**Resource scarcity gradients in the post-Green Revolution Indo-Gangetic Plains:**

**Implications for agricultural technology use and supply**

Olaf Erenstein


International Maize and Wheat Improvement Centre (CIMMYT), CG Block, NASC

Complex, Todapur Road, Pusa, New Delhi-110012, India

E-mail: o.erenstein@cgiar.org

June 2009

**Abstract**

The Green Revolution converted the Indo-Gangetic Plains (IGP) into South Asia's cereal basket. The recent slow down in cereal productivity growth and continuing poverty in the IGP pose a major challenge to agricultural research and development. To address this challenge it merits revisiting the resource scarcities that farmers actually face across the vast IGP. The paper uses a rapid primary data collection effort through village surveys in 12 clusters along an agro-ecological gradient in the Indian IGP to complement secondary data. The results show marked gradients in factor ratios and factor prices in the Indian IGP. Labor:land factor ratios and price ratios alone can thereby be misleading as they fail to capture the increasingly important role of capital in the post-Green Revolution setting. Relative to other IGP regions, the Green Revolution heartland is relatively capital abundant, explaining the advent of both land saving and labor saving technologies in the North-Western IGP. Further downstream the densely populated Eastern IGP is particularly capital scarce. Agricultural innovations emerging from either area are unlikely to be directly adequate for the other, calling for more investment in adaptive agricultural research to develop innovations in line with the prevailing resource scarcities.

Keywords: relative factor scarcity; spatial gradients; R&D implications.

# 1 Introduction

The Green Revolution of the 1960s boosted cereal productivity, particularly of wheat and rice (Evenson and Gollin, 2003; Lipton and Longhurst, 1989). This transformed the Indo-Gangetic Plains (IGP) into South Asia's cereal basket. It boosted staple food production, contributed to regional food security and alleviated malnutrition by ensuring relatively cheap food for the masses. Purchasing power for consumers was increased due to cheaper staple food whereas producers benefitted through higher productivity and income.

Notwithstanding the overall acclaimed success of the Green Revolution a number of concerns have emerged. South Asia (SA) in general and the IGP in particular still has persistent poverty and hunger and the highest number and concentration of poor and hungry in the world (Gill et al., 2003). The Green Revolution had differential impacts, both geographically (e.g. North-Western vs Eastern IGP) and socio-economically (in terms of gender and class). In the last decade cereal productivity growth has started to stagnate, particularly vis-à-vis population growth and economic growth. Climate change further threatens the Green Revolution gains. The perceived lack of new agricultural breakthroughs in SA since the Green Revolution has led to increasing calls for a second Green Revolution, which was given further impetus by the 2008 food crisis.

The agricultural research and development (R&D) community faces the challenge how to reinvigorate cereal productivity growth in an equitable and sustainable manner in SA's cereal basket. The likelihood of success will depend *inter alia* on the supply side of technical and institutional innovations having an adequate understanding of the demand

side, particularly in terms of understanding the underlying resource scarcities that farmers actually face. This is especially relevant in India's IGP with some stark contrasts and apparent paradoxes (Erenstein et al., 2007a; 2007c; 2009). Within the same region labor saving mechanization continues to advance despite persistent poverty and abundant underemployed landless labor. The region now includes states that compare to middle income countries and states that would rank amongst the poorest countries. The objective of the present paper is to assess resource scarcity and the associated spatial gradients in the post-Green Revolution IGP and to derive some of the implications for technology use and supply.

The analytical toolbox available to agricultural economists to generate such understanding is ever expanding, ranging from sophisticated computer models to participatory and/or multidisciplinary approaches. Off late the applied field has seen an increased interest in livelihood analysis, value chain analysis and poverty mapping (Erenstein et al., 2007a; 2007c; 2009). Each contribution has its own merit in terms of enhancing analytical and developmental processes. But the multitude of evolving approaches may alienate policy/decision makers and confound discussions. Results from ever more complex questionnaires, models and indicators easily get lost in the detail. A promising approach used in this paper blends quantitative with qualitative approaches. The present study thereby focuses on a few key quantitative indicators from a rapid primary data collection approach and links these to the bigger picture needed to determine R&D priorities and thereby the supply side of agricultural technology. The next section briefly describes the IGP study area and the data and methods used. The

subsequent section presents land and labor scarcity in the IGP setting and continues by examining the underlying resource scarcity gradients. These gradients are subsequently used to derive some of the implications for technology use and supply.

