06 Outcomes and Impact from Agricultural Development

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Coastal areas have a large number of people, who mainly depend on agriculture and aquaculture for

their livelihoods and who are likely to be vulnerable to the climate variability. With a high dependency on natural resources (land and water) as well as exposure to extreme weather events, the people of the coastal region of Bangladesh are particularly vulnerable. The Blue Gold Program (BGP) aimed to improve food security and reduce poverty of coastal households living in the area of selected 22 coastal polders through participatory water management and agricultural development. This chapter explore the changes in agricultural land use, improvement in agricultural production, employment generation in agriculture and economic return of agricultural development.[Notes 1]

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Changes in crop agricultural production[edit | edit source]

Changes in agriculture land use[edit | edit source]

The total size of the cultivable areas of BGP is divided up into the following categories of land: (i) highland; (ii) lowland; (iii) fresh water gher; and (iv) salt water gher. WMGs reported about the total size of their command areas and highland and lowland as defined subjectively by each of the WMGs. Cultivable land that is used as perennial gher or as seasonally gher is both identified as gher. Seasonal gher is used for fish production in one and two seasons (most likely in kharif-1 and kharif-2) as well as used for crops (in boro/rabi), whereas also vegetables may be grown on the banks of ghers.

Data in Table 6.1 for each zone shows that in both Khulna and Satkhira land (mainly lowland) has been converted into ghers – but much more of this has taken place in Satkhira than Khulna. In Khulna 60% of the land is now gher and in Satkhira 70%. Only a small area of saline gher was reported – almost all in Satkhira, but there is also a very small amount in Khulna in polder 30. There has been a small increase in the area of saline gher. Although people say that land has been converted from saline to fresh water ghers (especially in Khulna), this conversion seems to have taken place before the start of BGP. There has been a small fall in the total command area as land

has been converted into non-agricultural uses or lost to river erosion.

Table 6.1: Land types

			Khulna	Satkhira	Patuakhali	Total BG
Share of land area	Highland	2013-14	19%	17%	49%	31%
		2020-21	18%	15%	49%	30%
	Lowland	2013-14	26%	55%	51%	39%
		2020-21	22%	14%	51%	32%
	Fresh gher	2013-14	55%	22%	0%	29%
		2020-21	60%	62%	0%	37%
	Salt gher	2013-14	0.1%	6.4%	0%	0.8%
		2020-21	0.1%	8.5%	0%	1.1%
	Total		100%	100%	100%	100%
Area (acres)	Total area	2013-14	112,208	7,450	90,377	230,035
		2020-21	111,090	27,418	90,162	228,670

Source: WMG survey 2021

Changes in use of different types of land[edit | edit source]

Changes in land use is illustrated below for the high land, low land, fresh water gher and saline gher. Use of cultivated land has been divided for each season into three categories: (i) paddy; (ii) other crops; and (iii) fish/shrimps.

(a) Highland[edit | edit source]

Changes in the use of highland are shown in Table 6.2. In the rabi season, there has been a modest increase in the area under boro paddy, but this increase largely comes from polders in the Khulna zone. Boro is more widely grown in Satkhira, but its share of land is unchanged, and little is grown in Patuakhali. There has been a more significant increase in non-rice crops with increases in all three zones, especially in Patuakhali.

Overall in the kharif-1 season there has been a modest decline in amount of paddy (aus) and a modest increase in non-rice crops. There is little change in the amount of land being used by crops, which at around one third is much lower than in the rabi or kharif-2 seasons. The potential to increase cropping in the kharif-1 season is constrained by land being still occupied by some rabi crops (especially boro paddy) as well as the uncertain start of the monsoon.

Table 6.2: Use of highland

		Khulna		Satkhira		Patuakhali		Total	
		2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21
Rabi	paddy	36%	60%	74%	80%	0%	3%	24%	40%
	other crops	18%	13%	2%	3%	54%	87%	33%	45%
	Fish	10%	8%	10%	17%	0%	0%	7%	8%
	Total	64%	81%	85%	100%	54%	90%	64%	93%

Kharif-1	**paddy**	2%	2%	1%	6%	22%	15%	10%	8%
	other crops	10%	22%	6%	8%	0%	1%	6%	12%
	Fish	32%	47%	24%	68%	0%	0%	19%	31%
	Total	44%	70%	31%	82%	22%	16%	34%	50%
Kharif-2	**paddy**	50%	40%	32%	22%	94%	100%	65%	62%
	other crops	8%	10%	0%	3%	0%	0%	4%	5%
	Fish	32%	49%	26%	66%	0%	0%	19%	32%
	Total	90%	99%	58%	91%	94%	100%	88%	98%
Total	**paddy**	88%	102%	108%	109%	116%	118%	99%	109%
	other crops	36%	45%	8%	14%	54%	88%	42%	62%
	Fish	74%	104%	59%	150%	0%	0%	45%	70%
	Total	198%	250%	174%	273%	171%	206%	186%	241%

Percentage of cultivable land Source: WMG survey 2021

In the kharif-2 season most land is occupied by aman paddy. There have been increased areas of aman in all three zones, especially in Satkhira where less was grown before BFP. There have also been increases in non-rice crops in Khulna and Satkhira.

(b) Lowland[edit | edit source]

In the rabi season there has been an overall small increase in the area of boro paddy – with this mainly coming from the Khulna zone. The area under non-rice crops has doubled, with a very large increase in Patuakhali, where this increase was larger than that in highland – suggesting that improved drainage of low land may have contributed. In Khulna there has been a fall in the area of other crops – in contrast with the increase on highland. It may be that on highland these 'other crops' are high value crops such as watermelon and vegetables, while on lowland they are pulses and oilseeds which have been discouraged by changing weather patterns.

