giridih	4,318	54	55
Simulia	Purulia	4,376	59	47
Baligara	Purulia	4,270	59	29
Kalidaha	Purulia	3,902	62	36
Kumardi	Purulia	4,218	56	37
Patharkata	Purulia	3,127	82	49
Tilaboni	Purulia	3,813	59	21
Gokulnagar	Purulia	5,473	50	55
Sarjumhato	Purulia	2,874	79	36

households is to consider their asset holdings. Survey results suggest that asset holdings among sampled households were quite limited. For example, about one quarter of our sampled households reported owning no household appliance. Among major household appliances, only 23% of the households reported owning a radio and only 5% reported owning a TV set. Just under a third (32%) of the sampled households reported owning animal-powered transportation, not a single household reported owning an automobile, and only 4% reported owning a motorcycle. Most households (78%), however, did report owning human-powered transportation (such as bicycles). For complete details on household ownership of appliances and equipment, see Table 15.

Ownership of agricultural implements and machinery was similarly limited, according to the survey results. The total average value of agricultural implements across all households surveyed was Rs. 3,035 (equivalent to about $76). Village-level means ranged from Rs. 566 to Rs. 18,528—mainly because of variations in the ownership of tractors, rice mills, and water pumps, which are quite rare in any case. Ownership of mechanical threshers was reported in only five villages, and water pumps were found in only seven of the 16 villages. Tractor ownership was similarly rare, with tractors being reported in only three villages. Bullock carts (reportedly owned by about one-third of households) were found among surveyed households in all villages and rice mill ownership was reported in only one village. Ownership of smaller hand tools and other common agricultural implements was found in nearly all the households surveyed. Ninety-six percent of our sample households reported owning either hand tools or animal-driven equipment (Table 15).

Survey results suggest that livestock are held mainly for the draft power they can provide (i.e., for plowing or for pulling a cart) and as a form of savings, but they are rarely sold in the market. The mean value of total livestock holdings was Rs. 7,926 across all households surveyed. Nearly two-thirds (64%) of the sampled households reported bullock ownership, and on average they owned two bullocks

Table 15. Farm capital equipment holdings of surveyed households.

General indicators of capital and equipment holdings	Value or %
Farm tools and equipment	
Total value of all agricultural implements (Rs.)	3,025
Owned only basic hand tools (%)	91
Owned hand tools + animal-driven equipment	96
Owned some power-driven equipment	4
Household appliances and amenities (%)	
Reported owning no appliances	25
Owned at least one minor appliance	53
Owned some cooking appliance(s)	17
Transportation (%)	
Reported owning no private transportation	13
Owned only human-powered transportation	78
Owned animal-powered transportation	32
Ownership of particular items	
Farming tools and machinery	
Share of households reporting ownership of a “desi” plow (%)	82
Value (Rs.)	187
Share of households reporting ownership of a mechanical thresher	2
Value (Rs.)	2,625
Share of households reporting ownership of a diesel water pump (%)	3
Value (Rs.)	13,750
Share of households reporting ownership of a tractor (%)	1
Value (Rs.)	203,557
Share of households reporting ownership of a rice mill (%)	0
Value (Rs.)	200,000
Household appliances and amenities (%)	
Share of households reporting ownership of a radio	23
Share of households reporting ownership of a clock/watch	50
Share of households reporting ownership of a television	5
Share of households reporting ownership of an electric fan	4
Transportation equipment (%)	
Share of households reporting ownership of a cart	32
Share of households reporting ownership of a bicycle	78
Share of households reporting ownership of a motorcycle	4

per household. The reported ownership rate of other smaller livestock or poultry was lower but still significant. Surveyed households reported owning goats, chickens, buffalos, cows, and calves at rates of 46%, 16%, 15%, 39%, and 11%, respectively (Table 16).

Other indicators of household welfare

Apart from the level of household income and asset holdings, the living standard can also be measured by household satisfaction of basic needs. In terms of access to education, results from the 1991 census show that the incidence of illiteracy in the area was high: 65% in Purulia and 80% in Giridih.[3] The average years of schooling among the household heads was 3.6 years, with Purulia again displaying better levels of educational attainment than Giridih (3.9 years in Purulia versus 3.4 in Giridih).

Access to other basic public services also appears low, according to survey results (see Table 17). Less than 12% of the sampled households had access to electricity. In seven of the 16 surveyed villages, none of the sampled households had access to electricity. Among the nine other villages, the proportion of households with access to electricity ranged from 3% to 33%. The source of drinking water for the majority of households is dug wells (54%), but other sources include tube wells (20%), "tanks" (ponds) (9%), rivers (8%), temporary dug wells (5%), and the tap (piped-in water) (2%) (Table 18). On average, households reported that a walk of 11.4 minutes is required to reach their nearest source of water. This represents a significant labor burden on female members of the household, who are principally responsible for fetching water for household needs. These travel times vary markedly across surveyed villages, with a low of 4.5 minutes in Parsatanr village, where most households have access to dug wells, and a high of 27 minutes in Palkia, where the only water source for most of the households is a neighboring river (Table 17). The inaccessibility of most of the surveyed villages, as mentioned earlier, also suggests that access to other public services (e.g., health care, legal institutions, social welfare) is difficult and time-consuming.

Table 16. Average livestock holdings of surveyed farms. Total value of current livestock holdings is Rs. 7,926.

Type of livestock	Number or %
Share of households reporting owning a bullock	64%
Number owned	2.1
Share of households reporting owning a chicken	16%
Number owned	3.8
Share of households reporting owning a pig	3%
Number owned	2.9
Share of households reporting owning a goat	46%
Number owned	2.8
Share of households reporting owning a cow	39%
Number owned	2.2
Share of households reporting owning a calf	11%
Number owned	2.0
Share of households reporting owning a buffalo	15%
Number owned	2.2

Table 17. Access to electricity and water by village.

Village	District	Percentage of households with access to electricity	Average travel time to reach water source (min.)
Charak Patla	Giridih	0	13.8
Fateha	Giridih	0	9.3
Fulchi	Giridih	0	9.9
Luppi	Giridih	0	9.2
Mangodih	Giridih	0	9.6
Naitanr	Giridih	0	12.0
Palkia	Giridih	3	26.6
Parsatanr	Giridih	31	4.5
Simulia	Purulia	3	13.7
Baligara	Purulia	27	12.1
Kalidaha	Purulia	18	6.5
Kumardi	Purulia	24	15.6
Patharkata	Purulia	12	14.1
Tilaboni	Purulia	0	10.1
Gokulnagar	Purulia	32	7.7
Sarjumhato	Purulia	29	9.5
Giridih District average		5	11.7
Purulia District average		18	11.2
All villages		12	11.4

[3] Although India carried out a census in 2001, results at the state and district level for eastern states are not yet available.

Sources of household income

Role of nonagricultural income. Diversification of income sources is one of the most prevalent household strategies for coping with risk and vulnerability in rural areas with less favorable economic and agroclimatic conditions. The adoption of income diversification strategies seems clearly apparent among the farm households surveyed for this study, and is displayed in the diversification of employment in which families apply their labor and in household agricultural activities.