## 2    Materials and methods

### 2.1    Study area

The study area encompasses the Indo-Gangetic Plains (IGP) in India comprising 0.47 million km$^2$ and 280 million rural inhabitants. The overall area includes 149 districts in five states across northern India along the Himalayan range: Punjab, Haryana, Uttar Pradesh, Bihar, and West Bengal. The IGP can be broadly subdivided into the North-Western IGP (upstream, traditionally a wheat producing and consuming area) and the Eastern IGP (downstream, traditionally a rice producing and consuming area) with a transition zone in-between. The Green Revolution allowed for the rapid area expansion of irrigated rice during the rainy season into the NW IGP and irrigated wheat during the dry winter season into the cooler parts of the E IGP, contributing to rice-wheat now being the prevailing cropping system (Erenstein et al., 2007a; 2007c; 2009; Timsina and Connor, 2001).

The IGP encompasses significant geographical disparity in terms of the incidence of poverty, resource endowments and technology use. Rural development indicators in the Green Revolution heartland of Punjab and Haryana in the NW IGP now compare well with those of middle income countries. Yet large tracts of the IGP remain marred in dire

poverty. The district level poverty head count ratio in the IGP thereby varies from a low of 1.5% to 63% (using the national poverty line, Debroy and Bhandari, 2003).

## 2.2 Data and methods

The main data source for the present paper was a village-level survey of 72 communities from April to June 2005 in the Indian IGP (Erenstein et al., 2007c). The communities were randomly selected using a stratified cluster approach. At the first level, the Indian IGP was grouped into four subregions: the Trans-Gangetic Plains (TGP: Punjab and Haryana) and the Gangetic Plains of Uttar Pradesh (UP), Bihar (BH), and West Bengal (WB). At the second level, three representative districts were purposively selected, one from each of the three main IGP agro-ecological subzones within the subregions. At the third and final cluster level, six villages were randomly selected around a central point, typically the district headquarters. The villages selection was done by taking two villages along three opposing directions, one village typically relatively close (generally within 5 km) and the second further away (generally more than 15 km). Within each village a self-selected group of key informants were interviewed using a semi-structured survey instrument.

The 12 surveyed districts lie along an upstream to downstream gradient. The present paper focuses on the cluster averages for selected indicators – particularly on the proxy's for the land, labor and capital production factors and their factor prices. Elsewhere the 12 research sites have been further characterized and the comprehensive results of the 72

village surveys provided (Erenstein et al., 2007c; Erenstein et al., 2007d; Singh et al., 2007; Thorpe et al., 2007; Varma et al., 2007).

Village surveys provide a valuable and rapid data collection tool – particularly for quick characterization of production systems and obtaining disaggregated market prices. They thereby provide an useful and timely complement to primary data from household surveys and secondary data. For instance, although formal interest rates have the advantage of being tracked and published, they have their shortcomings in terms of capturing actual capital scarcity. These shortcomings include public intervention in market rates, inaccessibility to less endowed segments of society, and particularly relevant here, a general inability to capture intra-country variations. The informal sector is often despised for charging what are perceived as usurious rates. But whatever the criticisms levied against it, it is often the prevailing rural credit source in rural India and it provides a more realistic estimate of the cost of capital in rural settings. As a proxy for the capital factor cost the paper uses the informal interest rate as reported in the surveyed communities. Similarly, the rural wage rate for males and the prevailing irrigated land price as reported in the surveyed communities are used as proxy's for labor and land factor costs respectively.