In the kharif-1 season most land is still fallow, although there has been a significant increase in non-rice crops in Khulna and in aus paddy in Satkhira. In the kharif-2 season most land is used for aman, and there has been an increase in the area of this crop, especially in Satkhira- although here most lowland is now converted into ghers.

Table 6.3: Use of lowland

		Khulna		**Satkhira**		**Patuakhali**		**Total**	
		2013-14	**2020-21**	**2013-14**	**2020-21**	**2013-14**	**2020-21**	**2013-14**	**2020-21**
Rabi	**Paddy**	12%	54%	82%	98%	0%	3%	18%	25%
	other crops	41%	31%	1%	0%	32%	81%	30%	60%
	Total	53%	85%	83%	98%	32%	84%	47%	85%
Kharif-1	**Paddy**	2%	2%	2%	19%	5%	2%	4%	3%
	other crops	6%	27%	6%	8%	0%	0%	3%	9%
	Total	9%	29%	8%	28%	6%	2%	7%	12%

Kharif-2	**Paddy**	88%	94%	43%	64%	92%	100%	82%	96%
	other crops	4%	4%	0%	0%	0%	0%	1%	1%
	Total	92%	98%	43%	65%	92%	100%	84%	97%
Total	**Paddy**	103%	150%	126%	182%	98%	106%	104%	124%
	other crops	51%	62%	7%	9%	32%	81%	34%	71%
	Total	154%	211%	133%	191%	130%	187%	138%	195%

Percentage of cultivable land; WMG survey 2021

(c) Fresh water ghers[edit | edit source]

Fresh water ghers are mainly reported by WMGs in Satkhira and Khulna (Table 6.4); there are only a few such ghers in Patuakhali. In the rabi season more fresh water gher land in both zones is now being used for boro – suggesting an improvement in water management. In the khairif-1 season most fresh water gher land is used for fish, although non-rice crops (such as vegetables on the banks of ghers) have also increased. In kharif-2, as in kharif-1, most land is used for fish – the area of fish in both these seasons has increased and less land is fallow – which may have been enabled by better water management. The area of aman paddy has also decreased in kharif-2.

Table 6.4: Use of fresh water gher land

		Khulna		**Satkhira**		**Total**	
		2013-14	**2020-21**	**2013-14**	**2020-21**	**2013-14**	**2020-21**
Rabi	**Paddy**	41%	68%	63%	83%	43%	71%
	other crops	9%	10%	1%	1%	9%	8%
	fish ghers	22%	20%	17%	16%	22%	19%
	Total	73%	97%	80%	100%	74%	98%
Kharif-1	**Paddy**	1%	2%	0%	0%	1%	1%
	other crops	9%	13%	0%	3%	8%	11%
	fish ghers	59%	77%	86%	96%	61%	81%
	Total	69%	92%	86%	99%	70%	93%
Kharif-2	**Paddy**	23%	10%	6%	5%	22%	9%
	other crops	7%	10%	0%	2%	7%	8%
	fish ghers	59%	80%	90%	93%	62%	83%
	Total	90%	99%	96%	100%	90%	100%
Total	**Paddy**	65%	79%	69%	88%	66%	81%
	other crops	26%	33%	1%	6%	23%	27%
	fish ghers	140%	177%	193%	205%	145%	183%
	Total	232%	289%	262%	299%	234%	291%

Percentage of cultivable land; Source: WMG survey 2021

(d) Saline water ghers[edit | edit source]

Saline water ghers are only found in a limited part of polder 30 (Khulna) and polder 2&2E (Satkhira) (Table 6.5). In the rabi season there has been a modest increase in the use of saline water gher land for boro paddy cultivation and decline in area under fish in Satkhira, but an increase in polder 30. In kharif-1 there has been an increase in the amount of land used for fish. In kharif-2 most saline water

gher land in polder 30 was being used for aman, but it is all now fish. It is possible that this land used to be non-saline in the monsoon season and so was used for paddy but has now become saline all year round. This saline water gher land is unable to be used at other times of year for crops which are intolerant to high levels of salinity.

Table 6.5: Use of saline water gher land

		Khulna		Satkhira		Total	
		2013-14	2020-21	2013-14	2020-21	2013-14	2020-21
Rabi	paddy	0%	16%	7%	16%	7%	16%
	other crops	0%	8%	0%	1%	0%	2%
	fish	29%	47%	92%	83%	89%	81%
	total	29%	72%	99%	100%	96%	98%
Kharif-1	paddy	0%	0%	0%	0%	0%	0%
	other crops	0%	0%	0%	1%	0%	1%
	fish	34%	51%	83%	99%	81%	96%
	total	34%	51%	83%	100%	81%	97%
Kharif-2	paddy	74%	0%	0%	0%	3%	0%
	other crops	0%	0%	0%	1%	0%	1%
	fish	26%	100%	92%	99%	89%	99%
	total	100%	100%	92%	100%	92%	100%
Total	paddy	74%	16%	7%	16%	10%	16%
	other crops	0%	8%	0%	4%	0%	4%
	fish	89%	198%	267%	280%	259%	275%
	total	163%	222%	274%	300%	269%	295%

Percentage of cultivable land; Source: WMG survey 2021

Changes in overall land use[edit | edit source]

The overall land use in three seasons for each of the three zones is shown in Table 6.6. For the Khulna zone boro paddy and other crops were of almost equal importance in the rabi/boro (winter/dry) season before the project, followed by fish ghers, with over one third of land fallow. There has now been considerable expansion in boro, and some decline in other crops and fish, with significantly less fallow land.