Looking at the primary occupation of working-age household members reported in our Purulia survey (data on primary and secondary occupations of household members were not obtained in Giridih), the most commonly observed occupation is "unpaid family labor on family farm," which was reported by 50% of the total individuals across the surveyed households that reported having a principal occupation. The next most common principal occupation of surveyed individuals was miner (20%), followed by casual day laborer (10%) and paid full-time or part-time agricultural laborer (4%). For secondary occupations, the most frequently reported occupations were, again, unpaid family labor on family farm (45%), casual day laborer (19%), and paid full-time or part-time agricultural laborer (13%) (Table 19). These results suggest that the economic activities of our sampled households are largely dominated by unpaid family labor on family farms and in agriculturally related jobs, but also show that there is significant diversity in the occupational activities of surveyed households. This diversity is even clearer when we examine this issue from the perspective of the share of household income derived from different types of employment (see the discussion below). Results make clear that the share of the households engaged in formal labor markets is relatively low—a little more than one-third of the male workers (35%) and one-quarter of the female workers (28%) reported being employed in wage-paying jobs according to our survey. Table 19 summarizes the full survey results regarding the principal and secondary occupations of individuals surveyed.

Table 18. Sources of drinking water for surveyed households.

Source	Dug well	Tube well	River	Community tank	Temporary dug well	Tap	Own tank	Other
% share of households	54	20	8	7	5	2	1	3

Table 19. Primary and secondary occupations of workers from surveyed households.

Primary occupation category	Total frequency	%	Secondary occupation category	Total frequency	%
Family labor (unpaid) working on family's farm	555	49.6	Family labor (unpaid) working on family's farm	232	45.0
Family labor (paid) working on family's farm	4	0.4	Permanent (year-round) full-time agricultural laborer	2	0.4
Permanent (year-round) full-time agricultural laborer	9	0.8	Permanent (year-round) part-time agricultural laborer	65	12.6
Permanent (year-round) part-time agricultural laborer	42	3.8	Part-time worker in industry/manufacturing	1	0.2
Full-time service worker in private sector	21	1.9	Full-time service worker in private sector	3	0.6
Part-time service worker in private sector	2	0.2	Part-time service worker in private sector	2	0.4
Full-time service worker in public sector	24	2.1	Self-employment in small-scale manufacturing	31	6.0
Part-time service worker in public sector	1	0.1	Merchant	24	4.7
Artisan/craftsperson	2	0.2	Grocery shop	2	0.4
Self-employment in small-scale manufacturing	20	1.8	Construction worker (houses, buildings, roads)	2	0.4
Grocery shop	9	0.8	Worker in mining	31	6.0
Merchant	32	2.9	Transportation worker	4	0.8
Worker in mining	225	20.1	Homemaker	3	0.6
Occasional nonagricultural job	2	0.2	Retired/receiving pension	5	1.0
Transportation worker	5	0.4	Other (private tutor)	7	1.4
Homemaker	9	0.8	Doctor	2	0.4
Handicapped or suffering illness	6	0.5	Daily laborer	100	19.4
Retired/receiving pension	24	2.1			
Unemployed	4	0.4			
Other (private tutor)	8	0.7			
Doctor	6	0.5			
Daily laborer	107	9.6			
Singer	2	0.2			

Despite the predominance of agricultural employment in terms of the reported frequencies of the primary and secondary occupations of surveyed household members, nonagricultural income plays an important role in its contribution to household income. As mentioned earlier, with the exception of the relatively small-scale barhi plots, most plots are left fallow after the monsoon season, which frees household labor for nonagricultural income–generating activities outside the monsoon season, or to engage in part-time nonagricultural activities during the growing season. Households surveyed reported engaging in a wide variety of nonagricultural income–earning activities. Eighty-three percent of the sampled households are engaged in some kind of nonagricultural employment (Table 11). Considered alongside the high share of household workers mentioning work on the family farm as their primary (or secondary) occupation, this indicates that most households work their farms on a part-time or seasonal basis.

Nonagricultural income, although rarely the main employment of workers in surveyed households,[4] represented an important share of total household income. Averaged across all households, nonagricultural income sources contribute 39% of the total (gross) household income. This share is roughly the same as the share of the income contribution by crop production (38%) when the value of agriculture is estimated considering the imputed market value of crops produced and consumed on the family farm (36%) as well as income from sales of farm output (only 2%). The imputed value of household income from livestock and animal/poultry raising provided less than one-fifth of family income, averaging a 15% share (including both the imputed value of home consumption and market sales) across all surveyed households. The remaining income reportedly came from a variety of miscellaneous sources, and accounted for only 3% of total gross income when averaged across all households surveyed (Table 11).

The figures cited in the previous paragraph refer to broad averages across all households in the two districts and 16 villages where the survey was conducted. However, both the average share of nonagricultural income and the types of nonagricultural economic activities households engaged in varied widely across villages. The village-level average share of nonagricultural income ranges widely between a low of 19% in Charak Patla village in Giridih and a high of 55% in Parsatanr village in Giridih and Gokulnagar village in Purulia (Table 14). In some villages, household self-employment (or small household enterprises) such as rope making, construction, masonry, coal mining, brick making, making tobacco products (such as *bidi*), and the production of bamboo crafts (e.g., baskets) represents an important source of income. Income from off-farm employment is a more important source of nonagricultural income in other villages. The most typical type of off-farm nonagricultural employment reported among workers from surveyed households involved work as casual day laborers in the service sector (e.g., rickshaw puller, construction laborer, soil cutting, tea stall, and other types of shop employee). A common feature of both the on- and off-farm nonagricultural activities that surveyed households engaged in was the high labor intensity and relatively low labor productivity of these jobs, which were associated with low levels of earnings from these jobs. However, a relatively small number of workers were employed full-time in stable nonagricultural jobs such as agricultural extension, railway workers, schoolteachers, and employees at mining companies (in Giridih), and employment in these jobs was associated with higher levels of remuneration. In some surveyed villages, seasonal migration of workers to other rural areas under irrigation or that enjoy a longer rainfed growing season provided an important source of seasonal employment and household income (see Table 11 for details). Instances of families sending seasonal migrants to major cities such as Delhi, Bombay, and Kolkata were also observed in the survey results.

The importance of nonagricultural income for many households in the area suggests that any technological intervention in agriculture (especially innovations involving cultivation during the winter season) needs to take into account the opportunity costs of labor in nonagricultural activities. The existing patterns of nonmonsoon season employment or migration suggest that the introduction of agricultural activities in fallowed fields is unlikely to be adopted unless the returns to labor are at least as high and as secure as those currently available through nonagricultural employment or migration to agricultural jobs elsewhere. At the same time, the low productivity (thus low return) of most nonagricultural economic activities observed in the area suggests that farm households perceive the potential returns from agricultural production—once subsistence needs have been satisfied—to be very low given present biophysical and socioeconomic conditions in the area.

Rice in household income. The total gross imputed value of rice produced by surveyed households averaged a 35% share of the total gross household income across all households in the sample (see

[4] Workers employed by mining companies, however, are a major exception, as we can see in Table 19.

Table 11). The importance of rice income to the household's overall income was positively correlated with the size of landholdings. The share of gross rice income in the total household gross income among the landless, marginal, small, medium, and large farmers was 6%, 31%, 46%, 51%, and 60%, respectively (see Table 20).