## 3    Land and labor scarcity in the IGP setting

Land scarcity induced by population-growth has received considerable attention as one of the factors driving agricultural land use change (Boserup, 1965; Ruthenberg, 1980). The increasing land scarcity thereby induces land saving technical and institutional change

(Hayami and Ruttan, 1985). Conversely, labor scarcity is likely to induce labor saving changes. The diverging impact of the Green Revolution in sub-Saharan Africa (SSA) and South Asia (SA) has been associated with their relative resource scarcities (Erenstein, 2006). Green Revolution innovations are typically land saving; whereas SSA is stereotyped as having abundant land with scarce labor, whereas SA is perceived to be land constrained with abundant labor. Underlying the stereotypes is SA's population, which is basically double SSA's but on a more limited land mass, resulting in a nearly 10-fold higher population density (312 vs 33 people / km$^2$, World Bank, 2007).

The magnitude of the SSA-SA contrast in population density is striking. However, within each region there are also notable intra-regional contrasts. For instance, the IGP is one of India's and SA's most densely populated regions, whereas the downstream plains have again double the population density of the upstream plains (Table 1). The population density is in turn associated with farm size (negatively) and poverty (positively) for the IGP states (Table 1, Erenstein et al., 2007a; 2007c; 2009). The close relationship between rural population density and poverty in the study sites is particularly striking (Figure 1).

Although intra-regional contrasts such as those observed within the IGP are of a lesser magnitude than the SSA-SA contrast, they are still likely to influence the demand and supply for agricultural innovations. In the case of the IGP and based on the population density and farm size alone (Table 1), one would hypothesize that the upstream NW IGP would be more inclined towards labor saving innovations and the downstream E GP more inclined towards land saving innovations, *ceteris paribus*.

In Table 2 selected agricultural indicators are presented for the 5 states in the IGP. In line with expectations the NW upstream states have the highest tractor densities – implying a widespread use of labor saving mechanization. However, contrary to the implied labor:land ratios, the NW states also use more land saving intensification practices such as irrigation and fertilizer and achieve higher yields. This suggests the *ceteris paribus* condition does not hold, i.e. there are other confounding factors. For instance, there are underlying environmental differences: e.g. the irrigation gradient is also inversely related to the rainfall gradient. There are also a number of socio-economic differences, albeit that produce prices were found to be relatively similar across research sites. The remainder of this paper aims to unravel the observed differences. We hypothesize that a major factor explaining the apparent intensification paradox is the omission of capital costs.

An implicit assumption in singling out labor or land scarcity as driving technological change is that capital is typically and equally scarce for small holder producers. However, smallholder agriculture has become more capital intensive in the post-Green Revolution IGP. This makes capital a key factor to understand the diverging innovation pathways and productivity levels.

## 4    Resource scarcity gradients

Figure 2 presents the three factor prices as reported in the surveyed villages. The reported interest rates increase from the upstream NW IGP sites to the downstream E GP sites, suggesting increasing capital scarcity. *Ceteris paribus*, one would expect increasing

9

capital scarcity to translate into more limited use of capital intensive goods. In line with expectations, the reported tractor density per farm household in the surveyed communities is inversely associated with the informal cost of capital (Figure 3).

The reported wage rates decline from the upstream NW IGP sites to the downstream E GP sites (Figure 2). *Ceteris paribus*, one would expect the labor factor cost to reflect labor scarcity (i.e. demand for labor exceeding supply). Labor scarcity thereby is likely inversely associated with population density and poverty, which both show a marked and closely linked gradient in the IGP as reported earlier (Figure 1). In line with expectations, rural wage rates are indeed positively associated with the population *above* the poverty line (Figure 4). The wage differentials within the IGP have also lead to intra-regional agricultural labor migration. Labor flows typically originate from the East (contributor/source) to the NW (recipient/sink), and is both of a more permanent and seasonal nature, the latter following the agricultural calendar peaks (rice and wheat harvesting; rice transplanting).