Table 6.6: Seasonal land use

		Khulna		Satkhira		Patuakhali		Total	
		2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21
Rabi	paddy	36%	60%	74%	80%	0%	3%	24%	40%
	other crops	18%	13%	2%	3%	54%	87%	33%	45%
	fish ghers	10%	8%	10%	17%	0%	0%	7%	8%
	Total	64%	81%	85%	100%	54%	90%	64%	93%

Kharif-1	**paddy**	2%	2%	1%	6%	22%	15%	10%	8%
	other crops	10%	22%	6%	8%	0%	1%	6%	12%
	fish ghers	32%	47%	24%	68%	0%	0%	19%	31%
	Total	44%	70%	31%	82%	22%	16%	34%	50%
Kharif-2	**paddy**	50%	40%	32%	22%	94%	100%	65%	62%
	other crops	8%	10%	0%	3%	0%	0%	4%	5%
	fish ghers	32%	49%	26%	66%	0%	0%	19%	32%
	Total	90%	99%	58%	91%	94%	100%	88%	98%
Total	**paddy**	88%	102%	108%	109%	116%	118%	99%	109%
	other crops	36%	45%	8%	14%	54%	88%	42%	62%
	fish ghers	74%	104%	59%	150%	0%	0%	45%	70%
	Total	198%	250%	174%	273%	171%	206%	186%	241%

Percentage of cultivable land; Source: WMG survey 2021

In the kharif-1 (early monsoon) season fish ghers were, and still are, the main land use in Khulna, with the area now significantly increased. This, along with some growth in other crops, means that 70% of the cultivable land is now cultivated in this season. In the kharif-2 (late monsoon) season, half the land was used to grow aman paddy. This has now fallen to 40%, with a significant increase in the area under fish ghers. Overall cropping intensity in this zone has increased from 198% to 250%.

In Satkhira, land use in the rabi-boro season is predominantly boro paddy, and the area of this crop has increased. Along with a small increase in area of fish, overall land use in this season is now 100%. The main land use in kharif-1 is fish ghers, which has more than doubled as before BGP, when over two thirds of land was left fallow. An increasing area under fish, along with small areas of paddy and other crops mean that almost two-thirds of land is now utilized in this season. In kharif-2, prior to BGP, one third of land was growing aman paddy, and just over one quarter used for fish ghers. The area under fish ghers has now more than doubled, with a decline in aman paddy – but with an overall increase in land utilization in this season. Annual cropping intensity has increased from 174% to 273%.

In Patuakhali, there is virtually no land used for fish ghers. In the rabi/boro season almost all land is used for other (non-rice) crops, which have expanded considerably during BGP. In the kharif-1 season almost one quarter of land was used for aus paddy, but this has now declined, with an increase in the area of fallow land. In kharif-2 almost all land is (and was) used for aman paddy. Overall cropping intensity has increased from 171% to 206%.

Change in cropping pattern and crop types[edit | edit source]

For paddy there has been a move from traditional local varieties to modern HYVs and hybrids (Tables 6.7 and 6.8). There are no reports of cultivation of local varieties of boro (these seem to have disappeared in Bangladesh), but there is a move from conventional HYVs to hybrid seeds for this crop. This is particularly apparent in the Khulna zone, where two-thirds of boro is now hybrid, up from 30% since 2019. Only in Patuakhali is a significant area of aus grown, and there has been a dramatic switch from local varieties to HYVs, with almost no local varieties now grown. There has

also been a switch from local to HYV in the aman season – less so in Khulna where almost half of this crop is still local variety (LV). In Satkhira HYV aman predominated before BGP but has continued to increase.

Table 6.7: Land under different types of paddy

		Khulna		Satkhira		Patuakhali		Total	
		2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21
Boro	HYV	24%	20%	63%	51%	0%	2%	19%	17%
	Hybrid	6%	40%	11%	29%	0%	1%	4%	23%
Aus	Local	1%	0%	1%	1%	17%	0%	7%	0%
	HYV	1%	2%	1%	5%	5%	14%	2%	7%
Aman	Local	36%	19%	10%	3%	75%	35%	48%	23%
	HYV	14%	22%	22%	20%	19%	65%	17%	39%
All paddy	Local	37%	19%	11%	4%	92%	35%	55%	23%
	HY/hybrid	45%	84%	97%	105%	25%	83%	43%	86%
	Total	82%	102%	108%	109%	116%	118%	99%	109%

Percentage of cultivable land; Source: WMG survey 2021

Table 6.8: Share of improved varieties for boro and aman

	Boro – 2013-14		Boro – 2020-21		Aman – 2013-14		Aman – 2020-21	
	HYV	hybrid	HYV	hybrid	LV	HYV	LV	HYV
Khulna	80%	20%	33%	67%	71%	29%	46%	54%
Satkhira	85%	15%	63%	37%	32%	68%	13%	87%
Patuakhali	100%	0%	74%	26%	79%	21%	35%	65%
Total	82%	18%	42%	58%	74%	26%	37%	63%

Percentage of total area of each crop Source: WMG survey 2021

The proportion of cultivable land occupied by other crops is shown in Table 6.9. In the Khulna zone, sesame was an important crop, but this and a number of other more minor crops (such as mung bean) have declined in importance due to unfavourable growing conditions – with more emphasis being placed on more reliable irrigated boro and on more profitable fish ghers. However, the area of two non-rice crops have greatly expanded – vegetables and watermelons. As a result, the total area occupied by non-rice crops in all three seasons has increased from 41% to 53% of the cultivable land, with most of this increase taking place since 2019 when non-rice crops still accounted for 43% of the cultivable land.

In Satkhira there is only a small area of non-rice crops – mainly vegetables and a little jute. The area of vegetables has been increasing. Non-rice crops are most important in Patuakhali. Mung bean is by far the most important of these crops, and its area has increased by over four times. Prior to BGP, keshari (grass pea, a local pulse crop) was the principal non-rice crop, but this has now virtually disappeared, farmers saying that it is now unprofitable and difficult to grow with uncertain weather conditions. Areas under sesame, felon (cow pea) and sweet potato have also declined, while more groundnut, chili, sunflower, vegetables and watermelon are being grown. Compared to the 2019 WMG survey, more land in Patuakhali is now under mung bean and vegetables, and less under keshari, sesame, watermelon and groundnut.