However, the relatively small average share of total gross income derived from rice (especially among the smaller landholders) carries important policy implications vis-à-vis efforts to improve the standard of living among poor households in the study area. It suggests that efforts to increase rice productivity alone are unlikely to contribute greatly to poverty reduction. Given the relatively high share of nonagricultural income in total household income among surveyed farms, a broader approach giving attention to ways of improving labor productivity in nonagricultural work, as well as improving rice cultivation and converting farming activities to the cultivation of higher-value crops, is needed to substantially improve household income. This point can be made clear by engaging in a small thought experiment. Let us assume that the average yield of rice could be doubled without increasing the level of any input (including labor)—a pure 100% rise in technical efficiency, and keeping nonrice income at current levels. Under this unrealistic scenario, the average per capita income of individuals in surveyed households would increase by only about 30% (from Rs. 4,018 to Rs. 5,273). The estimated poverty incidence (based on per capita gross income) would fall from 60% to 53%—a modest 12% reduction. In reality, dramatic increases in rice yields of this magnitude are largely unknown and the yield increases that have been achieved have been induced by technological innovations accompanied by increased input use (e.g., fertilizer, labor), or by moving from monocropping to double cropping. Even if new rice technologies (both new varieties and cropping practices) enabled double cropping in the study area, adoption would be contingent upon households being able to secure needed inputs and profitably market the surplus rice, and returns would need to be higher than those from the low-productivity nonagricultural activities in which many are now engaged.

Table 20. Income sources and poverty of surveyed households by size of farm.

Landholding class	Per capita gross income (Rs.)	Poverty incidence (%)	Share of nonagricultural income (%)	Share of rice income (%)
Landless	3,092	69	64	6
Marginal farmers	3,340	69	42	31
Small farmers	4,441	52	30	46
Medium farmers	5,629	41	22	51
Large farmers	11,536	15	23	60
Average across all classes	4,018	60	39	35

An alternative route for improving the welfare of poor households in the study area would be to focus on technological innovations that increase rice productivity in ways that release household labor and land resources for nonrice agricultural production and/or for nonagricultural activities but that enable households to more easily fulfill their subsistence demand for rice. Assessing the potential of such alternatives, however, demands a much more in-depth analysis than what is used in this introductory report. Nonetheless, the preliminary conclusion that even a dramatic yield increase in rice production *alone* would be unlikely to reduce rural poverty in eastern India, given the relatively small share of rice income among the poor in the area, provides a strong working hypothesis that could be explored in subsequent analysis.

Social and institutional influences on household choices and outcomes

Caste system

Ethnically, the Chhotanagpur Plateau lies in what is commonly referred to as the *tribal belt* of eastern India because of the high proportion of individuals from scheduled tribes (ST) and scheduled castes (SC) in the population. Under Indian law, citizens from ST or SC are eligible for targeted public assistance and political representation in state and federal legislatures of ST and SC is guaranteed. These measures are intended to remedy past discrimination against ST and SC and to facilitate full participation of ST/SC members in the economy and polity.

Across the sampled villages, households of ST or SC background constitute an average of one-third of all households surveyed. The share of ST families was higher in Purulia than in Giridih, whereas the share of SC families was higher in Giridih than in Purulia (see Table 21). In general, survey results suggest that villages in Giridih tend to be more segregated (or to have more homogeneous populations defined in terms of their caste background), whereas villages in Purulia had more heterogeneous populations in terms of caste composition.

There was wide variation in the share of ST/SC families across the sampled villages. Categorizing surveyed households into four caste groups: ST, SC, other backward castes (OBC), and other castes (OC)—which includes all higher castes, we observe that, in two villages (Charak Patla and Palkia), the entire population of households surveyed came from ST families. Both of these villages are in Giridih District. Two other villages (Fateha and Parsatanr—both in Giridih) were exclusively inhabited by households of SC and OBC backgrounds. At the other extreme, other surveyed villages displayed a high degree of heterogeneity in the caste background of the inhabitant households. Three villages (Baligara and Pathor Kata in Purulia, and Luppi in Giridih) had no single dominant caste category among the households interviewed (Table 21). However, even in villages with heterogeneous castes, residential segregation according to caste was observed. For an illustration of this, see Figure 6, which shows the physical separation of families of different caste backgrounds across *tolas* (or subvillage clusters) in Luppi village. It is also noteworthy that *tolas* dominated by ST families tended to occupy more marginal lands, with many farm plots located on unproductive marginal upland.

Other villages represent intermediate cases involving villages whose inhabitants came predominantly from OC households (Fulchi and Naitanr villages in Giridih) or a mix of SC or OBC dominant villages with significant representation of other caste

Table 21. Castes of families surveyed by village.

Village	Scheduled tribe	Scheduled caste	Other backward caste	Other caste	Village	Scheduled tribe	Scheduled caste	Other backward caste	Other caste
	(%)					(%)			
Overall	18	14	49	20					
Giridih District	9	26	45	21	*Purulia District*	19	10	52	19
Charak Patla	95	5	0	0	Baligara	11	11	57	22
Fateha	0	8	89	3	Gokulnagar	0	12	65	24
Fulchi	26	3	6	65	Kalidaha	3	29	53	15
Luppi	23	14	54	9	Kumardi	24	3	65	9
Mangodih	0	14	60	26	Pathor Kata	9	15	24	53
Naitanr	0	14	29	57	Sarjamhato	3	24	65	9
Palkia	94	6	0	0	Simulia	0	6	79	15
Parsatanr	0	3	97	0	Tilabani	26	56	12	6

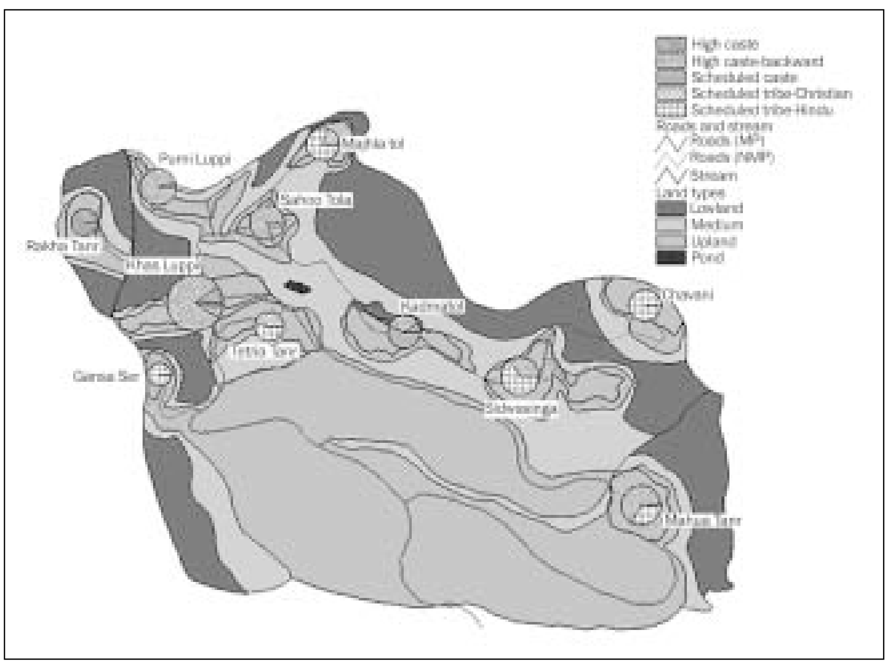


Fig. 6. Caste-based residential segregation in rural villages: example of Luppi village in Giridih District.

groups (see Box 1 for a complete characterization of the caste composition of the surveyed villages).

The relationships between a household's caste affiliation or the caste structure of a village and various economic outcomes appear complex. While one might expect that households from higher castes would have higher income or enjoy a higher standard of living, only some indicators present in our survey data suggest that this is the case, while other indicators suggest that less advantaged castes enjoy better economic outcomes. As expected for example, none of the large farm households belonged to scheduled castes, and the share of households from the scheduled caste background tended to be higher among the landless and marginal farmers than among the small or medium farmers (see Table 22). Within villages, we would expect some association between landholding size and caste, that is, that higher castes would control larger landholdings. This tendency was observed to some extent in Giridih but not in Purulia (see Table 23 for complete results).