The reported land prices are the highest in the Green Revolution heartland of Punjab and Haryana, and then show a marked drop and a subsequent more gradual decline proceeding towards the downstream E GP sites (Figure 2). *Ceteris paribus*, one would again expect the land factor cost to reflect land scarcity. Farm size thereby could be interpreted as being an inverse proxy for land scarcity. However, in the Indian IGP we observe a close positive relation between land price and farm size (Figure 5) – i.e. the

highest land prices are associated with the largest average farm size. What factors can explain this apparent land price-farm size paradox?

One factor is location. Land's unmovable nature indeed implies location is of prime importance. The NW location indeed has a number of advantages, including preferred access to cereal produce markets, good access to agricultural inputs, support services and infrastructure and a productive irrigated environment. One may also posit that economies of scale may distort land prices by providing a positive incentive to increase farm size. However, providers of agricultural machinery services have largely made machinery divisible and thereby accessible to small holders.

We hypothesize that a major factor explaining the apparent land price-farm size paradox is the cost of capital. An associated contributing factor is the productive yet low risk rice-wheat production system in the NW. These systems have limited short term production risks (widespread irrigation mitigating drought risk and no major or difficult biotic stresses) and no market risk (guaranteed procurement at minimum support prices). High yields and large farm sizes have lead to large marketable surpluses (Table 2). This has made rice-wheat systems into low risk 'cash cows'. The surplus cash in turn reduces the cost of capital and leads to reinvestment into capital goods (machinery) and land.

The diverging factor price gradients over the IGP have major implications for the relative factor prices (Figure 6). Both land and labor prices decline from the upstream NW IGP sites to the downstream E GP sites. The labor:land factor price ratio thereby shows the

11

least spread over sites. Still, the very high land price in the Green Revolution heartland (upstream NW IGP) results in the lowest labor:land factor price ratios coinciding with low labor:land factor ratios (reflecting the low population density and large farm size, as discussed above).

Contrary to labor and land costs, capital costs increase along the same geographical gradient. As a result, the factor price ratios that include capital show the largest spread. Especially the three West Bengal study sites stand out with their relatively huge capital:labor and capital:land factor price ratios (Figure 6).

## 5 Implications for technology use and supply

### 5.1 Technology use in crops

Low capital cost makes the NW IGP relatively capital abundant, and thereby should induce the use of innovations that are relatively labor *and* land saving. In contrast, the high capital cost in the E GP should induce capital saving innovations. This is born out by the observed gradients in selected indicators for capital intensive labor saving technologies (e.g. tractor density) and capital intensive land saving technologies (e.g. widespread irrigation; high fertilizer rates) over IGP states (Table 2). Among the surveyed sites, the NW IGP indeed shows the most widespread use of labor saving technologies (e.g. herbicides; mechanization of field operations like land preparation, establishment, harvesting and threshing) and land saving technologies (improved

varieties[1], irrigation, and fertilizer). In view of the widespread use of land saving

technologies wheat and rice yields are also highest in the NW IGP (Table 2).

The relative abundance of capital and aggravated by status considerations has contributed

to an apparent over-capitalization in the NW IGP, particularly for tractors. Ownership of

harvest combiners is also concentrated in the NW, but these show considerable intra-

regional mobility following the rice and wheat harvests. The relative abundance of capital

has likely also contributed to land price inflation as discussed earlier. Indeed, seasonal

land rents are so substantial in the rice-wheat heartland that in some cases renting out of

agricultural land can be more profitable than actually producing rice-wheat (Erenstein et

al., 2007b).