Table 6.9: Land under non-rice crops

	Khulna		Satkhira		Patuakhali		Total	
	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21
mung bean	2.6%	0.7%	0.0%	0.0%	15.3%	62.9%	7.3%	25.1%
keshari	0.0%	0.0%	0.0%	0.0%	18.8%	0.5%	7.4%	0.2%
sesame	11.8%	1.5%	0.1%	0.0%	2.7%	0.1%	6.8%	0.8%
groundnut	0.0%	0.0%	0.0%	0.0%	4.6%	7.9%	1.8%	3.1%
watermelon	0.2%	7.3%	0.0%	0.0%	1.9%	3.8%	0.8%	5.1%
vegetable	19.0%	34.3%	2.8%	7.8%	0.7%	1.8%	9.9%	18.3%
other	7.9%	9.1%	4.7%	6.0%	10.1%	10.6%	8.4%	9.3%
Total	41.4%	52.9%	7.6%	13.8%	54.1%	87.5%	42.4%	61.8%

Percentage of cultivable land; Source: WMG survey 2021

The FGDs in Khulna explained that improved water management had enabled increased areas of crops to be grown with a move from one crop per year to two or three. Reduced waterlogging has enabled high value vegetables to be grown. Even where there has not been much improvement in water management (polder 28/1), some farmers have been able to adopt improved methods. Farmers are now more aware of new technologies and BGP's "farming as a business" theme has been appreciated. There has been widespread adoption of HYVs and new varieties, displacing local varieties along with mung bean and sesame which have become harder to cultivate due to changing weather patterns.

In Satkhira there was one FGD in an area of fresh water ghers, and another in the (more limited) area of saline water ghers. In the latter area, salinity means little cropping is possible. In the fresh water area, improved water management, along with training, means farmers can now plant the right variety at the right time. Both paddy and fish production have increased, and there is much interest in growing mangos on higher land. FGDs in Patuakhali emphasized the switch from local to high yielding varieties as well as the introduction of multiple cropping. Increased yields have resulted in higher farm income. Farmers now have better contact with DAE which can help in solving problems.

Increase in Cropping intensity[edit | edit source]

Data show a significant increase in cropping intensity in three zones of BGP. Cropping intensity has been calculated as the sum of crops and fish ghers in each season divided by the sum of crops, ghers and fallow land. This definition treats fish ghers as another crop in each season and takes no account of the frequency of fish harvests – so land used as a perennial (year-round) gher would have a 300% cropping intensity. With this approach overall cropping intensity has increased from 186% to 241%, with a larger increase in Satkhira of 99 percentage points - largely due to expansion of fish ghers in polder 2&2E and their more intensive use, together with an increase in the area of paddy (Table 6.10). Overall cropping intensity as recorded by the 2019 WMG survey was 228%, so there has been an increase of 13 percentage points in the last two years.

Table 6.10: Cropping intensity

Zone	Rabi /boro season		Kharif-1 season		Kharif-2 season		Cropping intensity		
	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	change
Khulna[Notes 21]	64	81	44	70	90	99	198	250	52
Satkhira	85	100	31	82	58	91	174	273	99

Patuakhali	54	90	22	16	94	100	171	206	35
Total	64	93	34	50	89	96	186	241	55

Percentage of cultivable area used in each season; Source: WMG survey 2021

Changes in cropping intensity vary considerably between WMGs. Overall, 89% of WMGs report an increase in cropping intensity, 4% no change and 7% a decrease (Table 6.11) – compared with the 2019 survey when 80% of WMGs reported increased cropping intensity. The proportion of WMGs with an increase in cropping intensity was highest in Satkhira at 95%, with the other two zones equal at 88%, although the average change was lowest in Patuakhali.

Table 6.11: Change in cropping intensity

	Average change per WMG	Percentage of WMGs		
		Decrease	same	increase
Khulna	58%	5%	7%	88%
Satkhira	97%	2%	3%	95%
Patuakhali	37%	10%	2%	88%
Total	55%	7%	4%	89%

Source: WMG survey 2021

DAE calculates cropping intensity as the area of crops divided by the sum of the areas of crops, fish ghers and fallow land. Cropping intensity calculated in this way is lower in Khulna and Satkhira (as land under ghers is excluded), with a smaller increase (Table 6.12). However, it does show that, even leaving aside the fish ghers, the area of farm crops has expanded. The 2019 WMG survey showed a larger increase of 14 percentage points in Satkhira. This is now only 8 points due to the expansion of area used for fish production.

Table 6.12: Cropping intensity (DAE method)

	2013-14	2020-21	change
Khulna	124	155	32
Satkhira	115	123	8
Patuakhali	171	206	35
Total	141	171	30

Source: WMG survey 2021

Link between water management and cropping intensity[edit | edit source]

There could be a link between water management problem scores (WMPS) and cropping intensity. It would not be unreasonable to expect that WMGs with less water management problems (i.e. lower WMPS score) are able to use their land more intensively. It may also be possible that WMGs reporting a larger improvement in water management (decrease in WMPS) have been able to increase cropping intensity by more than WMGs where water management has not improved so much.