Overall, the correlation between landholding size class and caste was not particularly strong in our survey data. Considering the overall size of landholdings (regardless of land type), the majority of sampled households belonged to the three smaller landholding classes (i.e., landless, marginal, or small), regardless of their caste affiliation. Households with an OC background were not significantly more likely than families from lower castes to own larger land areas. For example, in Purulia District, the average landholding size among OC households was about 0.8 ha, which was larger than the average landholdings of ST or SC households, but was smaller than the average landholdings of OBC households in the district. In Giridih, the average landholding size among OC households was larger than the average landholdings of SC households, but was close in size to the average landholdings of ST or OBC caste households (Table 22).

When land is considered in terms of its agricultural potential, however, a slightly different picture emerges. Survey results show a systematic tendency of greater average size of lowland held by OC households in Giridih District (roughly 0.4 ha) vis-à vis the amount of lowland owned by households from the disadvantaged castes (Table 24). This tendency was not observed in Purulia, so this supports the conventional wisdom that disadvantaged castes tend to suffer greater marginalization in the more traditional Giridih District (formerly Bihar state).[5]

Box 1. Typology of villages by caste composition

1. Tribal villages (Charak Patla and Palkia in Giridih District)
2. All-caste villages (Luppi Village in Giridih, and Baligara and Pathor Kata in Purulia)
3. SC-/OBC-dominated villages with some OC (Mangodih in Giridih, and Simulia, Kalidaha, Gokulnagar, and Sarjamhato in Purulia)
4. SC-/OBC-only villages (with a single OC) (Fateha and Parsatanr in Giridih)
5. SC-/OBC-dominated villages with a few ST and one OC (Kumardi and Tilaboni in Purulia)
6. OC-dominated villages: Fulchi (mainly OC with some ST) and Naitanr (OC with some SC/OBC), Giridih only

Table 22. Caste composition (%) by landholding class by district.

District	Giridih				Purulia			
Landholding class	Scheduled caste	Scheduled tribe	Other backward caste	Other caste	Scheduled caste	Scheduled tribe	Other backward caste	Other caste
Landless	35	5	45	15	31	23	14	31
Marginal	9	23	44	24	22	11	51	16
Small	4	32	49	15	11	4	68	17
Medium	4	42	35	19	15	0	60	25
Large	0	22	44	33	0	0	100	0

[5] Medium land has the potential to grow more than one crop in an agricultural year, but lowland tends to be the most productive if we consider the rice crop only, which is the common scenario of the area.

Table 23. Average landholding size by land type, caste,[a] and village.

Land type	Charak Patla				Fateha				Fulchi				Luppi				Mangodih				Naitanr				Palkia				Parsatanr			
	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN
Giridih villages																																
Total land held (ha)	6.0	3.8	–	–	0.8	–	4.0	26	0	2.3	1.3	3.2	1.9	2.2	3.3	2.0	1.6	–	3.1	3.5	1.2	–	2.8	1.7	0	3.5	–	–	2	–	1.0	–
Upland held (%)	2.3	1.4	–	–	0.4	–	0.3	6.3	0	0.8	0	0.8	0.2	0.3	0.5	0.7	0	–	0.5	0.3	0.7	–	0.5	0.8	0	1.1	–	–	1.4	–	0.2	–
Upland as % of total land	38	33	–	–	43	–	10	24	–	45	0	20	6	8	15	27	0	–	13	08	50	–	19	35	–	30	–	–	69	–	25	–
Barhi land held	0.2	0.5	–	–	0.0	–	0.6	7.5	0	0.3	0.5	0.5	0.3	0.5	0.5	0.2	0.3	–	0.8	0.5	0.2	–	0.5	0.3	0	0.7	–	–	0.6	–	0.4	–
Barhi land as % of total land	3.0	13	–	–	1	–	16	29	–	14	44	20	27	23	13	13	28	–	33	13	20	–	20	14	–	19	–	–	31	–	50	–
Mid-upland held	1.5	0.8	–	–	0.2	–	2.1	2	0	0.5	0.9	0.8	0.8	1.2	1.2	0.4	1.2	–	1.0	1.3	0.2	–	1	0.4	0	0.7	–	–	0	–	0.2	–
Mid-upland as % of total land	25	22	–	–	34	–	55	8	–	19	56	25	41	57	40	25	66	–	29	44	24	–	32	35	–	23	–	–	0	–	16	–
Medium land held	0.0	0.04	–	–	0	–	0.0	0	0	0	0	0	0	0.2	0.7	0.2	0	–	0	0	0	–	0.2	0.0	0	0.1	–	–	0	–	0.1	–
Medium land as % of total land	0.0	1.0	–	–	0	–	1	0	–	0	0	0	0	11	12	18	0	–	0	0	0	–	7	6	–	3	–	–	0	–	2	–
Lowland held	2.0	1.1	–	–	0.1	–	1.0	10	0	0.6	0	1.1	0.6	0.1	0.4	0.6	0.1	–	0.9	1.4	0.1	–	0.6	0.2	0	0.8	–	–	0	–	0.2	–
Lowland as % of total land	33	31	–	–	23	–	18	40	–	21	0	35	26	1	20	17	6	–	25	35	6	–	22	11	–	26	–	–	0	–	7	–

	Simulia				Baligara				Kalidaha				Kumardi				Patharkata				Tilaboni				Gokulnagar				Sargumjato			
	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN	SC	ST	OBC	GEN
Purulia villages																																
Total land held (ha)	0.6	–	1.7	0.5	1.2	1.3	4.1	2.9	1.7	1.2	3.2	2.4	2.3	1.3	3.6	2.7	1.3	0.9	2.3	2.0	2.4	1.0	2.2	2.0	0.1	–	3.4	1.3	0.2	0	2.6	1.6
Upland held (ha)	0	–	0.3	0.1	0.2	0.5	1.2	1.2	0.5	0.5	1	0.6	0.3	0.3	0.5	0.4	0.2	0.40	0.2	0.2	0.6	0.3	0.6	0.5	0	–	0.4	0.0	0.1	0	0.7	0.1
Upland as % of total land	0	–	18	6	9	22	30	34	18	43	33	35	14	27	12	14	6	60	8	10	24	23	19	13	0	–	13	0	40	–	29	3
Barhi land held	0	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0.0	0.0	0	0.0	0.0
Barhi land as % of total land	0	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0.0	–	0.0	0.0
Mid-upland held	0.3	–	0.7	0.3	0.5	0.6	1.2	0.6	0.6	0.7	0.8	1.3	1	0.6	1.7	0	0.9	0.1	1.3	1.3	0.9	0.5	0.9	1.2	0.1	–	2.3	0.9	0.1	0	0.8	0.4
Mid-upland as % of total land	61	–	42	76	46	53	26	23	33	57	33	41	43	54	51	0	74	13	71	65	44	55	56	30	95	–	74	81	39	–	31	28
Medium land held	0.1	–	0.3	0.1	0.5	0.1	0.8	0.7	0.3	0	0.5	0.2	0.2	0.1	0.7	2	0.2	0.40	0.3	0.2	0.2	0.2	0.4	0.1	0.0	–	0.4	0.4	0.0	0	0.4	1.1
Medium land as % of total land	17	–	15	6	37	8	19	24	11	0	18	10	7	4	17	72	13	27	9	11	9	15	14	5	5	–	9	19	5	–	17	69
Lowland held	0.1	–	0.4	0.1	0.1	0.2	1.0	0.3	0.4	0	0.9	0.3	0.8	0.4	0.9	0.4	0.0	0	0.5	0.4	0.6	0.0	0.3	0.3	0	–	0.2	0.0	0.1	0	0.7	0.0
Lowland as % of total land	23	–	26	13	8	17	26	19	38	0	17	14	35	16	22	14	7	0	12	14	23	4	10	7	0	–	5	0	16	–	22	0

[a]SC = scheduled caste, ST = scheduled tribe, OBC = other backward caste, GEN = other caste.

