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NEW TECHNOLOGY DIFFUSION AND INDUCEMENTS TO INSTITUTIONAL INNOVATION IN LAND TENANCY AND LABOR CONTRACT SYSTEMS IN AGRARIAN BANGLADESH*)

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Abstract

In recent years, privatization and liberalization in agricultural input markets in Bangladesh, as well as improvements from the adoption of new technology and cropping systems, have occured in areas with year-round access to water for irrigation. This case study was conducted on two typical Bangladesh villages to determine how technological change induces institutional innovation in land and labor contract markets. The results show that the series of changes in land and labor contractual arrangement that becomes irrigated agriculture is more profitable with imperfect informal credit and a hired labor market.

1. Introduction

Among less developed countries, Bangladesh has been only partially successful in introducing new technology in agriculture. The new technology, relating to land savings and labor usage, has been introduced in packages that include high yielding varieties (HYV), chemical fertilizers and irrigation. While the components of a package are designed to complement each other, some of them can be adopted independently. However, farmers may face many problems in adopting particular technological options to their particular circumstances. The problems arising will vary in different socioeconomic groups and different production environments.

In the agriculture of Bangladesh, from the beginning of the green revolution,

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most of the technologies were highly subsidized and publicly operated. On the advice of the World Bank, subsidy withdrawal and privatization of these technologies (e.g., chemical fertilizer and irrigation equipment technologies) were completed by the end of the 1970s and the mid 1980s, respectively[15]. After the mid 1980s, the expansion of the total irrigation area sharply increased through the diffusion of tubewells (TWs), converting what was fallow land in the dry season (November to March) into fertile paddy fields well suited to seed-fertilizer technology[7]. Rice production under improved seed-fertilizer-water technology is becoming less profitable due to both an increase in the cost of production for withdrawal of subsidies and a decline in rice yields[13]. The national level data shows that although the total rice cropped area and rice irrigated area have increased 10% and 85%, respectively, over 1971-93, the total nonrice crop and nonrice irrigated areas have increased 60% and 40%, respectively. Thus, although the rice cropped area is increasing more slowly than the nonrice, it has seen the bulk of development in irrigation. The rice irrigation area accounts for 83% of the total irrigated area, of which 71% is the total irrigated area for dry season *boro* rice production. The proportion of irrigated area for nonrice production (17%) is almost insignificant[4]. Field level data shows that the declining profitability and expanded area of irrigated rice production have been accompanied by increases in nonrice irrigated area and nonrice cropping system changes. This may influence agrarian institutions, such as land and labor contractual systems, and it may also, in the informal credit market, affect the profitability of different farm categories in that irrigated developed area.

The various technical improvements have helped create more efficient farms of greater profitability, and these income enhancements represent a major incentive for further institutional change[5]. Ruttan and Hayami[16] have recently developed a theory of induced institutional innovation in which technical changes and changes in the relative resource endowments serve to alter the demand for institutional innovation. They drew on historical evidence from England, Japan and Thailand; and on empirical evidence gathered by Kikuchi and Hayami[12] from a village in the Philippines. They draw attention to the effects of both population pressure and irrigation technology on the contractual arrangements in land tenancy and labor contract systems. They do not clearly explain, however, why leasehold contracts are increasingly used for land tenancy, rather than the sharecrop contracts. Nor did they explore the complex connection that exists between land tenancy contracts and the informal credit market in agrarian Bangladesh.

Technological innovations have substantially altered the land rental market in Bangladesh agriculture, particularly with regard to tenure contractual arrangements. For example, in the contractual arrangements for sharecropping, the rental is now a fixed sum and the function of supply and demand has altered. Interest rates in the rural informal credit market play an important role in

changing the land tenancy systems. The labor contractual arrangements also change, from casually hired labor to contractual, piece-rate, or share-crop labor, which results in an imperfect labor market. Although these data from two Bangladesh villages do not suffice for statistical analysis, they do support the modern economic models of the inducements from institutional innovations.

A major purpose of this study is to analyze the mechanism by which technological change both induces institutional innovation and maintains existing contractual arrangements.

2. Issues and Hypotheses

In the mid 1960s, the package of new technologies known as the green revolution was introduced in Bangladesh. Rice in Bangladesh is grown in three distinct seasons: *boro* (January to June), *aus* (April to August), and *amon* (August to December). Modern varieties (MVs) were introduced for the *boro* and *aus* season in 1967 and for the *amon* season in 1970. Unfortunately, the rate of MV adoption has been slow, with the new varieties accounting for only 46% of the present rice cropped area[4]. Their performance has been better in some areas with a more favorable production environment, where cropping systems have been changed to include the profitable nonrice crops with short growth duration of MV rice crop. In unfavorable production environments, however, the progress and diffusion of technology have been slow. Because of the existing topographic and climatic conditions, improvements in technology have resulted in increases in nonrice and vegetable production in areas with well-developed irrigation facilities. The small or tenant farms are trying to increase their incomes by intensifying their production of the higher profit nonrice crops.

Most of the evidence from the early period of the green revolution suggests that the incidence of adoption positively related to farm size, which appears counterintuitive, given the evidence that the new technology is seemingly scale neutral[1].

Fujita, *et al.*[7] explain that the groundwater markets prevail in a monopoly form for water charge and tenure contractual arrangements that are decided on a water market basis, thus resulting in a multiple choice of contracts. This author found that the *Khaikhelasi* (mortgage) system resulted in an informal credit flow from the lower to upper strata in the long term. The yield of investment is about 38-61%, not much lower than the tubewell investment (IRR 69%) of the large farmers, a parity which should encourage the equitable distribution of income[2]. However, he did not emphasis the causes of multiple contract choices in the land tenure institutions.

Hossain[10] found that Bangladesh has maintained its food-population balance in the post independence period (1971-84) mainly through technological progress. He also found that the cost of production for cereals declined 20% while the gross

profit increased by 1.2 times. The sown area for non-cereal crops (excluding rice, wheat, maize and barley) decreased from 22% in 1965-70 to 17% in 1980-85. He suggested that additional support is needed for research to develop suitable varieties of non-cereal to make them competitive with rice and wheat MVs[3]. He also asserted that technological progress stimulates demand for institutional credit with easy terms and conditions for the small farmers, which in turn generates employment for the poor and improves income distribution.

Bouis[6] shows that the rice yield growth rates are declining in Asia and predicts that most Asian countries will experience a doubling of food demand before the end of the second decade of the next century. Given the land con-

