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SHRIMP CULTIVATION IN SOUTHWEST COASTAL BANGLADESH: A REVIEW OF COVERAGE AREA AND PRODUCTION

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Abstract: This study administers a survey on available literatures and secondary data sources on shrimp cultivation in Bangladesh. The survey results indicate that there are significant variations in production and area coverage data under shrimp farming in the country. It also finds a lack of uniqueness and uniformity in the available dataset. This study uses the concept of extrapolation and makes some assumptions to confine into a representative and updated dataset of shrimp and prawn cultivated area and production in the south-west region of Bangladesh. The study findings indicate that the calculated shrimp and prawn cultivated area in the region is 0.19 million hectare (ha) with 0.15 million ha minimum and 0.23 million ha maximum values for the year 2011. It also confines the shrimp and prawn production value to 369 million US$ with 155 million US$ minimum and 667 million US$ maximum values in the region for the year 2011. Since there is no consensus yet in the literatures about the shrimp and prawn area coverage and production data, the findings of this study may be a benchmark for future studies.

Keywords: Shrimp cultivation, Area coverage, Production, South-west Bangladesh

Introduction

Shrimp farming is an important economic activity in Bangladesh (UNEP, 1999). It helps to reduce poverty, generate employment and earn foreign exchanges for the country (Huntington, 2003; Masum, 2008; and PRICE, 2010). On the contrary, destruction of mangroves, conversion of rice fields into shrimp ponds, salinization of agricultural lands, deterioration of groundwater quality, drinking water crisis, health hazards, reduction in production of other agricultural crops and livestock resources in the surrounding areas are some adverse social and environmental effects of shrimp farming (Pillay, 1992; Primavera, 1991; and Rajalakshmi, 2002).

Shrimp farming has been expanding in Bangladesh since mid 1980s (Alauddin & Hamid, 1999; DTS, 2006 and Gammage *et al.*, 2005). It has been influencing the socio-economic, institutional, ecological and environmental conditions of the coastal regions of Bangladesh (Barmon *et al.*, 2011). *Bagda* (*P. monodon* or shrimp) and *golda* (*M. rosenbergii* or prawn) are the two main varieties of shrimp that are cultured in Bangladesh (DTS, 2006; Huntington, 2003; and Khatun, 2004). *Bagda* is cultivated in brackish water of the coastal regions, while *golda* is cultivated in fresh water of the country. The available dataset and

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studies often consider both the *bagda* and *golda* together instead of describing these two separately. A number of studies, such as Abedin & Kabir (1999), Abedin *et al.* (1997), Ahmed *et al.* (2008), Bhattacharya *et al.* (1999), Haque (2004), and Hasanuzzaman *et al.* (2011) tried to address the shrimp sector of Bangladesh from the economic perspective. These studies mostly consider secondary dataset while evaluating the shrimp sector.

In addition to Bureau of Statistics (BBS) and Department of Fisheries (DOF) of Bangladesh, Alauddin & Hamid (1999), ATDP II (2005), Barraclough & Finger-Stich (1996), DOF (1994), DTS (2006), Khatun (2004), MPO (1986), Nupur (2010), Raux and Bailly (2002), Rosenberry (1995), Sarwar (2005), and NACA (2002) are some important sources that reported shrimp cultivated area and production data in Bangladesh.

However, an intensive review of the said literatures reveals that there are significant variation in production and area coverage dataset under shrimp cultivation in the country. The reporting time for shrimp cultivated area and production data in the said literatures also vary significantly. Therefore, the authors attempt to calculate a representative and updated dataset of shrimp cultivated area and production. Accordingly, the main objective of the study is to construct an updated, representative and comprehensive dataset of shrimp cultivated area and shrimp production in the south-west region of Bangladesh.

Materials and methods

This study is mainly based on secondary data. Ahmed et al. (2008), Alauddin & Hamid (1999), ATDP II (2005), Barraclough & Finger-Stich (1996), BBS (2007 and 2011), DOF (1994 and 2011), DTS (2006), Hasanuzzaman et al. (2011), Huntington (2003), Khatun (2004), MPO (1986), NACA (2002), Nupur (2010), Raux and Bailly (2002), Rosenberry (1995), Sarwar (2005), and Williams & Khan (2001) are the main data sources for the study.