Size of landholdings and economic outcomes

A positive correlation existed between per capita or total gross income and landholding size among the surveyed farms. Similarly, poverty incidence was higher among households with smaller landholdings, but there was no difference in the level of poverty incidence between landless households and marginal farm households (see Table 20).

Survey results showed a positive correlation between landholding size and the total value of livestock held (see Table 25). A positive correlation also existed between landholding size and ownership of some appliances (e.g., radio, TV, electric fan) or a motorcycle. The share of households reporting owning no appliances was from 20% to 30% across all landholding classes. Ownership of basic farm equipment (such as the *desi* plow) displayed relatively little variation across farm size, but households with larger landholdings were more likely to own power-driven equipment such as water pumps (see Table 26).

The agricultural practices used by surveyed families were observed to vary systematically depending on landholding size. The adoption of intercropping, use of irrigation in rice crops, and use of "modern" inputs or practices (e.g., application of chemical fertilizer or insecticides/pesticides on rice) all tended to be positively correlated with landholding

Table 24. Average landholding size (by land type) and shares of land type held by caste and by district.

Caste[a]	Average landholding size by land type (acre)						Shares of land type owned (%)					
	Upland	Barhi	Mid-up-land	Medium land	Lowland	All	Upland	Barhi	Mid-up-land	Medium land	Lowland	Total
Giridih												
SC	0.4	0.2	0.6	0.0	0.3	1.5	23	21	40	0	16	100
ST	1.1	0.6	0.8	0.1	0.8	3.3	30	17	26	3	24	100
OBC	0.4	0.5	1.1	0.2	0.6	2.7	14	29	35	4	16	100
GEN	0.8	0.5	0.8	0.0	1.0	3.1	24	16	31	3	26	100
Caste	Average landholding size by land type (acre)						Shares of land type owned (%)					
	Upland	Barhi	Mid-up-land	Medium land	Lowland	All	Upland	Barhi	Mid-up-land	Medium land	Lowland	Total
Purulia												
SC	0.4	0	0.6	0.2	0.3	1.5	19	0	47	12	22	100
ST	0.3	0	0.5	0.1	0.2	1.1	31	0	48	11	8	100
OBC	0.6	0.002	1.2	0.5	0.6	3.0	21	0	45	15	19	100
GEN	0.3	0	0.9	0.5	0.2	1.9	15	0	55	10	12	100

[a]SC = scheduled caste, ST = scheduled tribe, OBC = other backward caste, GEN = other caste.

Table 25. Livestock holdings of surveyed households by farm size.

Item	Landless	Marginal	Small	Medium	Large
Total value of current livestock holdings (Rs.)	2,351	5,781	10,475	15,093	21,358
Total income from sale of livestock (Rs.)	251	548	731	565	500
Type of livestock					
Share of households owning a bullock (%)	22	63	76	83	46
Average number owned	2.0	2.0	2.1	2.3	3.0
Share of households owning a chicken (%)	4	12	19	35	54
Average number owned	3.0	2.8	4.1	4.6	5.0
Share of households owning a pig (%)	4	1	7	0	8
Average number owned	2.0	2.5	3.4	–	1.0
Share of households owning a goat (%)	29	43	52	63	62
Average number owned	1.9	2.3	2.9	4.5	4.5
Share of households owning a cow (%)	18	32	49	63	54
Average number owned	1.7	1.9	2.3	3.1	2.4
Share of households owning a calf (%)	2	8	13	28	23
Average number owned	1.0	1.8	1.8	2.5	1.7
Share of households owning a buffalo (%)	4	7	25	33	54
Average number owned	1.5	1.9	2.2	2.1	3.4

size. Nevertheless, there was little systematic relationship between landholding size and many other agricultural practices. In particular, no relationship was found between landholding size and the adoption rate of HYVs. These observations suggest that landholding size (unadjusted for land quality) was a poor measure of the agricultural potential of households' farms because of the disparate productive characteristics of different land types (see Table 27).

The impact of land reform and the panchayat system

Although Giridih and Purulia districts share similar agroecological characteristics, the political systems and governing institutions in the two states differ markedly. West Bengal State came under the Left Front government in 1976, which subsequently implemented a major land reform program. The land reform placed an area ceiling on legally permissible landholdings, redistributed land to the landless, and conferred secure tenancy rights. This was accompanied by the implementation of a system for democratic local governance, the panchayat, at the village level. Bihar State, in contrast, underwent no serious land reform and the panchayat system has not been vigorously implemented there. In Bihar, large landholders tend to exercise considerable influence over economic and political institutions down to the village level. Given the contrasting histories and resulting differences in institutional environments, we might expect some systematic differences in the socioeconomic outcomes (e.g., level of poverty, agricultural practices, etc.) between the two districts. In this section, we summarize district-wise comparisons in socioeconomic outcomes based on our survey data in order to explore this hypothesis.

As noted earlier, the caste structures of the villages demonstrate more villages with mixed caste compositions in Purulia, while villages are more segregated (including single-caste villages) in Giridih. This difference could trace its origins to the political developments mentioned in the prior paragraph. Historically, Giridih was settled earlier, but population density is higher in Purulia.

Table 26. Farm capital equipment and appliance holdings of surveyed households by farm size.

Definition	Landless	Marginal	Small (mean)	Medium	Large
General indicators of capital and equipment holdings					
Farm tools and equipment					
Total value of all agricultural implements (Rs.)	352	3,266	1,315	6,305	17,772
Owned only basic hand tools (%)	73	93	93	89	77
Owned hand tools + animal-driven equipment (%)	75	98	100	100	92
Owned some power-driven equipment (%)	0	3	3	9	15
Household appliances and amenities (%)					
Reported owning no appliances	22	25	24	30	23
Owned at least one minor appliance	40	46	66	59	77
Transportation (%)					
Reported owning no private transportation	13	14	12	13	8
Owned only human-powered transportation	65	77	84	83	85
Owned animal-powered transportation	100	100	100	100	100
Ownership of particular items					
Farming tools and machinery					
Share of households reported owning a "desi" plow (%)	24	82	98	98	85
Value of "desi" plows (Rs.)	175	173	196	206	266
Share of households reported owning a mechanical thresher (%)	2	1	3	4	0
Value of mechanical threshers (Rs.)	2,625	2,625	2,625	2,625	–
Share of households reported owning a diesel water pump	0	3	3	7	8
Value of water pumps (Rs.)	–	13,750	13,750	13,750	13,750
Share of households reported owning a tractor	0	0	0	2	8
Value of tractors (Rs.)	–	203,557	–	203,557	203,557
Share of households reported owning a rice mill	0	1	0	0	0
Value of rice mill (Rs.)	–	200,000	–	–	–
Household appliances and amenities					
Share of households reported owning a radio (%)	11	20	27	33	38
Share of households reported owning a clock/watch	38	43	65	54	77
Share of households reported owning a kerosene oven	2	7	8	9	46
Share of households reported owning a television	7	4	6	7	15
Share of households reported owning an electric fan	4	2	7	9	23
Transportation equipment (%)					
Share of households reported owning a cart	7	22	52	52	46
Share of households reported owning a bicycle	65	77	84	83	85
Share of households reported owning a motorcycle	2	3	2	7	31

For observed agricultural practices among the surveyed farms, several differences are seen. One major difference is that the intensively cultivated upland homestead plots (barhi land) that rely on a heavy use of labor and irrigation are widely observed in Giridih, but relatively few such plots tend to be found in Purulia (see Table 23). In rice production, HYV adoption, together with the use of modern chemical inputs (fertilizer and insecticides/pesticides), is somewhat more widespread in Purulia than in Giridih. In Purulia, 66% of the surveyed farm households reported using HYVs compared with only 39% of the surveyed households in Giridih. The main reason given for nonadoption in Giridih was the high cost of seed, while the main reason for nonadoption in Purulia was the higher risk associated with HYV cultivation. The rate of adoption of fertilizer in Giridih was 55% and in Purulia it was 66%, whereas insecticides/pesticides were adopted by 37% and 47% of the households surveyed in Giridih and Purulia, respectively.