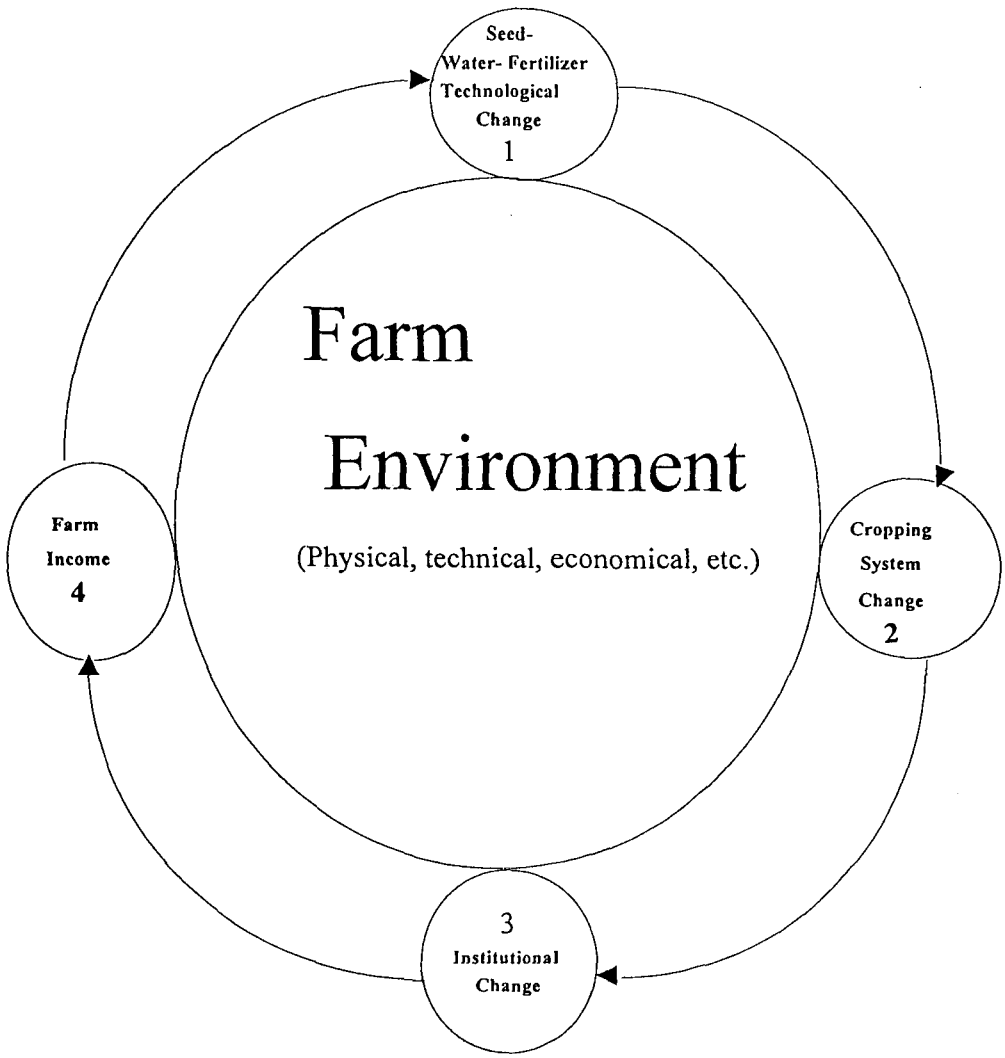


Figure 1. Flow diagram of technological and institutional change in agrarian Bangladesh.

straints in Asia, he suggests that rice prices will rise if yield growth rates continue to decline. But Ito, *et al.*[11] empirically show that rice is becoming an inferior good in Asia. Income elasticities declined and sometimes became negative between 1961-85 in most of the 14 Asian countries he studied. Accordingly, domestic demand for rice in these countries is not likely to grow as rapidly as it has in the past. Therefore, there is a potential for excess supplies of rice to develop in Asia, putting downward pressure on rice prices. Ito, *et al.* suggest that it may be more important to shift some land from rice to more profitable crop production as demand begins to level off or decline[4].

It is noteable that almost all of the previous studies recommended crop diversification by shifting land from rice crop to profitable nonrice crops, thereby maintaining growth and equity in irrigated agriculture. But none of them make clear how the diversification should be spread out, or what relative changes it may induce in the agrarian community. In this study, we suggest a detailed model for crop diversification by irrigation and other new technologies, and outline the possible effects of such diversification on agrarian communities. The flow diagram (Figure 1) will provide a better understanding of the technological change and associated techniques that can maximize the income of the farm business by changing the land and labor contractual systems in an agrarian community.

3. Survey Methods and Survey Areas

(a) Survey and Data

Data was collected by sample survey of Chandiara and Jugitala, two typical Bangladesh villages. The two villages were selected based on environment. Both villages are infrastructurally and technologically developed in their respective production environments, though, Chandiara has the more favorable geophysical environment for irrigated agriculture. It is also worth mentioning that Chandiara and Jugitala are geophysically typical of villages in their respective ecological zones. Technologically, both villages are fairly progressive compared to many villages in Bangladesh. Farmers were asked about the historical changes in cropping systems and contractual systems of land tenure institutions. They were also questioned on issues of wage labor and credit management for crop production.

A proportional stratified random sampling technique was followed for the selection of the different categories of tenure systems and farmland. From each village a total of 52 farm households was randomly chosen from a recent "Survey of the Agricultural Block" by the Ministry of Agriculture; thus 104 farm households were interviewed. Employing a direct questionnaire method, data were gathered at the farm level on subjects including socioeconomic factors, farm structure, HYV adoption behavior, crop production management, input-output

data for different crop production, and institutional arrangements regarding the land, labor and credit markets etc. This data was collected by the researcher himself with the aid of a master's student of Agricultural Economics and the respective block supervisors of the Ministry of Agriculture. The field work was conducted from December 1995 to February 1996 and the collected data related mainly to the crop year 1995.

(b) Description of the Study Areas

(i) Geophysical characteristics

Geophysically, Chandiara belongs to Chandina *thana* (a small administrative unit less than district) in the Comilla district. The village is located in a high rainfall zone in a flooded and fertile region of eastern Bangladesh. It experiences an annual average of 2000 millimeters rainfall[4]. The land type is medium - to - medium high and its soil type loamy - to - sandy loam, characteristics highly suitable to the cultivation of any crop. This area generally receives about 30 centimeter of flooding during the monsoon season or sometimes not. High water table, Chandiara has developed a concentration of both shallow tubewells (STWs) and deep tubewells (DTWs) to allow irrigation year-round.

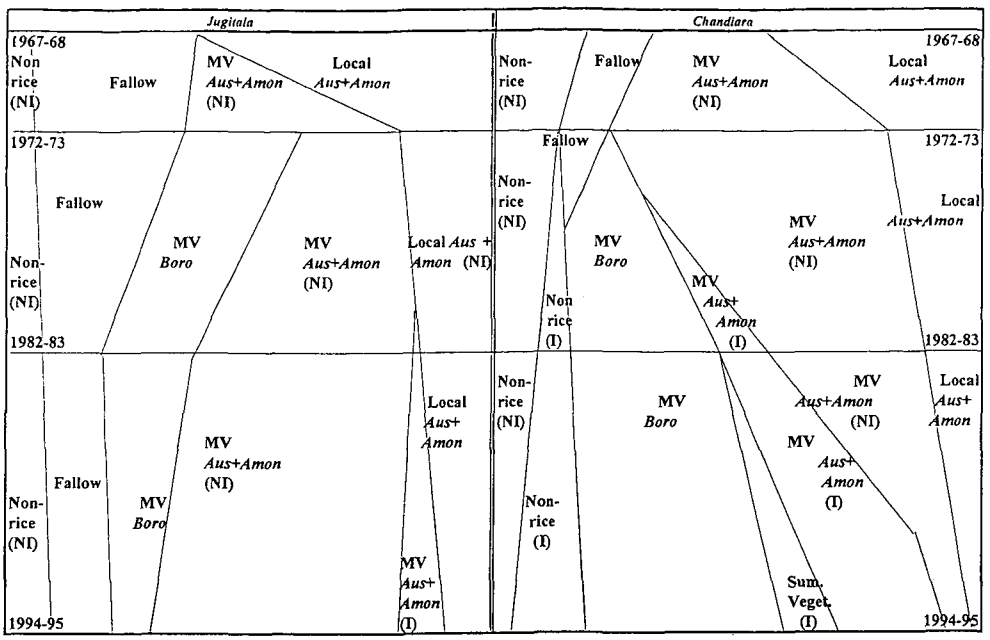
Jugitala is a village of Gazipur *thana* in the Gazipur district, and it has a combination of flat and broken topography. Its land type is medium high - to - high and its soil type clay loam - to - sandy clay loam, and it has higher seepage and percolation rates that are suitable for irrigated rice cultivation. Because of Jugitala's low water tables, only a few DTWs have been developed for irrigation in the dry season, and these only for *boro* rice cultivation.

Apart from differences in geophysical characteristics, both of the areas differ significantly from one another in terms of (a) patterns of land ownership and distribution; (b) intensity of irrigation; (c) cropping patterns; (d) incidence of landless; and (e) differential institutional arrangements[1].

(ii) Changes in land use and cropping system

Diversification of cropping systems was observed in the favorable production environment in Chandiara. From an agronomic point of view, the cropping system is quite favorable for all kinds of crops, including vegetables and cash crops, due to availability of irrigation water year-round (Figure 2). If irrigation facilities could be provided, year-round, to enhance Jugitala's unfavorable prduction environments, it might be possible to intensify rice cropping and cultivate a small amount of nonrice crop. The factors affecting the diversification of crops are the land and soil type. Chandiara's higher cropping intensity nearly twice that of Jugitala's, pays a higher farm income to the tenants and helps maximize the already substantial income from using family labor and rented land.