Table 6.13: Water Management Problem Score (WMPS) and cropping intensity

WMPS	Number of WMG		Cropping intensity	
	2013-14	2020-21	2013-14	2020-21
under 2	5	108	242%	250%
2 to 2.5	22	261	238%	244%
2.5 to 3	42	67	208%	233%
3 to 3.5	139	58	196%	239%
3.5 to 4	78	10	167%	201%
4 to 4.5	187	2	185%	214%
4.5 and above	33	0	137%	
total	506	506		

Score: 1 = very good, 2=good (i.e. no problem), 3-=average, 4=bad, 5=very bad; Source: WMG survey 2021

Table 6.13 shows the number of WMGs in each of seven bands of WMPS. It can be seen that there are many more WMGs in the lower WMPS bands at present than before the project – showing how water management has improved with lower WMPS being reported by WMGs. Table 6.13 also shows that the cropping intensity tends to be higher in bands with lower WMPS, suggesting that lower WMPS (less water management problems) is linked with higher cropping intensity. This applies both in the before BGP and current situations, but it can also be seen that cropping intensity is now higher within each WMPS band than it was before the project. This implies that cropping intensity would increase without improved water management – but not to the same extent as it would with improved water management.

It is also possible that WMGs with a greater improvement in their WMPS have a larger increase in cropping intensity. Table 6.14 shows that this applies for those WMGs where the WMPS has improved by more than 1.5 points. Similar analysis in the 2019 WMG survey found a similar link between change in WMPS and change in cropping intensity (CI).

Table 6.14: Improvement in WMPS and change in cropping intensity

Change in WPMS	Number of WMG	Change in CI
more than -1	2	4%
-1 to 0	13	51%
0 to 0.5	55	43%
0.5 to 1	52	44%
1 to 1.5	151	47%
1.5 to 2	80	57%
2 to 3	137	70%
3 to 4	16	84%
Total	506	0%

Change in cropping intensity in percentage points Source: WMG survey 2021

Although average cropping intensity may improve for each group of WMGs grouped according to WMPS, there is great variation within each group and the overall correlation between WMPS and cropping intensity is weak, the correlation coefficient for before project data being -0.35, current data being -0.20 and the coefficient for change in WMPS and cropping intensity is 0.22. As perfect correlation is a coefficient of +/- 1.0, none of these relationships is very strong.

Increase in Crop yields[edit | edit source]

There has been a substantial increase in the productivity of paddy (Table 6.15). Apart from a switch to more productive HYV and hybrid varieties, average yields of each type of paddy has increased by between 13% to 54% with widely grown HYV boro and aman increasing by about 30%. Yields of non-rice crops have mostly also increased, with the exception of chilli and watermelon. The table also shows yield data from the 2019 WMG survey, and for most crops yields have also increased over the last two years – exceptions being sunflower, chilli and watermelon. The increase in yield of mung bean[Notes 3] is notable. This is a key crop in Patuakhali, and in 2019 yields were below the pre-project level due to unfavourable weather (excessive drought, unexpected and heavy rainfall). Mung yield has now recovered to over double the 2019 level and is 71% above the pre-project average. Data on aquaculture (gher fish) yields needs to be used with caution as seasonal yield data may not reflect the annual productivity of ghers.

Table 6.15: Average crop yields

		Yield kg/ha			HH reporting (n)		Yield kg/ha
		2013-14	2020-21	change	2013-14	2020-21	2019 survey
Paddy	boro HYV	4,983	6,370	28%	443	711	5,649
	boro hybrid	6,849	7,754	13%	262	665	7,692
	aman local	2,682	3,677	37%	797	504	3,102
	aman HYV	3,841	4,991	30%	542	606	4,878
	aus local	2,252	3,460	54%	166	59	2,757
	aus HYV	3,657	4,711	29%	87	233	4,313
Other crops	Maize	2,430	4,230	74%	10	11	2,991
	Mung bean	913	1,558	71%	304	263	714
	Keshari	1,142	1,456	28%	225	27	1,062
	Felon	1,210	1,492	23%	37	66	1,097
	Sesame	1,137	1,475	30%	255	90	835
	Groundnut	2,020	2,234	11%	170	176	2,211
	Sunflower	1,708	2,068	21%	14	15	2,606
	Sweet potato	3,427	8,698	39%	103	104	13,153
	Jute	2,263	2,290	1%	11	103	2,485
	Chilli	1,331	1,264	-5%	185	174	2,139
	Watermelon	5,499	2,011	-8%	39	187	49,084
Aquaculture	rabi	676	672	-1%	146	175	699
	kharif-2	830	1,664	100%	230	310	1,099
	kharif-1	530	802	52%	164	201	637

Source: WMG survey 2021

Increase in employment through agricultural development[edit | edit source]

Changes in labour use in crop and fish production have been calculated based on the crop budgets for each zone and crop areas in each polder. Pre-project labour use has been estimated, taking into account that lower yields meant that less labour was needed for harvest and post-harvest work.

Table 6.16 shows the total labour used in crop production and gher aquaculture in each of the three zones. The total labour requirement is now estimated to be 18.7 million person-days, an increase of around 50% on the pre-project situation. Paddy production absorbs over half of this labour, followed non-rice crops and then by fish / shrimp aquaculture. The table also shows how much labour is hired (men and women) and how much comes from men and women members of the farm households.

Table 6.16: Labour inputs for crops and aquaculture

		Paddy		other crops		fish / shrimp		Total	
		2013-14	2020-21	2013-14	2020-21	2013-14	2020-21	2013-14	2020-21
Khulna	hired men	2,664	4,145	403	913	-	-	3,068	5,058
	hired women	-	-	896	1,675	-	-	896	1,675
	HH men	635	782	633	1,322	755	1,043	2,022	3,146
	HH women	116	290	223	400	252	348	591	1,037
Satkhira	hired men	1,074	1,154	11	32	-	-	1,085	1,186
	hired women	-	-	32	96	-	-	32	96
	HH men	256	253	36	93	175	446	468	792
	HH women	-	-	9	25	47	120	56	145
Patuakhali	hired men	2,511	2,624	219	457	-	-	2,730	3,082
	hired women	-	-	173	511	-	-	173	511
	HH men	864	927	292	482	-	-	1,156	1,409
	HH women	256	309	134	279	-	-	390	587
total	hired men	6,249	7,923	633	1,403	-	-	6,883	9,326
	hired women	-	-	1,101	2,281	-	-	1,101	2,281
	HH men	1,755	1,963	961	1,896	930	1,488	3,646	5,347
	HH women	372	598	366	703	299	468	1,036	1,770
	Total	8,376	10,484	3,061	6,284	1,229	1,956	12,666	18,723

Thousand person-days; **Source: WMG survey 2021**

Economic return of improved agriculture production[edit | edit source]

Increase in farm income[edit | edit source]

An increased cropping area, improved cropping patterns and increased yields have resulted in

increased farm incomes. This increase in income has been calculated based on budgets for the main crops in each zone and using cropping patterns and yields derived from WMG survey data (for details on yield assumptions and crop budgets, see Annex 6.1).