Table 27. Agricultural practices of surveyed farms by farm size.

Adoption and nonadoption of agricultural practices	Share (%) of households adopting by farm size				
	Landless	Marginal	Small	Medium	Large
Use of improved crop varieties					
Paddy	11	53	57	48	46
Maize	4	4	7	7	0
Wheat	0	2	4	5	0
Potato	11	21	31	22	46
Reason for nonadoption of improved rice varieties					
Seed too costly	13	28	20	18	20
Risky	50	21	25	20	25
Method used to sow rice and reason for adoption					
Share of households adopting transplanting	15	48	40	35	31
Cost-effective	4	9	10	4	8
Proper management	14	18	17	9	8
Good yield	25	48	40	33	31
"Behind plow" sowing	2	22	25	26	62
Proper management	0	15	21	18	54
Good yield	4	23	24	27	62
Broadcasting (direct seeding)	16	31	35	43	15
Lack of know-how	4	05	9	13	0
Traditional practices	29	27	27	36	15
Mixed cropping/intercropping practices	2	23	29	37	54
Reason for adoption					
More stability	4	15	21	17	55
Avoid risk	4	13	15	11	0
Increase total production	0	10	13	22	18
Reason for nonadoption					
Sole crop higher yield	8	10	10	7	9
Lack of know-how	35	56	44	33	18
Seed proportion unknown	04	7	11	24	0
Farmyard manure/chemical fertilizer application	29	92	92	96	92
Adoption					
FYM only	28	36	25	20	0
FYM + fertilizer	28	56	67	74	85
Reason for nonadoption					
High price	3	1	1	2	0
Lack of funds	7	6	6	4	0
Fertilizer damages soil	0	0	2	0	0
Share of households using insecticides/pesticides on rice	9	41	48	59	77
Reason for adoption					
Higher yield	18	34	41	44	62
Reduce riskiness	0	12	15	13	23
Reason for nonadoption					
Lack of funds	25	39	30	22	0
Lack of know-how	18	19	20	22	08
Share of households adopting irrigation on rice crop	11	0.25	41	35	54
Reason for adoption					
Better-quality grain or straw	3	12	23	11	8
Good yield	21	22	33	31	54
Reason for nonadoption					
Lack of sources	17	53	40	51	15
Lack of funds	0	11	5	7	8

The establishment of rice crops using transplanting was slightly more prevalent in Giridih (81%) than in Purulia (76%), whereas direct seeding was more common in Purulia (14%) than in Giridih (4%) (the remaining households adopted “behind the plow” seeding). The surveyed farms in the two districts irrigated their rice crops at similar rates. Mixed cropping/intercropping was more widespread in Giridih than in Purulia (Table 9). While it is possible that differences in the availability of agricultural extension services or competitive input markets are associated with political and economic differences between the two districts, these different practices could also be due to differences in soil types and common landscape positions of farm plots, which influence soil moisture and weed conditions, across the two districts.

The “capital poor” nature of the farm households, on the other hand, was similar across the surveyed households in the two districts. Most of the households in both districts reported owning basic hand tools (88% in Giridih, 93% in Purulia), while a small minority reported owning diesel water pumps (3% in both districts) (Table 28). Despite some observed differences in agricultural practices, average rice yields across the two districts were roughly equal (2,824 kg ha^{-1} in Giridih and 2,663 kg ha^{-1} in Purulia) (Table 6).

Ownership of animals appears to be somewhat more common in Giridih than in Purulia, and this could be because animal rental markets (especially rental of bullocks) appeared to be more active in Purulia. Also, in Purulia, year-round holding of bullocks is constrained by the lack of grazing land due to the diminished availability of common grazing land in the district. On the whole, rental markets for livestock were thin according to the survey results. The average values of livestock holdings were higher in Giridih (Rs. 9,076) than in Purulia (Rs. 6,822), but the total income from livestock sales was higher in Purulia (Rs. 967) than in Giridih (Rs. 159) (Table 28).

In terms of credit markets, households in Purulia tended to rely more on informal sources (neighbors and money lenders) than households in Giridih (where credit through commercial banks, the Gramin Bank, and state sources was more common) (see Table 28). This runs counter to our a priori expectation that economic transactions would be more formalized in Purulia than in Giridih because of a higher level of institutional development in Purulia resulting from the more advanced development of the panchayat system in that district.

Labor market participation among male workers was somewhat higher in Giridih than in Purulia, but was about the same between the two districts among female workers. In the study area, a strict division of labor based on gender is observed, with male workers being responsible for land preparation and weeding, while transplanting is seen as a female labor task. Harvest and threshing are shared by male and female laborers. Market transactions in farm outputs and livestock (e.g., in terms of the shares of income from the sale of farm outputs and of livestock) appeared to be slightly more prevalent in Purulia than in Giridih. The average cash income of the surveyed farm households in Purulia was higher than in Giridih, while the reverse was true for the total imputed value of home consumption of farm outputs (see Table 11).

For observed household-level welfare outcomes, the estimated average per capita gross income was the same between the two districts (Rs. 4,026 in Giridih and Rs. 4,010 in Purulia), and the share of income from nonagricultural sources was roughly 40% among the surveyed households in both districts—although the share of households engaged in nonagricultural activities was higher in Giridih than in Purulia.

The level of inequality in the distribution of landholding and income appears to be slightly lower in Purulia than in Giridih, as one would expect given the land reform in Purulia. The Gini coefficients for land distribution in Purulia and Giridih were 0.48 and 0.49, respectively. In terms of the estimated income distribution, the Gini coefficients for the two districts were the same at 0.38 (see Table 11). While the observed difference in inequality between the two districts is very small, this might suggest that the land reform implemented in West Bengal was successful. Such a conclusion, however, cannot be drawn definitely without better information on the extent of inequality in land distribution across the two districts before West Bengal implemented its land reform. Although the two districts share roughly equal levels of average per capita income and land distribution was slightly less unequal in Purulia, the estimated poverty incidence was higher in Purulia (63%) than in Giridih (57%) (Table 11). This is due to the higher poverty line established in Purulia than in Giridih, which itself reflects the higher average living cost in rural West Bengal.

Ownership of household appliances was slightly more common among the surveyed households in Purulia than in Giridih. For example, the proportion of the households reporting ownership of at least one (minor) appliance was 59% in Purulia and 47% in Giridih. Nearly a third (31%) of the surveyed households in Purulia reported owning a radio, while less than half that share (14%) of households in Giridih reported owning one. According to the survey, 7% of the households in Purulia and 4% in Giridih owned a television set. Eighty-six percent of the households surveyed in Purulia reported owning a bicycle, while 70% did so in Giridih (Table 28).[6] The positive correlation between landholding size and ownership of appliances appeared to be slightly more pronounced in Purulia than in Giridih.