Among the surveyed sites, the E IGP indeed show the most widespread use of capital

saving technologies (manual weeding/harvest/threshing; low fertilizer rates; more animal

traction use) and relatively low rice and wheat yields. In the evolution of agricultural

systems stationary power sources typically get adopted before motive power sources

(Hayami and Ruttan, 1985). In line with this stationary threshers have become common

place in most of the rice-wheat systems of the IGP, whereas the arrival of combine

harvesters is much more recent. However, the scarcity of capital in West Bengal is such

that even motorized threshers have not made many inroads, with threshing often still

manual or relying on peddle threshers. Another capital saving innovation is reciprocal

---

[1] Use of improved rice and wheat varieties is near universal in the NW IGP, albeit not very capital intensive

in view of the prevailing practice of seed recycling for a number of seasons.

labor, instead of the wage or task based remuneration that prevails in more capital abundant settings.

### 5.2    Technology use in livestock

*Ceteris paribus*, with low labor:land ratios one would expect extensive livestock keeping systems and with high labor:land ratios more intensive systems. In the IGP this again does not hold. Low input-low output systems prevail in the downstream plains of West Bengal, whereas higher input-higher output systems prevail in the upstream plains. This again suggests capital scarcity is a more deciding factor than labor:land ratios as such. The upstream plains indeed invest relatively more in livestock production, be it in terms of feeding (e.g. more green fodder production), larger herd sizes and more productive and valuable herds (primarily buffalo and cross-bred, limited local cows). A second confounding factor is the multiple services of livestock keeping in poorer societies (Moll, 2005). In relatively capital scarce settings one can plausibly expect the financial service functions (liquidity, insurance, asset accumulation) to take a more prominent role relative to the purely physical production functions. This goes a long way in explaining the increased incidence of local cattle with limited productivity levels in the downstream plains, as well as an increased role for small ruminants – which tend to be more liquid and less capital intensive than large ruminants. A further indication of livestock-capital linkages is the positive association of aggregate herd size (in cow equivalents) in the survey sites and the population above the poverty line at the district level.

## 5.3   *Technology supply*

Understanding technology use is valuable in itself for agricultural R&D. But how does this compare with technology supply? The prevailing pre-occupation of agricultural scientists with yield has long secured a bias towards land saving technologies. Labor saving technologies have also received considerable interest. Least served has been the supply of capital saving technologies.

Recently the IGP has seen a surge in interest in resource conserving technologies that reduce input use per unit of output, but the main thrust behind their development was resource conservation and to a lesser extent cost savings ({Laxmi, 2007 LAXMI2007B /id}{Erenstein, 2008 ERENSTEIN2008C /id}). Within the IGP (and India), capital scarce production systems have long suffered from a relative neglect from policy and research. National food security concerns have led to long standing support for rice and wheat, particularly in the capital abundant NW IGP. The national agricultural research system is typically also strongest in the NW IGP. However, the land and labor saving technologies developed for the capital abundant NW are not necessarily appropriate for less capital abundant regions. Yet the technologies emerging from the NW typically set the scene in terms of the perceived ideal and stereotype modern Indian agriculture.  The present paper suggests that more attention needs to be given to local adaptation instead of simply transferring 'capital-biased' technologies. In this respect it is interesting to note the many similarities between West Bengal and Bangladesh and the potential cross-border lessons these offer. For instance, Bangladesh has had considerable success with micro-credit and

two-wheel tractors – the latter being more appropriate for the small farms and plots and less capital intensive than four-wheel tractors.

At the same time technology supply can not be a panacea. There is a major complementary role for appropriate and integrated policy/institutions, both in the agricultural and non-agricultural sphere. The various IGP sites would benefit from a more enabling environment for overall economic and human development. This includes enhancing the human capital base and skills through better basic education and stimulating the economic growth of the secondary and tertiary sectors to absorb surplus labor from the primary sector and the rural landless. Equity also merits more active policy consideration. The rural society in the IGP is marked by social contrasts (gender, caste, class) and these have often been further consolidated by the past agricultural developments. Interregional equity considerations could imply shifting some of the cereal procurement and institutional support further downstream. In the end, inequity is also likely to have slowed down economic growth (World Bank, 2005).