Table 6.17 shows that net farm income has more than doubled (131% increase), and more than half of total net income comes from non-rice crops – especially vegetables. However, in relative terms the increase has been highest for paddy. The relative increase has also been higher in the Patuakhali and Satkhira zones, and lower in Khulna – but in absolute terms the value of the increase is higher in Khulna. High value crops play a major role in this increase. Watermelon and vegetables contribute to almost half (49%) of the total net farm income in Khulna zone, compared with only 26% for fish. While fish contributes much more in Satkhira (61% compared with 12% for vegetables), overall vegetables and watermelon provide 37% of the net income compared with 22% from fish.

Table 6.17: Total net farm income

	2013-14 BGP - BDT million				2020-21 – BDT million				Change	
	paddy	other crops	fish	total	paddy	other crops	fish	total		
Khulna	676	1,987	1,214	3,878	1,515	4,321	2,003	7,840	3,962	102%
Satkhira	174	73	304	551	361	257	949	1,567	1,016	184%
Patuakhali	462	1,065	0	1,527	1,512	2,809	0	4,321	2,794	183%
total	1,312	3,125	1,518	5,955	3,389	7,387	2,952	13,728	7,773	131%
Increase					158%	136%	94%	131%		
Share in total income	22%	52%	25%	100%	25%	54%	22%	100%		

Source: WMG survey 2021

Table 6.18 shows that there is no obvious correlation between increase in net income and increased cropping intensity (CI), reduction in water management problem scores (WMPS), and increase in area of high value crops (HVC - vegetables and water melon).

However, farmers in the FGDs repeatedly said that improved water management had allowed them to crop more intensively, grow more valuable crops and get improved crop yields. There may be too much variation between WMGs within polders for this to show up when comparing the averages for different polders.

Table 6.18: Increase in farm income and performance indicators

Increase in net income	Number of polder	Average change in		
		CI*	WMPS	HVC area*
<40%	2	19%	0.83	-10%
40-100%	5	54%	1.50	10%
100-150%	2	63%	1.53	23%
150-200%	7	58%	1.33	16%
>200%	6	44%	1.63	10%

**** change in percentage points;*** **Source: WMG survey 2021**

Return to the investment in BGP[edit | edit source]

The increase in net farm income can be compared with expenditure of project funds to see if benefits

(in terms of increased farm income) are sufficient to justify the investment in BGP. Cumulative expenditure of BGP funds up to June 2021 is shown in Table 6.19. The BWDB and DAE expenditure includes GoB contributions to BGP costs.

Table 6.19: Cumulative expenditure

	Million BDT				Total per WMG
zone	**BWDB**	**DAE**	**TA**	**Total**	**Million BDT**
Khulna	1090.44	29.16	1259.11	2378.71	9.15
Satkhira	263.38	13.79	311.71	588.88	9.20
Patuakhali	1457.52	44.85	1689.58	3191.95	17.54
total	2811.34	87.80	3260.41	6159.55	12.17

Source: WMG survey 2021

Table 6.20 shows the payback period required for the increase in annual net farm income to equal the cumulative project expenditure. As annual benefits of BDT 7,773 million exceed cumulative expenditure of BDT 6,160 million, the payback period is only 0.79 of a year (about 41 weeks). But this varies considerably between polders. Net farm income has declined in polder 28/2 so there is no payback period here. For other polders it ranges from 0.22 years in polder 25 to 3.12 years in polder 47/3.

Table 6.20 also shows the expenditure and benefits per WMG per polder. Average BGP expenditure per WMG is BDT 12.17 million and average benefit is BDT 15.36 million. Average benefit is fairly similar between the three zones, but there is considerable variation between polders in Khulna and Patuakhali. Average expenditure per WMG also varies greatly between polders, but on average this is higher in Patuakhali than in the other two zones – so the average payback period for Patuakhali is longer (1.14 years).

Table 6.20: Payback period for project investment

	Expenditure	Benefit	Payback	Per WMG (BDT m)	
polder	**BDT m.**	**BDT m.**	**years**	**Expenditure**	**Benefit**
Khulna					
22	108.97	156.58	0.70	9.08	13.05
25	294.23	1324.27	0.22	4.82	21.71
26	260.74	267.63	0.97	17.38	17.84
27/1	102.20	227.35	0.45	6.81	15.16
27/2	36.99	53.71	0.69	6.17	8.95
28/1	84.50	29.18	2.90	7.04	2.43
28/2	236.86	-36.59	-6.47	19.74	-3.05
29	386.22	1015.26	0.38	6.90	18.13
30	272.15	426.07	0.64	6.80	10.65
31P	280.22	363.58	0.77	23.35	30.30
34/2P	315.65	135.03	2.34	16.61	7.11
sub-total	2378.71	3962.09	0.60	9.15	15.24
		Satkhira			
2&2E	588.88	1016.23	0.58	9.20	15.88
		Patuakhali			