Figure 2 shows changes in land use and in the cropping systems. In Jugitala, before the introduction of new technology, almost all of the land was fallow in the dry season. Some land was cultivated with MV in *aus* and *amon* paddy under rainy conditions in the wet season (April to October). In the dry season, it is not



Note: MV = Modern variety, I = Irrigated, NI = Non-irrigated.

Figure 2. Historical Change in the land use and cropping systems in the study villages.

possible to cultivate MV rice and vegetables without irrigation. In the early 1970s, when three DTW were installed in Jugitala with government support, some fallow land was cultivated under modern seed-fertilizer-water technology and improved cultural practices. But after the mid 1980s, with the privatization of DTWs, and the trade liberalization in agricultural input market, the rice area decreased slightly in the dry season due to the high cost of irrigation water to the small and tenant farms. However, the MV rice area increased in the wet season without irrigation, while the owners of private DTWs only introduced irrigation to the wet season rice crop for timely planting. Traditional irrigation for family consumption accounted for an insignificant proportion of nonrice and vegetable crop areas cultivated in the dry season.

The cropping systems differ in Chandiara, although there was a similarity at the initial stage of the green revolution. In the early years of the new technology, irrigation was used mainly for dry season rice. Within a few years, Chandiara's water market had improved due to a favorable water table, and the government policy changes of the mid 80s with respect to agricultural input markets. These policy changes induced the installation of several STWs by the large and innovative farmers, as well the dedication of a limited amount of area for nonrice crops, in co-existence with the shorter plantings of MV rice crops in the dry season. Some land was also devoted to nonrice crops in the wet season,

especially to more profitable summer vegetables. Previously most farmers produced MV *aus* and *amon* rice in the wet season under mostly rainy conditions. Irrigation, while increasing such production, has also increased production in the dry season, for a combined historical change in the cropping intensity area in Bangladesh.

In Jugitala, some fallow land was replaced by MV *boro* rice in the dry season, and in the wet season local *aus* and *amon* were replaced by MV *aus* and *amon* rice. The high land is still fallow in the dry season.

In Chandiara, all of the fallow land in the dry season was replaced by irrigated *boro* rice, and the wheat area was partially replaced by vegetables. Local potato land was replaced by HYV potato and oilseeds, and non-irrigated vegetables were replaced by potato/wheat and irrigated vegetables. A new summer vegetable was planted instead of jute and the non-irrigated local rice in the wet season was replaced by MV rice under mostly irrigated and some nonirrigated condition.

Thus, the pressure of new technology that changed the cropping systems in the study villages, also affects the demand for land, labor and credit that may change the land and labor contractual systems.

4. Empirical Results and Discussion

(a) The logic of Tenancy Choice: Emergence of Sub-tenancy Systems

As in other developing countries, land is a basic indicator of the socio-economic status of rural households in Bangladesh. Among farm households sampled in Chandiara, approximately 54% were tenant and 23% rented of total cultivated land, whereas in Jugitala the percentage were 44% and 17%, respec-

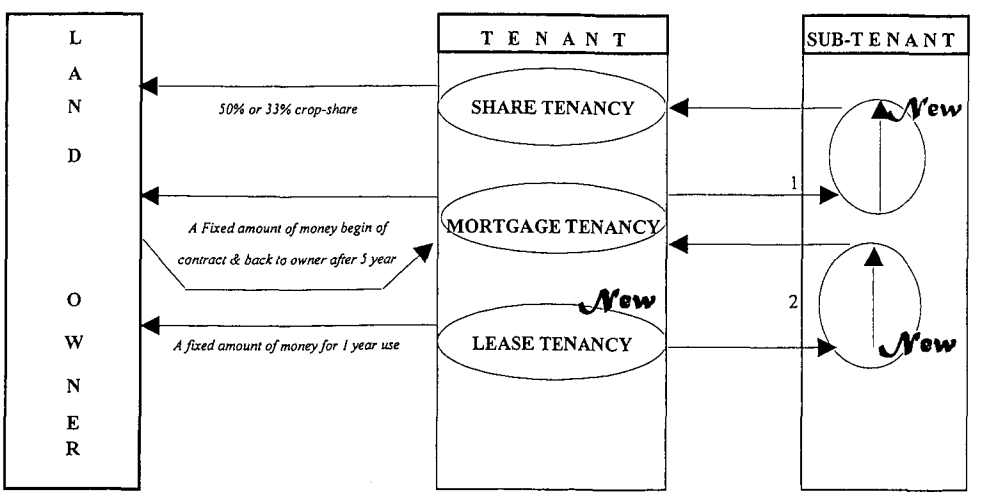


Figure 3. Flow diagram of land tenancy contracts in the study villages.

Table 1. Distribution of farm land and farm operators of the sample households by tenurial status in the study villages

Area	Owner cultivation	Tenant cultivation					Total
		Lease tenancy	Share tenancy	Mortgage tenancy	Sub-lease tenancy	Sub-total	
Chandiara							
No. of plots	276	10	24	24	13	71	347
(%)	(79)	(3)	(7)	(7)	(4)	(21)	(100)
Land area(ha)	26.38	0.86	2.23	3.05	1.66	7.8	34.16
(%)	(77)	(3)	(6)	(9)	(5)	(23)	(100)
No. of farm operator	45*	7	14	10	9	28**	52***
(%)	(86)	(13)	(27)	(19)	(17)	(54)	(100)
Jugitala							
No. of plots	268	0	44	10	0	54	322
(%)	(83)	0	(14)	(3)	0	(17)	(100)
Land area(ha)	36.52	0	6.54	0.75	0	7.29	43.81
(%)	(83)	0	(15)	(2)	0	(17)	(100)
No. of farm operator	42*	0	19	7	0	23**	52***
(%)	(80)	0	(37)	(13)	0	(44)	(100)

Source : Field Survery, 1995

Notes :

*Includes owner-tenant operators.

**The nunbers of tenants in different tenure class do not added because some tenants cultivate different plots under different tenancy contracts.

***The nunbers of owner and tenant-operators do not added up to the total because some operators cultivate both owned and rented plots.

tively (Table 1). Figure 3 shows the existing land tenancy contracts in the studied villages. Traditionally, share tenancy[5] was the most common type of tenancy contract in Bangladesh, just as it was in our study areas. According to Yokoyama[18], in Indonesia, when agriculture moved in the direction of a cash economy and became commercialized, a shift from share - to cash - based fixed tenancy contracts occurred. In our study villages, it was found that about 90% of total rented land was under share tenancy in Jugitala, against only 29% of rented land in Chandiara. In Jugitala, apart from share tenancy, only 10% of total rented land was mortgage tenancy[6], compared with around 40% in Chandiara, where the cropping intensity is almost two times higher than Jugitala. This type of tenancy contract mostly derived from demand for informal credit for profitable cash crop production, such as potatoes and other vegetables, or agribusiness or set up capital inputs. Many farmers enjoying this contract in

Chandiara used the informal credit to send their sons overseas to work. However, lease tenancy[7], another form of contract, (11% of rented land) began 15 years ago in Chandiara, when the development of new technology adopted an increasing rate in agricultural production, however, the former two contracts are traditionally arranged in both villages. Sublease tenancy[8], a new form of tenancy contract that started illegally about 10 years ago during a similar increase in irrigation and cropping intensity, was found to involve 21% of total rented land in the sample households in Chandiara.

It may be expected that the higher cropping intensity, due to the adoption of new technology, would have increased the economic rent of land. However, partly because of social interaction within the closed community and partly because of land reform regulations, it is difficult for landowners in a tenancy contract. The crop shares shifted from 50 : 50 to 33 : 67 between landowner and tenant for nonrice crops except potato, 80 kg of potato per *gonda* was fixed in Chandiara. The logic may be that, although the share of output decreased, the rent paid was higher than previously when mainly traditional technologies were used. It is difficult to say conclusively, given the lack of data for traditional practices in these regions. On the other hand, the reason may be that vegetable and nonrice profitable crops are more risky in terms of weather, available technology and current input use, which could cause a risk-aversive landlord to reduce his sharecropping, and end in a fixed sum for the potato.