Indicators of the level of education such as the literacy rate or the average years of schooling were slightly higher in Purulia (35% literacy rate and 3.9 years of schooling) than in Giridih (20% literacy rate and 3.4 years of schooling). Furthermore, average educational attainment appears to have risen more rapidly in Purulia in recent years than in Giridih. This can be inferred from the higher reported "maximum years of schooling within the household." Evidence of gender discrimination (e.g., differences in wage rates commanded by male and female workers) suggests that this discrimination was more pronounced in Giridih than in Purulia. There was a higher share of female-headed households among the surveyed families in Purulia than in Giridih (Table 28).

Taken altogether, this comparison of welfare indicators among surveyed households in the two districts provides some evidence that, on average, households in Purulia have a higher standard of living than households in Giridih. While average levels of per capita income and agricultural productivity (measured by average rice yields) were roughly the same in the two districts, a larger number of the other welfare outcomes performed better in Purulia than in Giridih. Although the poverty incidence was slightly higher in Purulia than in Giridih, inequality indicators (e.g., land distribution and gender discrimination) suggest that Purulia is (slightly) more egalitarian. Various measures of social development suggest that Purulia has achieved a higher level of development than Giridih—individuals in the surveyed households were slightly more educated. Participation in markets, the use of modern technology and practices in agriculture, and ownership of household appliances all tended to be more widespread among the house-

Table 28. Comparisons of selected aspects between Giridih and Purulia districts.

Item	Giridih	Purulia
Demographic aspects		
Average family size	7.1	6.7
Share of female-headed households (%)	4	7
Average age of household head	45.3	49.4
Household head's average years of schooling	3.4	3.9
Maximum years of schooling within the household	5.9	7.3
Sources of credit (%)		
Money lender	32	37
Commercial bank	38	24
State programs	0	4
Store selling agricultural inputs	0	4
Landlord	0	5
Neighbor	1	16
Relatives	5	6
Gramin bank	22	5
Agricultural implement ownership		
Total value (Rs.)	4,154	1,932
Share of households owning only basic hand tools (%)	88	93
Share of households owning no appliances (%)	50	0
Share of households owning one minor appliance (%)	47	59
Share of households owning water pump (%)	3	3
Share of households owning radio (%)	14	31
Share of households owning clock (%)	46	54
Share of households owning TV (%)	4	7
Share of households owning bicycle (%)	70	86
Share of households owning motorcycle (%)	4	4
Livestock holdings (Rs.)		
Total value	9,067	6,822
Income from sale of livestock	159	967
Labor market participation (%)		
Share of farm households active in labor markets (male)	41	30
Share of farm households active in labor markets (female)	30	27

[6] However, there were some appliances for which households in Giridih reported a higher or equal incidence of ownership: gas ovens in Giridih (14%) versus Purulia (2%) and motorcycles (4% in both districts).

holds in Purulia. Although this observation does not prove that West Bengal's land reform and greater development of the panchayat system in Purulia have positively influenced social and economic development in this district, it is consistent with such positive effects.

Summary and policy implications

Summary of the findings

This report has provided a broad description of the natural and socioeconomic characteristics of the Chhotanagpur Plateau. This represents one of India's most poverty-stricken areas because of a harsh natural environment, low productivity in agriculture, and inaccessible or poorly functioning markets. The main climatic factor constraining agricultural activities is rainfall, which is highly seasonal—making agricultural activities highly uncertain depending on the onset and withdrawal of monsoon rain and interim dry spells. Low irrigation potential during the dry season (because of the relative scarcity of surface and underground water) further constrains options for agricultural production. At least four major topographical landscape types can be distinguished, with each land type requiring distinct cropping systems.

Agricultural production in our sample villages is characterized by a low use of market-purchased inputs (e.g., fertilizer, insecticides, hired labor, capital rental), low rate of HYV adoption, and heavy reliance on traditional techniques. More than 90% of the farmers own only basic hand tools and animals, and the ownership of modern agricultural machinery (e.g., tractor, water pump, thresher, etc.) is rare. However, the agricultural practices adopted—including input-use intensity—vary depending on land types; generally, input-use intensity and thus yields tend to be higher in lower lands than in upper lands, except for the case of *barhi* land, the portion of upland adjacent to farmers' residences, where the intensive use of labor and irrigation water leads to high yields (but sometimes a negative net return). Although the use of irrigation and modern inputs (but not HYV adoption) varies somewhat according to landholding size, generally, landholding size (without adjusting land types) is not always a good predictor of the production capacity or wealth holding of the household. Given the severe biophysical constraints, the average rice yields in the area are quite low. Furthermore, there is a strong subsistence orientation among the farmers. Ninety percent of the sampled households produce rice, for example, but only 21% sell their outputs.

A defining socioeconomic characteristic of the area is the predominantly low level of living standard and the high incidence of poverty. The average per capita income is quite low (Rs. 4,018), the proportion of households below the poverty line is high (60%), and the rate of ownership of various household assets or appliances (e.g., TV, radio, etc.) is quite low (with 20–30% owning no household appliance at all). Nonincome indicators of household welfare, such as literacy rate, the years of schooling (3.6 years), and access to electricity (12%), also conform to the general picture of a low living standard.

Partly as a result of household strategies in response to risk and vulnerability conditions, the households in the area have diversified their income sources; most of the households (83%) are engaged in some type of nonagricultural activities and nonagricultural income constitutes a significant proportion of the total income (39% on average). Most of the nonagricultural occupations in the area, however, have low productivity and low returns. Because of the strong subsistence orientation, large amounts of the resources are devoted to rice production for own consumption; income from rice (including both the imputed value of the home-consumed rice and the rice sold in the market) constitutes about 35% of the total household income on average. This implies that even a dramatic increase (e.g., 100%) in rice yield alone may lead to a relatively modest decline (12%) in poverty in the area, although estimating likely household responses to such a scenario would require much more in-depth analysis.

Among our sampled villages, large variations exist within them in the size of landholdings and among them in caste compositions. Both caste affiliation and the landholding size of a household are often observed to be strongly associated with economic outcomes, with a typical expectation being that both larger landholdings and nonscheduled castes (or nonscheduled tribes) are associated with better economic outcomes. Our data suggest, however, that such relationships are more nuanced and possibly more complex. Although some economic outcomes are positively correlated with larger landholdings or with nonscheduled caste affiliation, we find relatively few clear-cut relationships between them in other cases.

Another institutional aspect of interest in the area is the contrasting institutional characteristics between Purulia and Giridih districts and their potential economic consequences. Purulia has a functioning panchayat system and has implemented land reform with reasonable success. Despite our a priori expectation of higher "politicization" in Purulia than in Giridih, farm households rely more on state sources for their credit in Giridih than in Purulia, where households rely relatively more on informal sources (such as money lenders and neighbors). The incidence of poverty is slightly higher in Purulia than in Giridih (because of the higher cost of living in West Bengal than in Bihar), but inequality in land and in income distribution, as well as gender gaps, appears to be slightly lower in Purulia than in Giridih, as expected as a potential outcome of the land reform implementation and the presumably more "democratic" governance in West Bengal. Furthermore, the level of schooling, the use of modern inputs in rice production (HYV adoption, modern chemical inputs, but *not* irrigation), the share of cash income in total income, and the degree of participation in market transactions tend to be higher in Purulia than in Giridih. Interestingly enough, however, despite those marked differences, some of the key outcome indicators—such as average rice yields and average per capita household income—are roughly the same between the two districts.