A survey on the available secondary sources indicates that a separate discussion and published dataset on shrimp (*bagda*) sector alone are scarce. Rather, the available sources often discuss both the shrimp and prawn together. Therefore, this study considers both shrimp and prawn (SP) aquaculture together. It is observed that there are variations in quantity, timing as well as units used in quantifying the shrimp production in Bangladesh. Therefore, this study considers 2011 as the study year and tries to convert the available price and monetary data of various years to present value (PV) of the year 2011. Moreover, this study uses 1 US$=80 Tk[1] exchange rate to convert the 'PV at Tk' in US$. The study primarily focuses on the south-west (SW) region of Bangladesh. The Khulna, Satkhira and Bagerhat districts are defined as the SW region of Bangladesh in this study. The basic socio-economic and demographic features of the region are listed in Table 1.

Table 1: Overview on the SW Region of Bangladesh

Item \ Location	Khulna	Bagerhat	Satkhira	SW Region	Bangladesh	Share of SW
Household (No.)	499,324	323,505	390,745	1,213,574	25,490,822	4.76%
Population (No.)	2,378,971	1,549,031	1,864,704	5,792,706	124,355,263	4.66%
Area (sq. km)	4,395	3,959	3,858	12,212	147,570	8.28%
Literacy rate (%)	57.81	58.73	45.52	-	46.15	-

Source: BBS (2011) and Authors' compilation.

[1]Taka (Tk) is the currency of Bangladesh.

The present study also tries to extend the result and predict for the whole SP producing area of the country. It considers Chittagong and Cox's bazaar districts in addition to the SW region while discussing from Bangladesh perspective. The considered five districts (Khulna, Satkhira, Bagerhat, Chittagong and Cox's bazaar) cover more than 90 percent of total SP producing areas in the country.

To construct a representative data of SP production, the study uses six approaches, developed by the authors (Fig. 1). The first approach uses total SP production data (in kg) and converts it into million US$ using price data and conversion factor (1 US$=80 Tk). Approach 2 uses total SP cultivated area in hectare (ha) and *per* unit production (in kg/ha) data and converts it into million US$ following the same method described for Approach 1.

The third and fourth approaches use total SP cultivated area (in ha) and divide it under *bagda* and *galda* categories using available data. The third approach uses per unit production (in kg/ha) data and the fourth approach uses per unit production (in Tk/ha) data. Finally, in both the third and fourth approaches, the calculated results are converted into million US$.

The fifth and sixth approaches use total cultivated area (in ha) and divide it under extensive, semi-intensive and intensive cultivation methods of SP farming using available data. The fifth approach uses per unit production (in kg/ha) data and the sixth approach uses per unit production (in Tk/ha) data. Finally, in both the fifth and sixth approaches, the calculated results are converted into million US$.