(i) Comparison of production and tenancy form

Traditionally it is assumed that under the sharecropping system, the marginal remuneration for the tenant farmer is only a part of the total marginal production of labor, and thus the tenant farmers are discouraged from contributing labor, resulting in an excessively small input of labor in Jugitala. This may be the cause of the so called "Marshallian inefficiency" of labor. But the empirical data did not support the presence of inefficiency in the share tenancy system in Chandiara with respect to yield level or the volume of input materials and labor for individual crop where it is possible to choose between share tenancy and lease tenancy. Moreover, a few studies show that if there is no cost for supervision included in the contract, no inefficiency occurs[9] in the variety of share tenancy for the individual crop prevailing in Chandiara.

It follows from these studies that if both the share and lease tenancy contract systems are present, and there is no difference between them with regard to input and output structure, the latter system, the lease tenancy, will be chosen in Chandiara.

Kikuchi, *et al.*[12] hypothesize that the gap between the economic rent accruing for the service of land and the actual rent paid to landlords widened in direct relation to the growing population pressure and potential cropping intensity. Given the institutional rigidity of the land rental market, this gap provided an opportunity for leasehold tenants to transform themselves into intermediate

landlords.

This study will verify Kikuchi's hypothesis using farm level data from Bangladesh. Because in Bangladesh farmers maximize their incomes by producing a variety of crops, it would be misrepresentative to consider a single crop. For example, in this study the costs and returns of cultivated crops were estimated for the 1995 crop calendar year for different tenure types. Results of individual crops[10] show that the operators' surplus of any rice crop was lowest in both areas and losses were found in share tenancy in Chandiara and for irrigated *boro* rice in Jugitala. But in Chandiara both *aus* and *amon* are irrigated, this requiring more fertilizer and labor. An unfavorable crop sharing to the share tenancy resulted in losses, although there was still a surplus gain for non-irrigated *aus* and *amon* but not for irrigated *boro* rice in Jugitala. Due to this trend, share tenants in Jugitala did not adopt modern rice variety for the *boro* season, and the land became almost fallow in this season. Although there is no vast scope for cultivation of nonrice crops due to lack of irrigation facilities and physical environmental constraints in Jugitala, but a share tenant produced wheat in a plot but produced no surplus; however surplus results prevailed in Chandiara which encouraged share tenants to produce nonrice crops. In Chandiara, any kind of nonrice crop other than jute is more profitable than rice. Agronomically, this village is famous for vegetable production, and almost all of the farms allocate a portion of their land to vegetables once or twice a year. Vegetable production involves a significant amount of labor and cash capital for current inputs. Share tenants, often having inadequate cash capital (although this is eased by frequent harvest of cash crops, apart from wage income and the informal credit market), produce a demand for changes to contractual arrangements from 50 : 50 share to 33 : 67 crop share or input shared by landlord caused cash fixed tenancy (lease or mortgage) while for landowners, inadequate labor supply and a risk involved for sensitive weather resulted in pressure for changes of contractual arrangements from cropshare to fixed kind share (for potato) or cash fixed tenancy. Due to changes in tenancy contracts, the operators' surplus for nonrice crop cultivation becomes higher in any contractual arrangement but continues to be lower in share tenancy. Lease or mortgage tenants obtain a small amount of surplus for rice crops, but much less than that from nonrice cultivation of such crops as vegetables and potatoes. Generally with aggregate crops, the share to land rent was the lowest and the operators' surplus highest for lease tenancy, which was followed by mortgage tenancy, where a substantial portion of economic rent was contributed (Table 2). This induced the lease tenant or mortgage tenant (here sublessor) to further rent out the leased land to some innovative farmer (sublessee). It was found that the land rent of the sublessee was very close to the sum of the land rent and the operators' surplus for the lease tenant (sublessor), although the surplus of the sublessee was very small. Thus, the sublessee would be directed to choose the most profitable cropping pattern.

Table 2. Aggregate costs and returns of the cultivated crops for a year based on land tenure status in the sample households

Costs/returns	Factor payments in Taka# per hectare per year					Factor share in per cent				
	Owner cultivation	Share tenancy	Lease tenancy	Mortgage tenancy	Sub-tenancy	Owner cultivation	Share tenancy	Lease tenancy	Mortgage tenancy	Sub-tenancy
Chandiara										
Output (1)	127,044	135,096	172,540	139,342	126,365	100.00	100.00	100.00	100.00	100.00
Current inputs (2)	33,493	25,777	36,215	31,169	30,134	26.36	19.08	20.99	22.37	23.85
Capital inputs (3)	14,454	16,405	22,511	15,734	16,623	11.38	12.14	13.05	11.29	13.15
Labour cost (4)	25,483	24,460	38,176	27,014	27,743	20.06	18.11	22.13	20.00	21.95
Land rent to: (5)	NA	49,955	25,000	25,000	44,850	NA	36.99	14.32	18.00	35.49
Landlord	NA	49,955	25,000	25,000**	25,000+	NA	36.99	14.32	18.00	22.87+
Sub-lessor	NA	NA	NA	NA	44,850	NA	NA	NA	NA	35.49
Total cost (6=2+3+4+5)	73,430	116,601	121,902	98,917	119,350	nn	nn	nn	nn	nn
Operator surplus (7=1−6)	53,614	18,495	50,638	40,425	7,015	42.20	13.69	29.52	29.00	5.56
Jugitala										
Output (1)	61,861	58,138	NF	40,214	NF	100.00	100.00	NF	100.00	NF
Current inputs (2)	9,610	7,634	NF	5,374	NF	15.54	13.13	NF	13.37	NF
Capital inputs (3)	6,792	6,866	NF	5,871	NF	10.98	11.81	NF	14.60	NF
Labour cost (4)	14,990	14,822	NF	9,220	NF	24.23	25.50	NF	22.93	NF
Land rent to : (5)	NA	24,253*	NF	24,253	NF	NA	41.72	NF	60.00	NF
Landlord	NA	24,253	NF	24,253$	NF	NA	4.72	NF	60.00	NF
Sub-lessor	NA	NA	NF	NA	NF	NA	NA	NF	NA	NF
Total cost (6=2+3+4+5)	31,393	53,576	NF	44,718	NF	nn	nn	nn	nn	nn
Operator surplus (7=1−6)	30,467	4,562	NF	−4,504	NF	45.34	7.84	NF	−11.00	NF

Source : Calculated from Field data, 1995

Note :

+Not included because it is not paid by the sub-tenant.

NA is not appropriate, nn is no need and NF is not found.

#Taka 40.00=1 U.S. Dollar.

*after deduction of 10% harvested crop and 50% of current input cost.

**consider the same opportunity with lease contract.

$ consider the same opportunity with share contract.

(ii) Profitability of cropping systems and tenancy form

The previous discussions might have raised the question of how the share tenant and sub tenant would choose the most profitable crops. This question is investigated in the following section. A farmer in either of the study villages has many choices of cropping pattern. On the other hand, there are limitations on the choice of contractual arrangements. If a landless farmer is not involved in any tenancy contract, he can save his labor and sell it to the hired labor market. The hired labor market is seasonal; it is possible to be unemployed over some periods. Here, the farmer has the opportunity to seasonally migrate to other areas. But his migration may be expensive. In Chandiara, for example, the migration cost is higher because of the great distance to the nearest city, which could account for higher incidence of land tenancy. For example, in this village almost all the landless laborers in our sample households were engaged in tenancy contracts. Thus, there is a higher demand for rented land. The marketable supply of land is limited. In Chandiara, in terms of profitability of farms, the lease tenancy is attractive to the tenant, whereas in Jugitala the share tenancy is preferred (Table 3). It was found that 40% of the rented land under sample households in Chandiara was operated by mortgage and 11% by lease tenancy, versus only 10% and 0% in Jugitala.

There are five major cropping patterns in Chandiara, and only three in Jugitala (Table 3). *Boro-aus-amon* cropping pattern that covered 8% of the total cropped area in Chandiara was less profitable for all types of tenure except share tenacy, which was found loss. In Jugitala, conversely *boro-aus-amon* is the most profitable pattern for all types of tenure except share tenancy, which profits most from the *fallow-aus-amon* pattern. This may represent an economic factor that mitigates against the introduction of irrigated *boro* crops in the share land of Jugitala (irrigation, of course, is also an important technical factor). The potato-*boro*-vegetables-*amon* pattern in Chandiara is always optimal for all tenancy types, but this does not mean that all land will be allocated in this pattern. Here we lack sufficient data on land allocation for each cropping pattern for each tenancy. That is, the exact profitability for each tenure category cannot be conclusively derived from our average percentages for each pattern for each village. Even considering the existing pattern at the village level, a surplus can be found in each category of tenancy, even in sublease tenancy. However, lease tenancy showed a higher surplus than share tenancy, and the very small surplus for the sublease tenancy is rendered insignificant by the idle family labor and resource use by the subtenant. The higher surplus of lease tenancy induced sublease tenancy in Chandiara. In Jugitala, however, share tenancy was more profitable for all cropping ptterns than mortgage tenancy, and consequently occured more often.