43/1A	120.85	161.14	0.75	9.30	12.40
43/2A	415.28	257.26	1.61	20.76	12.86
43/2B	455.62	580.70	0.78	16.27	20.74
43/2D	333.34	289.37	1.15	12.35	10.72
43/2E	37.16	100.48	0.37	3.10	8.37
43/2F	310.74	300.40	1.03	11.51	11.13
47/3	207.33	66.46	3.12	25.92	8.31
47/4	693.65	300.66	2.31	38.54	16.70
55/2A	346.67	359.64	0.96	26.67	27.66
55/2C	271.30	378.37	0.72	16.96	23.65
sub-total	3191.95	2794.47	1.14	17.54	15.35
Total	6159.55	7772.79	0.79	12.17	15.36

Source: WMG survey 2021

The four polders with very fast payback (under 0.5 years) have an average benefit of BDT 15.84 million – only a little more than the average for all polders, but their average expenditure is only BDT 5.14 million, under half of the average for all polders of BDT 12.17 million. It may be that the physical circumstances of these polders made water management improvement less costly than in other polders. The five polders (excluding 28/2) with a payback period of over 1.5 years, have average benefits of BDT 9.48 million per WMG, well below the average of 15.36, as well as above average expenditure of BDT 21.77 million. Polder 28/1 is in this group. Although its expenditure is well below average, it has lower benefits for any polder apart from 28/2. Polders 47/3 and 47/4 are also in this group. BG activities started later in these polders, but benefits per WMG in 47/4 are above average – but it has the highest expenditure per WMG of any polder.

An economic analysis of the investment in BGP has been carried out in order to calculate the economic internal rate of return. As in preceding calculation of the payback period, this analysis is limited to the impact of BGP interventions in water management and agricultural extension on crop production and aquaculture in ghers. The analysis has adjusted input and output prices to reflect their real value to the economy. The analysis uses the same data that was collected for the 2021 WMG survey. The analysis covers project costs and benefits over a 30 year period, with investment expenditure on BGP taking place over the first eight of these years (2013-14 to 2020-21).[Notes 4]

EIRR calculations assume that only a proportion of the improvement in cropping patters and crop yields reported in the WMG survey can be attributed to BGP. Interviews for 2021 WMG survey mostly attributed between 40% and 60% of the increase in farm income to BGP interventions. The base case for EIRR calculations assume that 25% of the increase in net farm income can be attributed to BG interventions. This results in an EIRR of 42%.

The EIRR has also been calculated with smaller proportions of the increase in farm income attributed to BGP. This shows that EIRR remains at an acceptable 15% even if only 10% of the increase in farm income is attributed to BGP. The effect of BGP benefits not being sustained has also been examined. If net benefits were to cease in 2023-24, two years after completion, then the EIRR would be reduced from 42% to 38% in the base case but would still be an acceptable 15% if only 15% of the increase in farm income were attributed to BGP. It is not surprising that investment in BGP has generated rapid returns and the resulting increase in farm income very quickly equals the investment cost. Improvements in water management infrastructure have removed bottlenecks in an existing system. No account has been taken of the original investment in building the system in the first place as this is a sunk cost. Removing bottlenecks gets the whole system, including the original

investments, to work better. Similarly, extension training enables farmers to get their own production systems to work better. Training does not cost much, while increasing productivity generates more income for very little extra cost, mainly harvesting and marketing the increased volume of production.

Notes[edit | edit source]

1. ↑ Section E (chapters 21, 22 and 23) of this Final Report provides more information on Blue Gold's approaches, interventions and results on agricultural development.
2. ↑ Only one polder (28/2) in Khulna recorded a fall of 6 percentage points, going from 199% to 193% (but there has been some recovery since 2019 when cropping intensity was only 162%). Polder 28/2 is close to Khulna city and is being absorbed into the expanding urban area.
3. ↑ Many farmers have adopted modern, high yielding types of mung bean, especially BARI-6. However, these improved types inter-breed with older local types, so much mung bean is of a semi-improved type. For this reason, this report has not tried to differentiate between modern and local varieties of mung bean.
4. ↑ The small amount of BG investment in 2021-22 has been excluded as data on benefits refers to the project prior to this expenditure. No further benefits are assumed beyond those quantified in the 2021 WMG survey.

See more[edit | edit source]

Previous chapter:		Next chapter:
Chapter 05: Outcomes and Impact from Participatory Water Management	**Blue Gold Lessons Learnt Wiki Section B: Development Outcomes**	**Chapter 07: Inclusive Development Approach: Outcomes and Impacts from Homestead Based Production**

Section B: Development Outcomes

Chapter 05: Outcomes and Impact from Participatory Water Management	Chapter 06: Outcomes and Impact from Agricultural Development	Chapter 07: Inclusive Development Approach: Outcomes and Impacts from Homestead Based Production
1. Increased resilience against climatic variability: outcomes and impact of rehabilitation work on water management 2. Organised coastal communities: outcomes and impact of institutional development	1. Changes in crop agricultural production 2. Change in cropping pattern and crop types 3. Increase in Cropping intensity 4. Increase in Crop yields 5. Increase in employment through agricultural development 6. Economic return of improved agriculture production	1. Homestead vegetables production 2. Homestead fruit production 3. Commercial fruit production 4. Poultry rearing 5. Goats 6. Cattle and buffalo 7. Pond fisheries 8. Feedback from FGDs on homestead production 9. Problems of agricultural and homestead production

Chapter 08: The Outcomes and Impact on the Livelihoods of Women	Chapter 09: The Overall Outcomes and Impacts on the Livelihoods of Coastal Communities in Blue Gold Polders
1. Women's role in economic activities 2. Main Occupation of women 3. Equality in food consumption 4. Decision making regarding assets and land 5. Mobility and participation 6. Overall empowerment of women	1. General features of coastal households 2. Land ownership and land tenure 3. Improvement in household income and asset 4. Enterprise development 5. Improvements in Living Standards

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A livelihood is a way of making a living. It comprises capabilities, skills, assets (including material and social resources), and activities that households put together to produce food, meet basic needs, earn income, or establish a means of living in any other way.