## 6    Conclusion

The Indian IGP presents marked gradients in land, labor and capital scarcities. The agricultural R&D community there could become more effective by more actively aligning innovation supply with the resource scarcities that farmers actually face. This calls for rethinking some of the stereotypes and flags the danger of generalizations. Agricultural innovations emerging from the relatively capital abundant North-Western IGP are unlikely to be directly adequate for the capital scarce, densely populated Eastern

IGP, and vice versa. This calls for more investment in adaptive agricultural research to develop innovations in line with the prevailing resource scarcities, which will likely help to reinvigorate cereal productivity growth in a more equitable and sustainable manner in SA's cereal basket.

## References

Boserup, E., 1965. The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure. Aldine, Chicago.

Debroy, B., Bhandari, L., 2003. District-level Deprivation in the New Millennium. Konark Publishers, New Delhi.

Erenstein, O., 2006. Intensification or extensification? Factors affecting technology use in peri-urban lowlands along an agro-ecological gradient in West Africa. Agr. Syst., 90 (1-3) 132-158.

Erenstein, O., Hellin, J., Chandna, P., 2007a. Livelihoods, poverty and targeting in the Indo-Gangetic Plains: a spatial mapping approach. Research Report. CIMMYT & RWC, New Delhi, India.

Erenstein, O., Hellin, J., Chandna, P., 2009. Poverty mapping based on livelihood assets: A meso-level application in the Indo-Gangetic Plains, India. Applied Geography, in press .

Erenstein, O., Malik, R.K., Singh, S., 2007b. Adoption and impacts of zero tillage in the irrigated rice-wheat systems of Haryana, India. Research Report. CIMMYT/RWC, New Delhi, India.

Erenstein, O., Thorpe, W., Singh, J., Varma, A., 2007c. Crop-livestock interactions and livelihoods in the Indo-Gangetic Plains, India: A regional synthesis. Crop-livestock Interactions Scoping Study - Synthesis. CIMMYT-ILRI-RWC, New Delhi, India.

Erenstein, O., Thorpe, W., Singh, J., Varma, A., 2007d. Crop-livestock interactions and livelihoods in the Trans-Gangetic Plains, India. Crop-livestock interactions scoping study-Report 1. Research Report 10. ILRI, Nairobi, Kenya.

Evenson, R.E., Gollin, D., 2003. Assessing the impact of the Green Revolution, 1960 to 2000. Science, 300 (2 May 2003) 758-762.

Gill, G.J., Farrington, J., Anderson, E., Luttrell, C., Conway, T., Saxena, N.C., Slater, R., 2003. Food Security and the Millennium Development Goal on Hunger in Asia. Working Paper 231. ODI, London.

Hayami, Y., Ruttan, V.W., 1985. Agricultural development: An international perspective. John Hopkins Press Ltd, Maryland.

Lipton, M., Longhurst, R., 1989. New Seeds and Poor People. Unwin Hyman, London.

Moll, H.A.J., 2005. Costs and benefits of livestock systems and the role of market and nonmarket relationships. Agricultural Economics, 32 181-193.

Ruthenberg, H., 1980. Farming systems in the tropics. Clarendon press, Oxford.

Singh, J., Erenstein, O., Thorpe, W., Varma, A., 2007. Crop-livestock interactions and livelihoods in the Gangetic plains of Uttar Pradesh, India. Crop-livestock Interactions Scoping Study-Report 2. Research Report 11. ILRI, Nairobi, Kenya.

Thorpe, W., Erenstein, O., Singh, J., Varma, A., 2007. Crop-livestock interactions and livelihoods in the Gangetic plains of Bihar, India. Crop-livestock Interactions Scoping Study - Report 3. Research Report 12. ILRI, Nairobi, Kenya.

Timsina, J., Connor, D.J., 2001. Productivity and management of rice-wheat cropping systems: issues and challenges. Field Crop Res., 69 (2) 93-132.

Varma, A., Erenstein, O., Thorpe, W., Singh, J., 2007. Crop-livestock interactions and livelihoods in the Gangetic plains of West Bengal, India. Crop-livestock Interactions Scoping Study-Report 4. Research Report 13. ILRI, Nairobi, Kenya.