Table 3. Farm profitability in agriculture of the study villages based on tenure systems

(Taka per hectare)

Cropping Pattern	% of cropped area in village	Own land	Share land		Lease land		Mortgage land		Sub-tenancy	
		Net surplus	Net surplus	Land rent	Net surplus	Land rent	Net surplus	Land rent	Net surplus	Land rent
Chandiara										
Potato-*Boro*-*Aus*-*Amon*	45	50,481	11,868	43,763	66,045	25,000	19,839	25,000	17,283	30,851
Vegetables-*Aus*-*Amon*	11	18,033	14,160	23,670	14,486	25,000	10,038	25,000	−70	34,892
Boro-*Aus*-*Amon*	8	23,920	−3,873	35,904	28,296	25,000	35,803	25,000	9,378	23,261
Potato-*Boro*-Vegetables-*Amon*	21	46,282	19,058	40,060	65,242	25,000	58,434	25,000	6,513	42,912
Wheat-Vegetables-*Aus*-*Amon*	15	18,863	NF	NF	31,253	25,000	NF	NF	12,448	35,870
Jugitala										
Boro-*Aus*-*Amon*	35	30,423	4,775	24,082	na	na	15,492	24,253	na	na
Fallow-*Aus*-*Amon*	60	21,630	5,730	17,423	na	na	−10,287	24,253	na	na
Wheat-*Aus*-*Amon*	5	21,674	5,513	17,594	na	na	na	na	na	na

Source : Calculated from Field data, 1995

Note :

na is not appropriate.

NF is not found.

(iii) Nominal rents and tenancy form

The land rent for share tenancy derives from the output share of landlords excluding their input share. In both villages, the land rent paid for share tenancy was higher than for lease tenancy, and that rent was about two times higher in Chandiara than the Jugitala due to higher cropping intensity (Table 4). The rent for mortgaged tenancy is derived from the opportune cost of the informal credit interest rate, which in turn is based on the annual income from mortgaged land in the form of lease rent paid to the landlords. The lease tenancy is the amount of money paid to the landlord for one year as a service charge for land use. In principal, both types of leaseholders probably enjoy the same interest from the rented land1[18]. In Jugitala, land rent for mortgage tenancy is derived from the opportunity cost of the rent from share tenancy. From the point of view of a landlord in Jugitala, there is no option but mortgage tenancy, while tenant prefer share tenancy for its higher surplus. In Chandiara, the lease tenancy contract draws less interest, and the landlords prefer share tenancy, from which they derive their highest rent. Ultimately, though, the decision of cropping choice remains with the tenant, and the landlord cannot know what cropping pattern will

Table 4. Comparison of rents based on tenancy from in the study villages, 1995

	Chandiara	Jugitala
Nominal land rent (Taka/year/ha)		
Share tenancy	49,955	24,253
Lease tenancy	25,000	n.a
Motgage tenancy	25,000*	24,253**
Sub-lease tenancy	44,850	n.a
Rate of return of tenancy market (%/year)		
Landlord Vs. Mortgage/Lease tenant	13.50[1]	19.64[2]
Mortgage tenant Vs. Landlord[3]	35.32	15.99
Lease tenant Vs. Mortgage tenant[4]	13.50	n.a
Mortgage tenant Vs. Share tenant[5]	24.21	19.64
Present value of the rent under share tenancy[6](Taka/year)	40,520	23,180

Source : Compiled from Table 3

Notes : n.a is not appropriate.

*Actaully there is no annual rent for the mortgage tenancy but the lease and mortgage tenancy enjoy the same interest in the rented land in Chandiara, thus substitued that rent to make comparison.

**Actaully there is no annual rent for the mortgage tenancy but the lease and share tenancy enjoy the same interest in the rented land in Jugitala, thus substitued that rent to make comparison.

(1) The formula used for estimated the rate of return of the landlord those who mortgage-out their land instead of lease contract in the following way :

$$M-\frac{M}{(1+i)^5}=L\sum_{n=1}^{5}\frac{1}{(1+i)^n}$$

where ; M is the total mortgage amount of money received by the landlord in the begining of the

contract, and L is the amount of money received every year by the landlord giving an amount of same quality land by lease tenancy. The n represent the number of year, here the average mortgage contract is 5 year.

(2) The rate of return of the landlord those who mortgage-out their land instead of share tenancy contract is estimated in the following way :

$$M-\frac{M}{(1+i)^5}=M_{st}\sum_{n=1}^{5}\frac{1}{(1+i)^n}$$

where ; M is the total mortgage amount of money received by the landlord in the begining of the contract, and M_{st} is the value of output received every year by the landlord giving an amount of same quality land by share tenancy, given within the five years the cropping pattern and production are same. The n represent the number of year, here the average mortgage contract is 5 year.

(3) The estimated rate of return of the mortgage tenant those who mortgage-in land from the landlord and cultivated by themself in the following way :

$$M-\frac{M}{(1+i)^5}=S_{st}\sum_{n=1}^{5}\frac{1}{(1+i)^n}$$

where ; M is the total mortgage amount of money paid by the tenant to landlord in the begining of the contract, and S_{st} is the value of output received every year by the tenant self cultivation of that same quality land, given within the five years the cropping pattern and production are same. The n represent the number of year, here the average mortgage contract is 5 year.

(4) The formula used for estimated the rate of return of the lease tenant those who mortgage-in land from landlord and again sublease the same to a sub-tenant as a mortgage contract basis :

$$M-\frac{M}{(1+i)^5}=L\sum_{n=1}^{5}\frac{1}{(1+i)^n}$$

where ; L is the amount of money paid by lease tenant to the landlord every year, M is the mortgage amount of money received by the lease tenant from the sub-tenant in the begining of the mortgage contract for that same quality land. The n represent the number of year, here the average mortgage contract is 5 year.

(5) The estimated rate of return of the mortgage tenant those who mortgage-in land from the landlord and share-out that same quality land to another sub-tenant as share contract instead of cultivation by themself :

$$M-\frac{M}{(1+i)^5}=S_{st}\sum_{n=1}^{5}\frac{1}{(1+i)^n}$$

where ; M is the total mortgage amount of money paid to the landlord in the begining of the contract, and S_{st} is the value of output received every year by the mortgage tenant from the sub tenant, given, within the five years the cropping pattern and production are same. The n represent the average number of mortgage contract year is 5 year.

(6) The present value of the rent under share tenancy in the following way :

$$R_m=\sum\left\{L_o(1-H_{irj})\frac{Y_{rj}}{(1+i)^{P_j}}-L_{ij}\frac{C_{rj}}{(1+i)^{P_j}}\right\}+\sum\left\{L_o(1-H_{inrk})\frac{Y_{nrk}}{(1+i)^{qk}}-L_{ik}\frac{C_{nrk}}{(1+i)^{qk}}\right\}$$

Where, R_m=Present value of the share rent, Y_{rj}=Output of the j-th rice ; (j=1,2,3), Y_{nrk}=Output of the k-th non-rice (k=1,2,3), C_{rj}=Current input for j-th rice, C_{nrk}=Current input for k-th nonrice, L_o=Rate of rent (landlords share after deduction of the share for harvest labour), L_{ij}=Landlords sahre of j-th rice current input, L_{ik}=Landlords share of k-th nonrice crop, H_{irj}=Rate of share of harvest labor for j-th rice, H_{inrk}=Rate of share of havest labor for k-th nonrice, i=Interest rate, P_j=Period for j-th rice cultivation, qk=Period for k-th nonrice cultivation. The values of the respective crops are included in Appendix Table 1.

be selected. If a landlord wants to dictate cropping choice, it may not be possible to use the land more than three times a year. Further, because the tenant's cropping intensity will be higher under such a scenario, the land rent will be about 25% less than potential. If a tenant is forced to choose the *boro-aus-amon* pattern, it will be less profitable for him than other cropping patterns. Even if the landlord obliges him to chooses the *boro-aus-amon* pattern, the tenant will suffer a loss. The tenant will specifically choose the most profitable cropping patterns, possibly nonrice crops and vegetables, based on his economic and resource constraints. The nonrice crops and vegetables are more sensitive to climate, weather, chemicals and fertilizer application. However, the tenant sometimes under reported the actual production and the daily monitoring of harvested vegetables was problemetic and tiring, and this might have reduced the nominal rent to landlord. Yokoyama[18] corroborates this result. In light of these reports, landlords may find lease and mortgage tenancies more attractive, since under these plans rent is received before cultivation. Here, in terms of land rent, the tenants have the option of choosing the lease or mortgage tenancy contract. But if they are not viable to select the best cropping pattern under available resource constraints, the surplus of the lease or mortgage tenancy will decrease. In this case, they have another option to lease out further to a sublessee that can easily obtain a rent as a sublessor equivalent to the rent of share land.