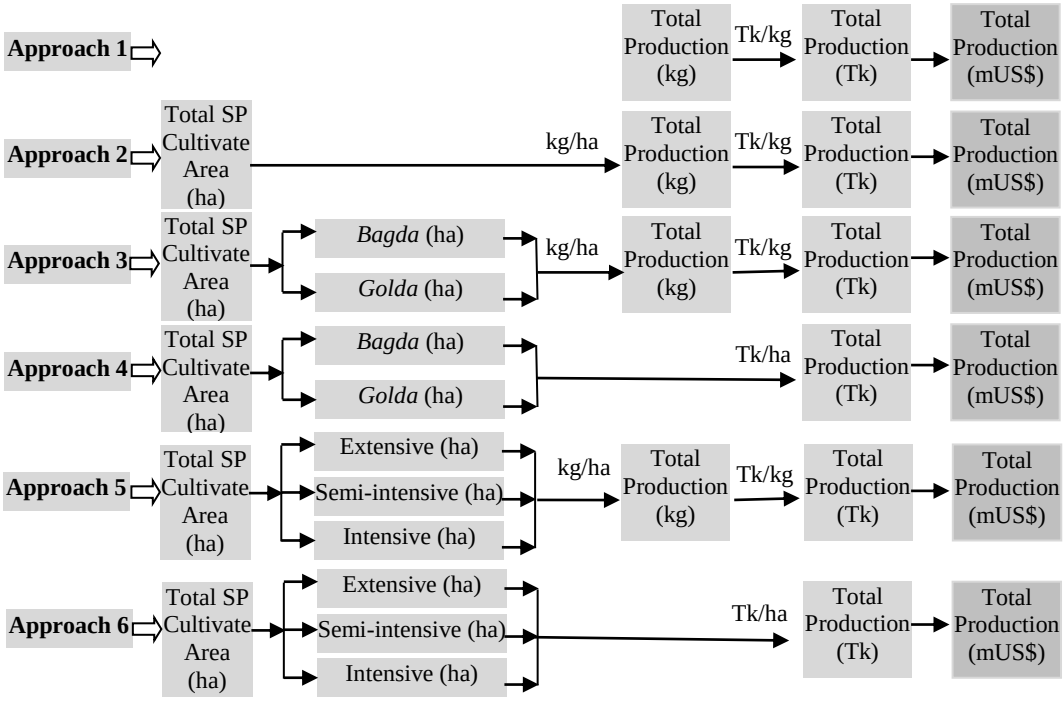

Fig.1: Approaches for quantifying shrimp and prawn (SP) production

Fig. 1 briefly describes the considered six approaches. There is no consensus yet in the literatures about which method suits best for calculating the monetary value of produced SP. Moreover, the calculated results vary significantly from each other. Hence, it might be difficult and misleading to advocate for one or more of the said approaches as best fit. For the very reason, the study considers all of these approaches and finally calculates the simple average of these six approaches to confine into a specific number. It also reports the standard deviation of the calculated average value.

Results and discussion

SP cultivated area

Bangladesh Bureau of Statistics (BBS) and Department of Fisheries (DOF) are the main sources for secondary data on SP cultivated area in Bangladesh. According to BBS and DOF database, SP cultivated areas are 0.16 and 0.22 million ha in 2008-2009 for SW region and Bangladesh, respectively with yearly averages of 0.14 and 0.18 million ha for the region and country during the period 1999-2009 (Table 2).

Table 2: Shrimp and prawn (SP) cultivated area during 1999-2009

Region / Year	SP Cultivated Area (ha)					Percent
	Khulna	Bagerhat	Satkhira	SW region	Bangladesh	Share of SW
1999-2000	29,551	47,710	29,544	106,805	141,353	75.56%
2008-2009	51,921	59,424	52,357	163,702	217,877	75.13%
Yearly Average	40,736	53,567	40,950	135,253	179,615	75.35%
Yearly Change	6.46%	2.47%	6.56%	4.86%	4.92%	-

Source: BBS (2007 and 2011) and DOF (2011).

However, a mismatch is observed among the data regarding SP cultivated area reported in some other literatures with the BBS and DOF dataset. Most of the available literatures reported country level data and the reporting year varies significantly across the studies (Table 3). Therefore, this study attempts to generate a representative dataset on SP cultivated area using all of the available information.

Table 3 demonstrates a divergent scenario of SP cultivated area in Bangladesh. The reporting years widely vary among the cited sources of Table 3. Similarly, a divergent scenario is observed regarding the share of SW region in total shrimp cultivated area of Bangladesh. For example, Nupur (2010) states that about 80 percent of the shrimp farming areas are situated in the south-west region of Bangladesh, while the rest are in the south-east part of the country. However, the BBS dataset provides more specific information: the SW region comprises 75.35 percent of total SP cultivated area of the country during 1999-2009. Some available literatures state that the shrimp cultivating area of Bangladesh grows at around 10-20 percent per annum (Ahmed *et al*., 2008; Huntington, 2003; Khatun, 2004; and Williams & Khan, 2001). However, Khatun (2004) talks only about *bagda*, Ahmed *et al.* (2008) refer to *galda* only and Huntington (2003) and Williams & Khan (2001) consider both *bagda* and *golda*. All of these growth related information seem to be approximate figures. Moreover, none of them describes the growth in the SW region. In contrast, the BBS dataset reports 4.86 percent and 4.92 percent annual compound growth rate of SP cultivated area for the SW region and Bangladesh, respectively during 1999-2009. Therefore, this study

proceeds with this BBS information regarding the share of SW region and growth for calculating the SP cultivated area for the SW region and Bangladesh over the time period.