World Bank, 2005. Equity and development. World development report 2006. Oxford University Press, Oxford.

World Bank, 2007. Agriculture for development. World Development Report 2008. World Bank, Washington DC.

**Table 1    Socio-economic indicators IGP States (state average)**

|  | Punjab | Haryana | UP | Bihar | W Bengal | All India |
|---|---|---|---|---|---|---|
| Population density (km$^{-2}$) | 484 | 478 | 690 | 881 | 903 | 325 |
| Farm size (ha) | 4.03 | 2.32 | 0.83 | 0.58 | 0.82 | 1.41 |
| Rural population below poverty line (% BPL) | 6.4 | 8.3 | 31.2 | 44.3 | 31.9 | 27.1 |

Source: Compiled from various secondary data sources as cited in Erenstein et al., 2007c.

**Table 2    Agricultural indicators (state average)**

|  | Punjab | Haryana | UP | Bihar | W Bengal | All India |
|---|---|---|---|---|---|---|
| Tractor density (per cultivated km$^2$) | 10.4 | 9.4 | 3.8 | 1.4 | 0.6 | 2.2 |
| Area irrigated (%) | 95 | 84 | 73 | 49 | 44 | 39 |
| Fertilizer use (kg/ha) | 184 | 167 | 127 | 81 | 122 | 90 |
| Wheat yield (t/ha) | 4.2 | 3.9 | 2.6 | 1.7 | 2.2 | 2.6 |
| Paddy yield (t/ha) | 3.8 | 2.9 | 2.0 | 1.1 | 2.5 | 2.1 |
| Wheat marketed (%) | 80 | 78 | 58 | 67 | - | 67 |
| Paddy marketed (%) | 96 | 91 | 74 | 68 | 55 | 70 |

Yields for Triennium ending 2005-06. Source: Compiled from various secondary data sources as cited in Erenstein et al., 2007c.
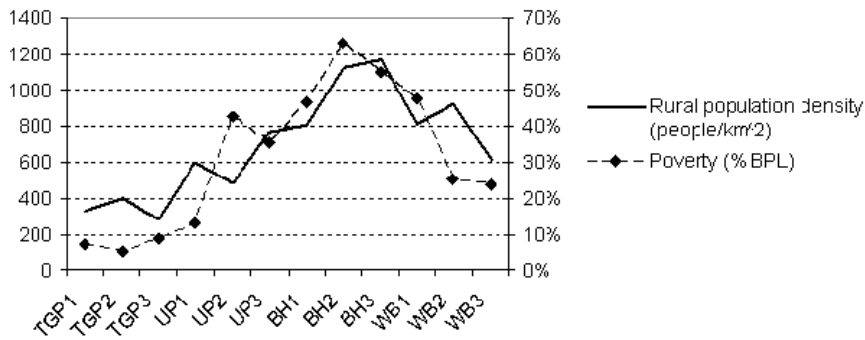
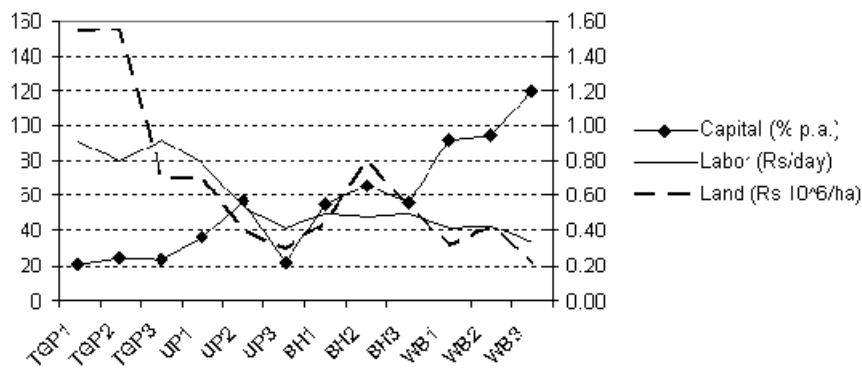**Figure 1    Poverty vs population density in IGP study districts (district level data)**