The landlord must also consider what payment sharecropper will receive after each harvesting. So the total rent of share land would be discounted following the formula of Yokoyama[18]: the present value[11] of rent under share tenancy in Chandiara is Taka (TK.) 40,520 (TK. 40=1 US dollar in 1995) per ha, substantially higher than that of TK. 25,000, the land rent under lease or mortgage tenancy in Chandiara. The Chandiara rent may actually be less, if one subtracts the many tenancy transaction costs in that village, and TK. 23,180 is less than the nominal land rent of share or mortgage tenancy in Jugitala (Table 4). Therefore, the Jugitala landlord will prefer the mortgage tenancy contract with its higher rate of return[11], while the Chandiara landlord will favor share tenancy. In the informal rural credit market, the moneylender's rate of interest on short term credit was about 120-200% annually in the study villages[12], although the share of that credit was insignificant because, if the rate was used to discount the nominal share rent, the resulting share rent would be equal to that in lease or mortgage tenancy in Chandiara, and much lower than that under the same arrangements in Jugitala. These results are in partial agreement with those from earlier studies in Bangladesh agriculture[7],[17]. In our study villages, it can be concluded that institutional changes in agriculture have not favored the landlord, but have been marginally biased toward the tenant.

In the lease market of Chandiara, a further supply of rented land was leased-out to the subtenant, because there has been a greater existing demand for rented land. The rate of return[11] on mortgage tenancy was about 35% per year, and if

the mortgage tenant further shares-out the same land to a sublessee without self cultivating the land himself, the rate of return[11], was found to be about 24% per year in Chandiara, and about 19% in Jugitala (Table 4). At 35%, the rate of return is about 3 times higher than the bank interest rate, which encourages the mortgage tenant to enter the mortgage tenancy contract. Or, considering another case, when the farmer has lease-in land, and needs money for investment in crop production, agribusiness, or set-up capital inputs, and if there is an unavailability of institutional credit, he will sublease (a source of informal credit) his land to a sublessee. Here, the rate of return is about 13.5%, similar to that of institutional credit (Table 4). If, considering the transaction costs of the institutional credit, the informal credit market is cheaper and more reliable, this may encourage the landlord to contract a mortgage tenancy, and the lease-tenant to enter into the sub-lease market.

So, we may conclude from the above discussion that, due to the diffusion of new technology, a substantial institutional change in contractual arrangements of the land tenancy market was affected by the informal rural credit market.

(b) Contract Systems in the Hired Labor Market Benefiting Both Parties

Previously we have discussed that landless, or marginal or small farmers with abundant labor, can either sell their labor to the hired market or rent additional land from the landlords. In this study, all such farmers avoided unemployment by both renting additional land and selling a portion of their labor to the hired market. Figure 4 shows the existing labor contract systems in the study villages. In the history of the labor market in both villages, almost all the farmers employed permanent labor for a season or for the year, which is called permanent hired labor. In our study, we regarded this as a substitution for family labor[17]. In the initial stages of the new technology, some labor, called casual hired labor worked on a daily-wage basis with foods and wages. When the seed-fertilizer-irrigation technology was concentrated in the study areas, the demand for labor increased and the laborer demanded to have increased the wage of hired labor without food payments. After the mid 1980s, when trade liberalization and privatization in agricultural input markets were completed, most of the hired labor worked on a contract basis[13]. The contract system was initiated especially for rice harvesting. This situation rapidly changed after the policy changes were accomplished and attention was diverted to other agricultural activities. Today in Chandiara, weeding activities and the transplanting of seed and seedlings are usually carried out under a contract system, with a piece rate contract used for the production of all crops. But a new mode of contract system used only for rice harvesting, known locally as *mollainna*[14] has been initiated in Jugitala. Nonetheless, Jugitala farmers continue to use the existing piece rate contract system for other rice production activities such as transplanting and weeding.

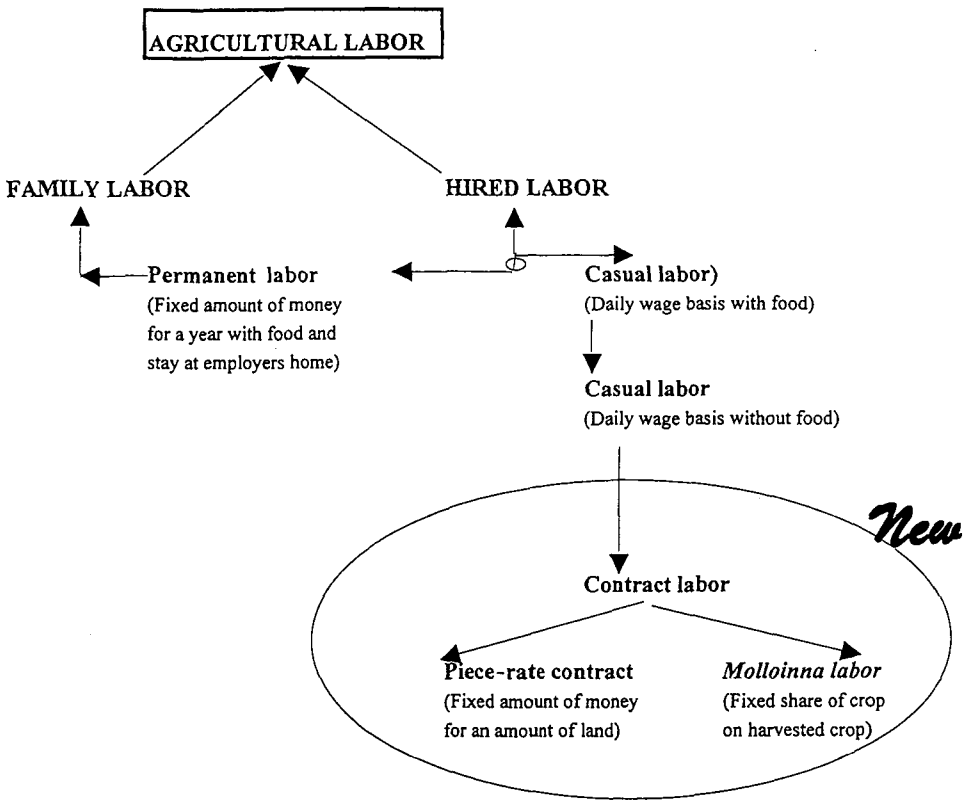


Figure 4. Pattern of labor contracts for agricultural activities in the study villages.