Table 3: Shrimp and prawn (SP) cultivated area in various years

Serial No.	Source	SP Cultivated Area (ha)		
		Reporting Year	SW region	Bangladesh
1	MPO (1986)	1983	-	51,000
2	Alauddin & Hamid (1999)	1983	-	51,000
3	Rosenberry (1995)	1994	-	134,000
4	DOF (1994)	1994	-	134,000
5	Barraclough & Finger-Stich (1996)	1996	-	110,000
6	NACA (2002)	1996	-	140,000
7	Raux & Bailly (2002)	1997	-	140,000
8	DTS (2006)	2003	-	203,071
9	Sarwar (2005)	2004	115,900	-
10	Khatun (2004)	2004	-	197,687
11	ATDP II (2005)	2005	-	200,000
12	Nupur (2010)	2008	-	217,887

Source: Authors' compilation based on Alauddin & Hamid (1999), ATDP II (2005), Barraclough & Finger-Stich (1996), DOF (1994), DTS (2006), Khatun (2004), MPO (1986), Nupur (2010), Raux & Bailly (2002), Rosenberry (1995), Sarwar (2005), and NACA (2002).

Table 4: Shrimp and prawn (SP) cultivated area

	SW Region (ha)			Bangladesh (ha)		
Year	Minimum	Average	Maximum	Minimum	Average	Maximum
1980	35,320	44,505	51,961	44,150	58,105	68,361
1985	42,305	56,197	65,873	56,147	73,893	86,936
1990	53,800	71,259	83,511	71,404	93,971	110,558
1995	68,419	90,364	105,937	90,805	119,506	140,599
2000	87,010	114,695	134,723	115,479	151,978	178,803
2005	110,653	145,640	171,330	146,858	193,265	227,388
2010	140,720	185,090	217,885	186,762	245,721	289,175
2011	147,650	194,186	228,615	195,960	257,810	303,417

Source: Authors' compilation based on Ahmed *et al.* (2008), Alauddin & Hamid (1999), ATDP II (2005), Barraclough & Finger-Stich (1996), BBS (2007 and 2011), DOF (1994 and 2011), DTS (2006), Huntington (2003), Khatun (2004), MPO (1986), NACA (2002), Nupur (2010), Raux & Bailly (2002), Rosenberry (1995), Sarwar (2005), and Williams & Khan (2001).

Based on the BBS dataset regarding the SW region's share and expansion of SP cultivated area, this study attempts to extrapolate the information of Table 3 for both SW region and Bangladesh during period 1980 to 2011. It assumes that the share and growth

information is true for the whole period. After extrapolating data of each of the reported studies in Table 3 for both SW region and Bangladesh separately for the period 1980-2011, it calculates year-wise simple averages to confine into a specific number for each year. Side-by-side, this study reports the year-wise minimum and maximum values to understand at least a range value of the SP cultivated area, if the calculated average value fails to represent the true scenario. The calculated results are reported in Table A1 of Annex and Table 4. According to the extrapolation based calculations, the calculated SP cultivation area in the SW region of Bangladesh is 0.19 million ha with 0.15 million ha minimum and 0.23 million ha maximum values for the year 2011. Similarly, the calculated SP cultivation area in Bangladesh is 0.26 million ha with 0.20 million ha minimum and 0.30 million ha maximum values for the year 2011.

SP production

This study uses six approaches, developed by the authors, to quantify the production of SP. The available information regarding production data is not well-organized and mismatches are found for the same variable cited in different sources. For example, some studies report total production in 'kg per year' while some others report production in 'kg per ha'. Some studies consider both *bagda* and *golda* together, while some others consider these two separately in reporting production data. Moreover, some studies report production data on the basis of production methods, such as, extensive, semi-intensive and intensive farming approaches. In reporting shrimp type-wise or method-wise production data, again, some sources report production in 'kg per ha' while some others report 'Tk per ha'. Consequently, the logical calculation from the approaches generates divergent results and there is no consensus yet about which one best fits to the real scenario.