Blue Gold Program

A process by which the local stakeholders are directly and actively involved in identification, planning, design, implementation, operation & maintenance and evaluation of a water management project.

0-30 cm: intermittent flooding, land suited to HYV T Aman in monsoon season

Prone to seasonal (<9 months) or perennial flooding (>9 months), land on which B aman can be grown in the monsoon season. Flood depth 180-300 cm or more

An area enclosed by low embankments to store either freshwater or brackish water for the production of fish, shrimps or prawns.

Water Management Group - The basic organizational unit in Blue Gold representing local stakeholders from a hydrological or social unit (para/village). Through Blue Gold, 511 WMGs have been formed and registered. The average WMG covers an area of around 230 ha has 365 households or a population of just over 1,500.

The first part of the kharif season (mid-March to mid-June). Rainfall is variable and temperatures are high. The main crops are aus, summer vegetables and pulses. Broadcast aman and jute are planted.

The second part of the kharif season (mid-June to mid-October) characterised by heavy rain and floods. T Aman is the major crop grown in this season. Jute is harvested.

A rice crop planted under irrigation during the dry season from December to March and harvested between April and June. Local boro varieties are more tolerant of cool temperatures and are usually planted in areas which are subject to early flooding. Improved varieties, less tolerant of cool conditions, are usually transplanted from February onwards. All varieties are insensitive to daylength.

The dry season (typically mid-October to mid-March) with low or minimal rainfall, high evapotranspiration rates, low temperatures and clear skies with bright sunshine. Crops grown are boro, pulses, sunflower, sesame and mungbean.

An area enclosed by low embankments to store either freshwater or brackish water for the production of fish, shrimps or prawns.

An area of low-lying land surrounded by an earthen embankment to prevent flooding by river or

seawater, with associated structures which are provided to either drain excess rainwater within the polder or to admit freshwater to be stored in a khal for subsequent use for irrigation.

Water Management Group - The basic organizational unit in Blue Gold representing local stakeholders from a hydrological or social unit (para/village). Through Blue Gold, 511 WMGs have been formed and registered. The average WMG covers an area of around 230 ha has 365 households or a population of just over 1,500.

a rice crop planted in March/April under dryland conditions. Matures during pre-monsoonal showers and is harvested in June/July. Insensitive to daylength.

a rice crop usually planted in March/April under dryland conditions, but in areas liable to deep flooding. Also known as deepwater rice. Harvested from October to December. All varieties are highly sensitive to daylength.

human intervention in the capture, conveyance, utilisation and drainage of surface and/or ground water in a certain area: a process of social interaction between stakeholders around the issue of water control.

Cropping intensity - The number of crop harvest per unit land per year. The average cropping intensity (CI) is calculated as the total area of all crops per year divided by the area of cultivable land. In its CI calculations BGP treats fish ghers as another crop; the DAE method excludes fish ghers in its CI calculations. Hence the CI calculated by BGP is higher than as calculated by DAE.

Varieties developed by farmers, sometimes referred to as local improved varieties (LIVs)

High Yielding Variety - Introduced varieties developed through formal breeding programs. HYVs have a higher yield potential than local varieties but require correspondingly high inputs of fertiliser and irrigation to achieve high yields.

low value crop(s)

Local pulse crop

Focus Group Discussions - in which a group of participants from similar backgrounds or experiences gather to discuss a specific topic of interest, guided by a group facilitator who introduces the topics for discussion and helps the group to participate in a lively and natural discussion amongst themselves

Soil is regarded as waterlogged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail. In agriculture, various crops need air (specifically, oxygen) to a greater or lesser depth in the soil. Waterlogging of the soil stops air getting in. How near the water table must be to the surface for the ground to be classed as

waterlogged, varies with the purpose in view. A crop's demand for freedom from waterlogging may vary between seasons of the year.

Focus Group Discussions - in which a group of participants from similar backgrounds or experiences gather to discuss a specific topic of interest, guided by a group facilitator who introduces the topics for discussion and helps the group to participate in a lively and natural discussion amongst themselves

Department of Agricultural Extension, a department of the Ministry of Agriculture responsible for disseminating scientific research and new knowledge on agricultural practices through communication and learning activities for farmers in agriculture, agricultural marketing, nutrition and business studies.

Water Management Problem Score

Cropping intensity - The number of crop harvest per unit land per year. The average cropping intensity (CI) is calculated as the total area of all crops per year divided by the area of cultivable land. In its CI calculations BGP treats fish ghers as another crop; the DAE method excludes fish ghers in its CI calculations. Hence the CI calculated by BGP is higher than as calculated by DAE.

hectare

Household

Bangladesh Taka

high value crop(s)

Bangladesh Water Development Board, government agency which is responsible for surface water and groundwater management in Bangladesh, and lead implementing agency for the Blue Gold Program

Government of Bangladesh; a donor to the Blue Gold Program

Technical Assistance

A defined set of temporary activities through which facilitators seek to effect change

Bangladesh Agricultural Research Institute

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Namespaces

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Variants

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Blue Gold Program Wiki

The wiki version of the Lessons Learnt Report of the Blue Gold program, documents the experiences of a technical assistance (TA) team working in a development project implemented by the Bangladesh Water Development Board (BWDB) and the Department of Agricultural Extension (DAE) over an eight+ year period from March 2013 to December 2021. The wiki lessons learnt report (LLR) is intended to complement the BWDB and DAE project completion reports (PCRs), with the aim of recording lessons learnt for use in the design and implementation of future interventions in the coastal zone.

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