**Figure 2    Factor prices in IGP study sites (village survey, capital & labor left Y-axis, land right Y-axis)**



**Figure 3    Tractor density vs inverse capital price in IGP study sites (village survey data)**
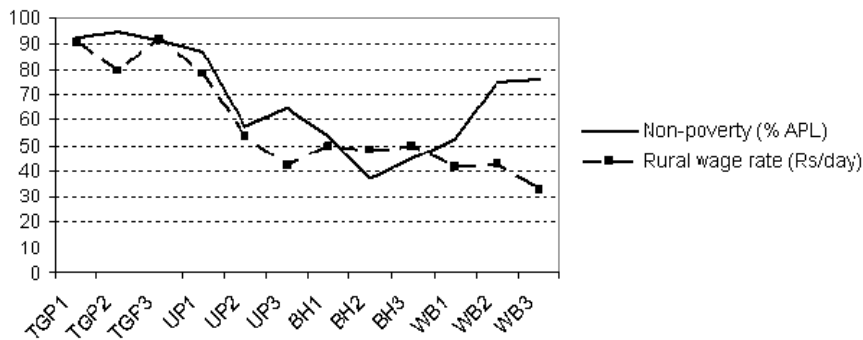
**Figure 4    Non-poverty (district level) vs wage rate (village level) in IGP study sites**
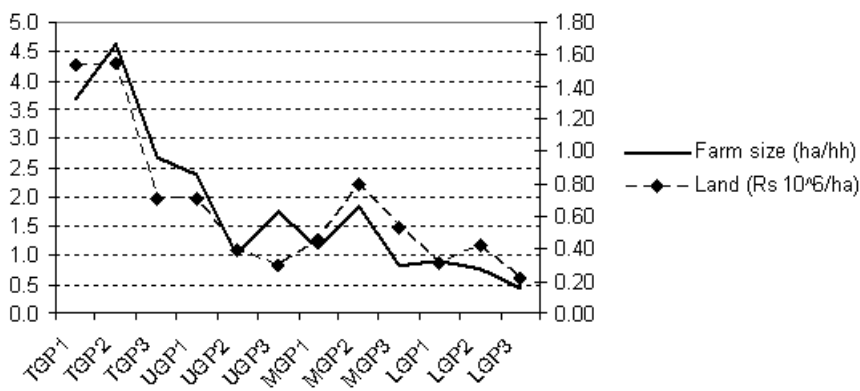


**Figure 5    Farm size vs land price in IGP study sites (village survey data, farm size left Y-axis, land right Y-axis)**
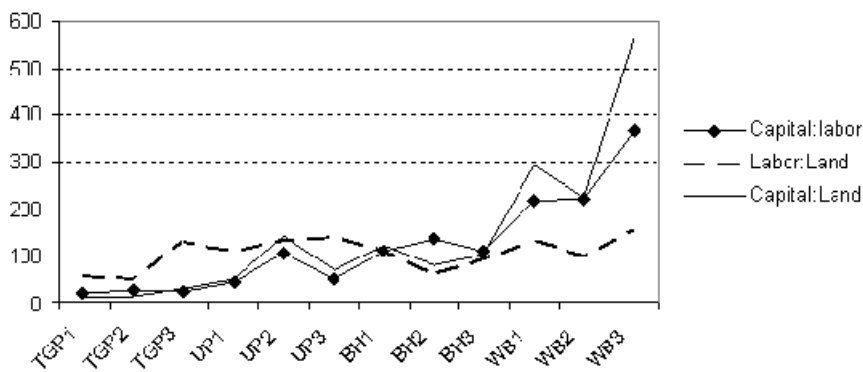


**Figure 6    Factor price ratios in IGP study sites (village survey data)**