Table 5: Shrimp and prawn (SP) production: Approach 1

Item	Unit	Symbol	Minimum	Average	Maximum
Production (Bangladesh)	kg/year	A	21,000,000	46,686,487	70,722,406
Production (SW region)	kg/year	B=A*0.75	15,822,875	35,176,878	53,287,228
Price	Tk/kg	C	629	760	953
Production (SW region)	Million Tk/year	D=B*C/1 million	9,949	26,744	50,766
Production (SW region)	Million US$/year	E=D/80	124.37	334.30	634.58

N.B.: The minimum, average and maximum production (in kg/year) of SP in Bangladesh are reported in 'A'. This study uses the information of BBS (2011), Huntington (2003), Raux & Bailly (2002), DTS (2006) and NACA (2002) to find production data of Bangladesh. Taking the BBS information regarding share of SW region in Bangladesh, it calculates the production (kg/year) of SP in SW region ('B'). Then, it uses the information of DTS (2006) and Hasanuzzaman et al. (2011) for price of shrimp and corresponding minimum, average and maximum values are reported in 'C'. Finally, it assumes 1 US$=Tk 80 to calculate SP production in the SW region of Bangladesh for year 2011 ('E').

Source: Authors' compilation based on BBS (2007 and 2011), Hasanuzzaman *et al.* (2011), Huntington (2003), Raux and Bailly (2002), DTS (2006), and NACA (2002).

Approach 1 uses the information provided by BBS (2011), Huntington (2003), Raux & Bailly (2002), DTS (2006) and NACA (2002) to calculate shrimp production in Bangladesh. Taking the BBS information regarding the share of SW region in Bangladesh, it calculates the production (in kg/year) of SP in SW region. Then, it uses the information of DTS (2006) and Hasanuzzaman *et al.* (2011) for price of shrimp and corresponding minimum, average and maximum values are calculated. Finally, it assumes 1 US$=Tk 80 to calculate SP production in the SW region of Bangladesh for the year 2011. According to this approach, the average SP production in SW region of Bangladesh is 334 million US$ with 124 million US$ minimum and 635 million US$ maximum values for the year 2011 (Table 5).

Approach 2 uses the information of minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh from Muir (2003), Rahman (1999) and Raux & Bailly (2002) for getting per unit production (in kg/ha/year) data. Then, it calculates the production (in kg/year) of SP in SW region. It uses the information of DTS (2006) and Hasanuzzaman *et al.* (2011) for price of shrimp and corresponding minimum, average and maximum values are calculated. Finally, it calculates SP production in the SW region of Bangladesh for the year 2011. The calculation results reveal that the average SP production in SW region of Bangladesh is 475 million US$ with 232 million US$ minimum and 915 million US$ maximum values for the year 2011 (Table 6).

Table 6: Shrimp and prawn (SP) production: Approach 2

Item	Unit	Symbol	Minimum	Average	Maximum
Area (SW region)	ha	A	147,650	194,186	228,615
Production	kg/ha/year	B	200	257	336
Production (SW region)	kg/year	C=A*B	29,530,047	49,954,251	76,814,745
Price	Tk/kg	D	629	760	953
Production (SW region)	Million Tk/year	E=C*D/1 million	18,568	37,979	73,181
Production (SW region)	Million US$/year	F=E/80	232.11	474.74	914.76

N.B.: The minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh are reported in 'A'. This study uses the information of Muir (2003), Rahman (1999) and Raux & Bailly (2002) for getting per unit production (in kg/ha/year) data ('B'). Then, it calculates the production (in kg/year) of SP in SW region ('C'). It uses the information of DTS (2006) and Hasanuzzaman et al. (2011) for price of shrimp and corresponding minimum, average and maximum values are reported in 'D'. Finally, it assumes 1 US$=Tk 80 to calculate SP production in the SW region of Bangladesh for year 2011 ('F').