(i) Distribution of labor by activities

In the social science research of developing countries, it is very difficult to determine the precise number of days devoted to agriculture, and particularly to specify the days spent on specific crops, because family labor and permanent hired labor engage in different activities. In this study, we have tried to estimate the labor use for different activities in rice cultivation only. We found that the average labor demand per ha rice cultivation was 156 labor-days in Chandiara and 119 labor-days in Jugitala (Table 5). The share of hired labor for the two villages was about 54% and 74%, with contract labor contributing about 39% and 67%, respectively. For harvesting of rice under the *molloinna* system, almost all farms hiring labor (94% of total hired labor for harvesting) were found in Jugitala. In Chandiara, the piece rate contract is becoming popular for transplanting, weeding and harvesting, but is still less popular than in Jugitala. The higher utilization of contract labor in Jugitala can be attributed to the lower migration transaction cost into nearby cities and other areas. Another economic cause will be explained in the next section. In Chandiara, the share of contract

Table 5. Comparison of family and hired labor used for rice production by activities

(Labor-days/hectare)

Activites	*Chandiara*					*Jugitala*				
	Boro	*Aus*	*Amon*	Total	% of total	*Boro*	*Aus*	*Amon*	Total	% of total
Land preparation	13.1	13.6	15.3	14.1	100	5.9	3.5	3.5	3.9	100
Family labor	9.6	9.9	9.9	9.9	70	3.2	2.5	2.7	2.7	69
Hired labor	3.5	3.7	5.4	4.2	30	2.7	1.0	0.8	1.2	31
Sowing and transplanting	44.7	39.8	37.3	40.3	100	30.6	30.1	27.7	29.1	100
Family labor	18.5	14.3	16.6	16.3	40	8.4	8.4	8.6	8.4	29
Hired labor	26.2(9.4)	25.5(11.6)	20.7(7.2)	24.0(9.4)	60(39)	22.2(13.8)	21.7(11.9)	19.1(6.7)	20.7(10.1)	71(49)
Plant protection	7.2	8.2	7.7	7.7	100	7.2	5.9	5.5	5.9	100
Family labor	5.4	5.5	5.7	5.4	70	5.2	4.4	4.7	4.7	80
Hired labor	1.8	2.7	2.0	2.3	30	2.0	1.5	0.8	1.2	20
Weeding	48.4	36.3	42.0	42.0	100.0	39.5	38.3	32.6	36.1	100
Family labor	17.5	13.6	19.0	16.8	40	10.1	11.6	11.9	11.4	32
Hired labor	30.9(14.3)	22.7(11.6)	23.0(6.2)	25.2(10.4)	60(41)	29.4(9.6)	26.7(12.1)	20.7(10.6)	24.7(11.1)	68(45)
Harvesting and threshing	57.1	49.4	49.4	51.6	100	64.0	42.0	36.8	44.0	100
Family labor	20.5	23.7	23.5	22.6	44	3.5	3.7	3.5	3.5	8
Hired labor	36.6(23.7)	25.7(8.4)	25.9(9.9)	29.0(13.3)	56(46)	60.5(57.3)*	38.3(36.3)*	33.3(30.9)*	40.5(38.0)*	92(94)*
Total activites	170.4	147.2	151.7	155.6	100	147	119.8	106.0	119.1	100
Family labor	71.6	66.9	74.6	71.1	46	30.3	30.6	31.4	30.6	26
Hired labor	98.8(47.4)	80.3(31.6)	84.5(33.1)	84.5(33.1)	54(39)	116.7(80.8)	89.2(81.3)	74.6(48.2)	88.4(59.3)	74(67)

Source : Field survey, 1995

Note : Figure in the parentheses indicates the contract labor for all areas.

*indicates 1/10th crop share for harvest labor in Jugitala.

labor is highest for *boro* rice, which is produced during the dry season, the peak season for the labor market due to the high rate of production of nonrice crops. In Jugitala, by contrast, *boro* rice was produced on only half of the cultivated land, less labor was required, and labor consequently migrated to others areas and returned in the wet season. Thus, *aus* and *amon* are the peak seasons for contract labor in Jugitala. Almost 100% of the cultivated land in Jugitala produced *aus* and *amon* rice in the wet season under rainy conditions, when farmers required more labor.

(ii) Imputed cost of labor: A two-way saving

The contract hired labor system, specifically the *molloinna*, can be considered an institutional innovation for [from the point of view of the employer (landowner)] reducing the labor cost or [from the point of view of the employee (labor)] increasing the wage income to respective levels equal to the marginal productivity of labor.

In earlier days, when the rice yields per ha were low, the casual hired labor might have represented a wage rate equal to the marginal product. However, as the productivity of rice farming increases due to the wide diffusion of new technology and lower transaction cost of migration, the labor demand could increased from the employee's point of view and, from the employer's point of view, the supply of labor become abundant due to growing population pressure, such that the daily wage rate will become substantially lower for the labor and higher for the landowner. In this situation, landowners could increase their farm income by changing the casual hired labor system to a piece rate contract basis. On the other hand, labor has also been encouraged to work on a piece rate contract basis, to increase their wage income by working in other fields. So the landowners and the laborers of Chandiara currently have several flexible options. These changes may be accepted by the landowners, due to a labor scarcity.

It seems reasonable to hypothesize that the *molloinna* system represents an institutional innovation designated to equate the cost of the marginal productivity of labor in Jugitala[12] and that the piece rate contract is an institutional innovation specific to Chandiara. To test this assertion, an imputation was made of labor inputs applied to rice production under piece rate contracts in Chandiara, and under *molloinna* contracts in Jugitala. Using the market rates, the imputed wage costs were compared with the actual shares of the total transplanting, weeding and harvesting laborers for piece rate and *molloinna* contracts. The results show a remarkable affinity between the imputed wages and the actual harvesters' shares (Table 6). The landowner's benefited by TK. 916 per ha for rice cultivation due to the change of labor institutions in Chandiara, and the laborers also benefited by TK. 1795 per ha, due to the replacement of casual hired contracts with new piece-rate contracts. This situation is more favorable to the laborer in Jugitala, where TK. 2730 per ha more can be earned in additional wage income than by casual hired contract, and where a large

Table 6. comparison between the imputed value of contract and harvested labor share

	Chandiara		*Jugitala*	
	Based on employers'(Famer)	Based on employees'(Labor)	Based on employees'(Famer)	Based on employees'(Labor)
Working days of labor (labor-days/ha)				
Transplanting	40.3	20.6	29.1	24.5
Weeding	42.0	24.7	36.0	24.5
Harvesting/threshing	51.6	27.4	44.0	23.5
Imput cost of labor (Taka/ha)*				
Transplanting	2,010	1,030	1,603	1,292
Weeding	1,260	740	1,803	1,173
Harvesting/threshing	2,580	1,370	2,724	1,455
A. Total	5,850	3,140	6,130	3,920
Actual share of labors Imputed value(Taka/ha)				
Transplanting	1,644	1,645	2,117	2,117
Weeding	1,645	1,645	1,410	1,410
Harvesting/threshing#	1,645	1,645	2,338	3,123
B. Total	4,934	4,935	5,865	6,650
B−A :	−916	1,795	−265	2,730

Source : Field survey, 1995

Note:

*The wage rate for transplanting, weeding and harvesting were TK.50, Tk.30, and TK.50 in Chandiara and TK.55, TK.50, and TK.62 respectively in Jugitala.

#Imput at the market price of rice TK. 7.40/kg in case of harvesting labor in Jugitala.

portion of the benefit is derived from harvesting under the *molloinna* systems. Landowner's, while benefitting as much as labor, still gained an additional TK. 265 per ha. This shows that the labor market in Jugitala is more imperfect than that in Chandiara, which may discourage the tenancy market. Thus, despite the imperfect innovations in the labor market, we can conclude that both labor and landowner have benefited from the recent agricultural development of Bangladesh.

Another factor underlying the diffusion of the *molloinna* and piece rate contract system is the reduction of risk in the labor market. Because the team leaders of that labor group contract to the landowner at least two weeks before the respective activities, it follows that the availability of timely labor is guaranteed by contract, without the landowner having to personally contract all of the laborers, which reduces the transaction cost of labor for the landowner. For the laborer, on the other hand, because both piece-rate and *molloinna* involve less risk of unemployment, more time can be dedicated to earning a higher wage income.

5. Summary

Technological developments leading to changes in cropping systems in irrigated agriculture and, therefore, to changes in land and labor contractual arrangements were investigated by use of a case study of two typical Bangladeshi villages. The technological variation across the physical environment resulted in different changes in the agrarian institutions. In the study villages, the tenant farming system has been shifting, from a cropsharing to a fixed cash rent system, with the diversification of agriculture following the introduction of vegetable production. The traditional farming system still exists, a crop sharing system for the risk associated with water availability.