Policy implications and areas for future research

To conclude, we now consider some implications of the results summarized in this report for policies intending to improve the welfare of the households in our survey area (and possibly in other similar areas). Three broad types of potential policy interventions are considered (although these are not mutually exclusive): (1) agricultural intensification based on investments in water resource management infrastructure, (2) facilitating access to nonagricultural employment and promotion of nonfarm enterprises, and (3) investments in human capital of the study-area residents.

Given the natural conditions of the study area, interventions aimed at increasing farm income through investments in water resource management infrastructure to facilitate agricultural intensification appear promising. As discussed earlier, the crucial constraint to agricultural intensification in the area is the uncertainty/variation in the onset and ending of the monsoon rain and the lack of water resources after the monsoon season—despite total annual rainfall that is usually adequate. This suggests that one potential intervention would be to invest in water-harvesting infrastructure, such as ponds or groundwater irrigation facilities, to smooth water availability throughout the year. Increased water availability outside the monsoon season would allow farm households to increase the number of crops cultivated each year and to grow higher-value water-intensive crops (e.g., fruits/vegetables). Both these changes could substantially increase the households' agricultural income. The feasibility of this option, however, is unclear and requires additional analysis of the potential for surface reservoirs, groundwater availability, and detailed estimates of the costs and economic viability of constructing alternative water-harvesting infrastructure. Box 2 contains additional discussion of potential paths for intensification on various land types.

Second, as was also discussed in this report, many households in the study area derive large shares of their income from outside the agricultural sector. This suggests that there may be potential for promoting small-scale nonagricultural enterprises and facilitating access of workers from the study area to nonagricultural employment opportunities either in the area or elsewhere. The fact that the surveyed households were found to depend on nonfarm income also suggests that any returns to labor from intensified agricultural activity, such as the ones considered above and in Box 2, must be at least as high as the returns from existing nonagricultural employment/microenterprises. The high proportion of nonagricultural income in total household income also suggests that facilitating access to nonagricultural income–generating opportunities has the potential to be as critical a policy intervention for poverty reduction as agricultural intensification.

Possible policy interventions to facilitate nonagricultural employment and the development of microenterprises include a range of options such as infrastructure development (roads, bridges, etc.) and information networks to ease worker transportation to employment opportunities and microcredit schemes. The relative efficacy of such policy instruments would need to be carefully assessed, and such assessment was outside the scope of our study. Furthermore, the study area's relatively thin markets and weak demand for labor in the nonagricultural sector must be recognized, as this could severely limit the poverty reduction potential of these types of interventions. Broader policy considerations, including that of the overall development strategy for increasing the demand for unskilled labor at the regional or national level, would likely be required for nonagricultural sector enterprise and employment growth to have a major impact on poverty in our study area.

A final policy instrument that could be considered is to invest in the human capital of poor households in the study area. Although the data described in this report do not provide an adequate basis for assessing the potential economic returns from education, a large empirical literature points to large economic (i.e., higher future income) and noneconomic (e.g., female education can facilitate a decline in fertility, improve local governance, etc.) benefits that education can yield to individual households and through positive externalities at the community level. The low level of education attainment among the households in our survey suggests that the marginal returns from investments in education in the study area could be high.

Finally, it warrants emphasis that at this stage of the study the descriptive statistics reviewed in this report do not provide sufficient grounds for making

Box 2. Possible technical interventions

Despite the generally unfavorable biophysical and socioeconomic conditions in the Bihar plateau, there could be some opportunities for technical interventions to improve its productivity and the natural resource base at different landscape positions. The findings from various experiments conducted in Giridih indicate the following potential agronomic interventions, taking into account crops that are agroecologically suitable, nutritionally enhancing, and culturally acceptable, as well as cropping practices that require minimal cash input, enhance soil fertility, and check land degradation.

Possible interventions in general

- Toposequence-wise microlevel planning with fruit plantation; social forestry with *Arjun* (for sericulture) and *Palash* (Lac culture) trees and fodder cultivation on uplands; drought-tolerant monsoonal short-duration nonrice crops and mixed cropping/intercropping on mid-uplands; and better management of medium-land and lowland rice.
- Formation of farmers' cooperatives for accessibility to all agricultural inputs and better marketing for harvested products.
- Increasing scope of employment through animal husbandry and village-level enterprises such as vermicomposting, biopesticides, etc.

Possible interventions on different toposequences

- The main interventions for the degraded uplands should be targeted at checking further land degradation through effective reforestation using appropriate and relevant tree species that can also provide products of use to the local residents, for example, medicinal plants, fruit trees, bamboo plantation, and the *Sal* tree for harvesting leaves that can be used as disposable plates.
- Given the poor water availability and soil conditions of the cultivable uplands, the present practice of growing low-yielding traditional rice should be replaced with planting of high-yielding nonrice crops that have lower water requirements and higher drought tolerance. Mixed cropping or intercropping with legumes would help to increase soil fertility. To check soil erosion, a plantation crop, especially fruit plants, should also be tried in some parts of the cultivable uplands.
- In the barhi lands where farmers are already cultivating intensively and applying high levels of inputs, there is a need to identify appropriate high-yielding varieties and to increase input efficiency.
- The medium lands provide the highest potential for supporting a variety of crops over an extended cropping period, particularly if there is supplementary irrigation and if farmers plant medium-duration high-yielding rice varieties requiring moderate inputs of manure and fertilizer in the main season. Construction of water-harvesting infrastructure to conserve rainwater for irrigation should be considered.
- The most important intervention in the lowlands is to develop short-duration flash-flood-tolerant high-yielding rice varieties for the aman season and cold-tolerant high-yielding rice varieties for the winter season so that the rice-rice system can be practiced. This work should be complemented by improving drainage so that the area can be used for (1) switching from traditional to high-yielding rice varieties and (2) allowing multiple cropping, hence taking advantage of the inherently higher fertility of the soil.

These technological interventions would be effective/feasible, however, only if they are consistent with the livelihood strategies of the farmers, if the enabling conditions are in place, or if they are accompanied by other appropriate policy environments (e.g., infrastructure improvement, price policies, etc.).

judgments as to which policy intervention is feasible or would be most effective in reducing poverty in the study area. To make such judgments, much more in-depth analysis is required. The marginal impacts of alternative policy interventions on the level of household income and on the incidence of poverty would need to be quantified using existing modeling techniques. Nevertheless, the data reviewed in this report suggest that the three broad types of policy interventions discussed above potentially have high returns in terms of poverty reduction and thus warrant serious consideration by policymakers.

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About the authors

P. Banik, agronomist and lecturer in the Agricultural Science Unit of the Biological Sciences Division of the Indian Statistical Institute in Kolkata, India.

C. Edmonds, research economist in the Economics and Research Department of the Asian Development Bank, Manila, Philippines, formerly an affiliate scientist at the International Rice Research Institute in Los Baños, Philippines, under financing provided by the Rockefeller Foundation Social Science Research in Agriculture Postdoctoral Fellowship Program.

N. Fuwa, international research fellow at the International Rice Research Institute in Los Baños, Philippines, and associate professor of agricultural economics at Chiba University in Chiba, Japan.

S.P. Kam, GIS specialist at the International Rice Research Institute in Los Baños, Philippines.

L. Villano, GIS researcher at the International Rice Research Institute in Los Baños, Philippines.

D.K. Bagchi, professor and head of the Agricultural Science Unit of the Biological Sciences Division of the Indian Statistical Institute in Kolkata, India.