Source: Authors' compilation based on Hasanuzzaman *et al.* (2011), Muir (2003), Rahman (1999), and Raux and Bailly (2002).

The third approach also uses the minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh from Huntington (2003) to divide the cultivated area under *bagda* and *galda*. Then, it uses the information provided by Aftabuzzaman (2004),

DTS (2006), Huntington (2003) and Khatun (2004) to get per unit *bagda* and *galda* production (in kg/ha/year). It also uses the information of DTS (2006) and Hasanuzzaman *et al.* (2011) for price of shrimp and corresponding minimum, average and maximum values are calculated. Finally, it calculates SP production for the year 2011. Table 7 illustrates that the average SP production in SW region of Bangladesh is 439 million US$ with 211 million US$ minimum and 800 million US$ maximum values for the year 2011 (Table 7).

Table 7: Shrimp and prawn (SP) production: Approach 3

Item	Unit	Symbol	Minimum	Average	Maximum
Area (SW region)	ha	A	147,650	194,186	228,615
Bagda Area (SW region)	ha	B	112,214	147,581	173,748
Galda Area (SW region)	ha	C	35,436	46,605	54,868
Bagda Production	kg/ha/year	D	133	179	230
Galda Production	kg/ha/year	E	336	426	496
Bagda Production (SW region)	kg/year	F=B*D	14,924,486	26,380,117	39,961,957
Galda Production (SW region)	kg/year	G=C*E	11,906,515	19,851,091	27,214,367
Price	Tk/kg	H	629	760	953
Bagda Production (SW region)	Million US$/year	I=F*H/80/1 million	117	251	476
Galda Production (SW region)	Million US$/year	J=G*H/80/1 million	94	189	324
Production (SW region)	Million US$/year	K=I+J	210.89	439.36	799.98

N.B.: The minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh are reported in 'A'. This study uses the information of Huntington (2003) to divide the cultivated area under bagda and galda ('B & C'). Then, it uses the information of Aftabuzzaman (2004), DTS (2006), Huntington (2003) and Khatun (2004) to get per unit bagda and galda production (in kg/ha/year) ('D & E'). It uses the information of DTS (2006) and Hasanuzzaman et al. (2011) for price of shrimp and corresponding minimum, average and maximum values are reported in 'H'. Finally, it assumes 1 US$=Tk. 80 to calculate SP production in the SW region of Bangladesh for year 2011 ('K').

Source: Authors' compilation based on Aftabuzzaman (2004), Hasanuzzaman *et al.* (2011), Huntington (2003), Khatun (2004), and DTS (2006).

Approach 4 starts with the information of minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh from Huntington (2003) to divide the cultivated area under *bagda* and *galda*. Then, it uses DTS (2006) data to get per unit *bagda* and *galda* production (in US$/ha). Finally, it calculates SP production in the SW region of Bangladesh for the year 2011. Table 8 illustrates that the average SP production in SW region of Bangladesh is 322 million US$ with 245 million US$ minimum and 379 million US$ maximum values for the year 2011 (Table 8).

Table 8: Shrimp and prawn (SP) production: Approach 4

Item	Unit	Symbol	Minimum	Average	Maximum
Area (SW region)	ha	A	147,650	194,186	228,615
Bagda Area (SW region)	ha	B	112,214	147,581	173,748
Galda Area (SW region)	ha	C	35,436	46,605	54,868
Bagda Production	US$/ha	D	1,027	1,027	1,027
Galda Production	US$/ha	E	3,648	3,648	3,648
Bagda Production (SW region)	Million US$/year	F=B*D/1 million	115	152	179
Galda Production (SW region)	Million US$/year	G=C*E/1 million	129	170	200
Production (SW region)	Million US$/year	H=F+G	244.58	321.66	378.70

N.B.: The minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh are reported in 'A'. This study uses the information of Huntington (2003) to divide the cultivated area under bagda and galda ('B & C'). Then, it uses the information of DTS (2006) data to get per unit bagda and galda production (in US$/ha) ('D & E'). Finally, it calculates SP production in the SW region of Bangladesh for year 2011 ('H').