No association was found between inefficiency in resource allocation and the sharecropping system, versus other forms of tenancy systems, for individual crops. The nominal difference between rents in the fixed rent system is explained by the interest rate for easy access to informal credit, requiring no security that is available in the villages. The real difference between rents in the sharecropping and fixed rent tenancy systems can be accounted for by landlord risk sharing, imperfect information and monitoring costs. Although contract enforcement was inexpensive for landlords, the imperfect knowledge of the tenants' cropping choice resulted in a higher transaction cost. Landlords with less ability to enforce a contract would thus choose a fixed-rent tenancy. This nominal difference of rent for the lease or mortgage tenants allowed them to sub-rent a part, or all, of their holdings to subtenants, despite land reform laws prohibiting such arrangements. The economic reason for the emergence of sub-lease tenancy was identified as the gap between the actual rent and the economic rent, which resulted partly from profitable nonrice cropping and partly from population pressure on the land.

Land tenancy is interlinked with the informal credit market. The landlord will receive the rent as cash if a tenancy contract is either a lease or mortgage, but in a share tenancy, the proceeds will be received after the harvesting of each crop. Thus, a discounting factor was considered for the informal credit market that derives from the lease or mortgage tenancy. The interest rate of the informal credit market is modestly higher than the bank interest rate and much lower than that of the traditional money lending market. Thus, the rural informal credit market derived from the lease or mortgage tenancy contracts are plays a prominent role in the agricultural development of Bangladesh.

Economic forces that have induced changes in land tenancy arrangements have also resulted in a diffusion of the labor contract system from a daily-wage basis to a piece-rate contract basis, or to a fixed crop share for harvested labor basis. Results show that both landlords and laborers have benefited, largely because laborers can utilize their full time in a contract job, while landlords pay less than in the previous system. Thus laborers work harder and earn a higher

wage income than on a daily-wage basis.

The survey results show that farmers, within the context of the new technologies, can make efficient choices among alternate contracts with due consideration to both their resource endowments and external conditions.

Appendix Table 1. The values of the respective crops for calculation of the present value (Rm) of the rent under share tenancy in Table 4

(per hectare)

Chandiara	j-th crops			k-th crops		
Parameters	*Boro* (1)	*Aus* (2)	*Amon* (3)	Potato (1)	Vegetables (2)	Others (3)
Lo	0.5	0.5	0.5	TK. 12,350 (fixed) or 0.175	0.33	0.33
HI	0	0	0	0	0	0
Y (Taka)	34,901	17,836	19,074	44,707	15,645	2,933
i (per month)	2.943	2.943	2.943	2.943	2.943	2.943
p (month)	6	9	12	3	6	9
L	0	0	0	0	0	0
C	5,303	2,611	3,125	11,745	2,379	615
q (month)	3	3	3	3	3	3
Jugitala	j-th crops			k-th crops		
Parameters	*Boro* (1)	*Aus* (2)	*Amon* (3)	Potato (1)	Vegetables (2)	Others (3)
Lo	0.5	0.5	0.5	n.a	n.a	0.5
HI	0.1	0.1	0.1	n.a	n.a	0.1
Y (Taka)	16,037	20,992	20,619	n.a	n.a	489
i (per month)	1.332	1.332	1.332	n.a	n.a	1.332
p (month)	6	9	12	n.a	n.a	3
L	0.5	0.5	0.5	n.a	n.a	0.5
C	2,248	2,164	3,033	n.a	n.a	194
q (month)	3	3	3	n.a	n.a	3

Source : Field surey, 1995

Note : n.a is not appropriate.

Notes:

1) For more details see (13), (14).

2) Similar trends were suggested by Taniguchi (17).

3) Alauddin (2) also suggested for greater crop diversification would sustain agricultural productivity in the long term.

4) Hayami (9) also indicated that if rice production increased steadily and demand for rice decreased due to income elasticity, then cereal producers would lose net income. He therefore urged agricultural diversification by crop rotation, substituting new crops for old, and crop-livestock interaction.

5) Share tenancy is the most common type of land tenure in both villages. Two types of share tenancy are observed in Chandiara. One is crop-sharing and the other is the fixed share system. The crop-sharing system normally consists of a 50 : 50 share for rice paddies and

33 : 67 share for nonrice crops (except potatoes) between owner and tenant, with all input and labor costs borne by the tenant. Under the fixed share tenancy, an agreed amount of crop per unit of land is usually paid as rent. The contract system is provided only for potato production, where 80 kilograms (kg) of potato is paid as rent per *gonda* (local unit of land measuring, about 0.024 hectare). In Jugitala, the sharecropping system for all crops is a 50 : 50 share between landlord and tenant, with the 50% current input cost borne by the landlords.

6) Mortgage tenancy, locally called the "*Poshani*" contract system, by which a tenant establishes the right to continue cultivating land for a certain amount of money deposited with the owner until the owner pays back the deposit to the tenant, is found in both areas. In this type of tenancy system, land is mortgaged out at the rate of TK. 3000 (TK. 40=1 U.S. Dollar in 1995) per *gonda* (TK. 123,500 per ha) in Jugitala and at the rate of TK. 4500 per *gonda* (TK. 185,250 per ha) in Chandiara under an agreement where in the land is returned to the owner after he pays back the principal amount. Generally, the owner must notify the mortgagee at least one crop calendar year or one season before he is expecting to pay back the deposits, so that the mortgagee can plan his land management for the next year or season. Generally, the mortgagee is allowed to cultivate the land with security for several years, often more than five crop calendar years. This contract serves as an important source of informal credit in the study areas, with an incidence particularly high in Chandiara.

7) The lease tenancy system occurred in Chandiara only for the short term, usually for one crop calendar, with the tenant providing a fixed amount of cash to the owner before the start of the new crop calendar year. This lease system is locally called "*Agorkhajna*". In the annual cash lease system, the tenant has to pay TK. 600 per *gonda* (TK. 25,000 per ha). After one crop calendar year, the land passes back to the owner automatically without the return of any money to the tenants. The practice is usually employed by absentee owners who have no contact with their tenants.

8) Sub-lease tenancy, a remarkable variation in the tenancy market, occurred only in the more technologically developed Chandiara area, although it is illegal in terms of land reform laws. Sub-lease tenancy contracts are usually arranged by the tenants or landlords with informal consent, sometimes without the formal consent of the landowners. Sub-lease tenancy can be classified into three categories. In the first, the landowners mortgage out to the tenants and immediately consent with the tenants to cultivate the land as a share tenancy for a specific crop or for one crop calendar. Most of the cases belonging to this group involve the irrigation machine owners. Interestingly, the landowner becomes a third party, effectively a sublessee. In the second, the landowner mortgages out to the tenant and the tenant leases out the same land without the consent of the owner. Although this arrangement is very rare, one such case, involving an owner who lived overseas, was found in this study. In the third, the tenants lease-in land from the owners and, without any consent of the owner, mortgage out to the sub-lessee while continuing to pay rent annually to the landowner. With this contract, the tenant has an opportunity to take informal credit without owning the land of the sublessor, or without decreasing his own land area. In the study areas, a few businessmen and one tubewell owner were engaged in these contracts.

9) For more details see Otsuka and Hayami (14) and Hayami and Otsuka (8).

10) Due to space limitation, costs and returns of the individual crops are not provided.

11) See the appropriate formula in the lower part of Table 4.

12) Other forms of credit from non-institutional sources (such as moneylenders or enterpreneurs) were often seen in Chandiara, where they constituted 3% of total credit. The nature of the non-institutional credit market is such that the moneylender or enterpreneurs provides the short term loan to the small and tenant farms if the enterpreneur will pay TK. 100 before cultivation of potato, after harvesting (short-term basis, usually 3 months), the loanee must repay the loan as a fixed amount of potato (40 kg per 100 TK.), although at the harvesting time the market price of 40 kg potatoes is about TK. 150. Thus, the interest rate per month is about 17%. In Jugitala, there was only one service man who lent money to farmers at the rate of 10% per month that covered 2% of total credit.
13) The contract labor system, also called piece-rate contract system, is the amount of cash money charged for a fixed amount or a piece of land for particular work. The contract activities are done by a group of labors consisting of 5-15 members.
14) The *molloinna* labor contract system is a fixed amount of crop-share, which is 1/10th share of the harvested crop for harvested labor.

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