Source: Authors' compilation based on Huntington (2003), and DTS (2006).

The fifth approach also uses the minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh from Paul & Vogl (2011) and NACA (2002) to divide the cultivated area under Extensive, Semi-intensive and Intensive methods. Then, it uses information of Bhattacharya *et al.* (1999), Gammage *et al.* (2005), Haque (2004), Mazid (1994), Rosenberry (1995) and DTS (2006) to get per unit production (in kg/ha/year) data for different methods. It also uses the information of DTS (2006) and Hasanuzzaman *et al.* (2011) for price of shrimp and corresponding minimum, average and maximum values are calculated. Finally, it calculates SP production in the SW region of Bangladesh for the year 2011. According to this approach, the average SP production in SW region of Bangladesh is 451 million US$ with 85 million US$ minimum and 936 million US$ maximum values for the year 2011 (Table 9).

Approach 6 also starts with the information of minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh from Paul & Vogl (2011) and NACA (2002) to divide the cultivated area under Extensive, Semi-intensive and Intensive methods. Then, it uses the information of Gammage *et al.* (2005), Haque (2004) and DTS (2006) to get per unit production (in Tk/ha/year) data for different methods. Finally, it calculates SP production in the SW region of Bangladesh for the year 2011. Table 10 illustrates that the average SP production in SW region of Bangladesh is 191 million US$ with 36 million US$ minimum and 339 million US$ maximum values for the year 2011 (Table 10).

Table 9: Shrimp and prawn (SP) production: Approach 5

Item	Unit	Symbol	Minimum	Average	Maximum
Area (SW region)	ha	A	147,650	194,186	228,615
Ext. Area (SW region)	ha	B	103,355	155,348	205,754
Semi-Int. Area (SW region)	ha	C	14,765	33,982	5,715
Int. Area (SW region)	ha	D	-	4,855	11,431
Ext. Production	kg/ha/year	E	100	238	350
Semi-Int. Production	kg/ha/year	F	250	617	1000
Int. Production	kg/ha/year	G	1000	1500	2000
Ext. Production (SW region)	kg/year	H=B*E	10,335,516	36,895,268	72,013,823
Semi-Int. Production (SW)	kg/year	I=C*F	3,691,256	20,955,865	5,715,383
Int. Production (SW region)	kg/year	J=D*G	-	7,281,961	22,861,531
Price	Tk/kg	K	629	760	953
Ext. Production (SW region)	Million US$/year	L=H*K/80 /1 million	81	351	858
Semi-Int. Production (SW)	Million US$/year	M=I*K/80 /1 million	4	92	61
Int. Production (SW region)	Million US$/year	N=J*K/80 /1 million	-	8	18
Production (SW region)	Million US$/year	O=L+M+ N	84.99	450.84	936.37

N.B.: The minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh are reported in 'A'. This study uses the information of Paul & Vogl (2011) and NACA (2002) to divide the cultivated area under Extensive, Semi-intensive and Intensive methods ('B, C & D'). Then, it uses the information of Bhattacharya et al. (1999), Gammage et al. (2005), Haque (2004), Mazid (1994), Rosenberry (1995) and DTS (2006) to get per unit production (in kg/ha/year) data for different methods ('E, F & G'). It uses the information of DTS (2006) and Hasanuzzaman et al. (2011) for price of shrimp and corresponding minimum, average and maximum values are reported in 'K'. Finally, it assumes 1 US$=Tk 80 to calculate SP production in the SW region of Bangladesh for year 2011 ('O').

Source: Authors' compilation based on Bhattacharya *et al.* (1999), Gammage *et al.* (2005), Haque (2004), Mazid (1994), Paul and Vogl (2011), Rosenberry (1995), DTS (2006), and NACA (2002).

Table 10: Shrimp and prawn (SP) production: Approach 6

Item	Unit	Symbol	Minimum	Average	Maximum
Area (SW region)	ha	A	147,650	194,186	228,615
Ext. Area (SW region)	ha	B	103,355	155,348	205,754
Semi-Int. Area (SW region)	ha	C	14,765	33,982	5,715
Int. Area (SW region)	ha	D	0	4855	11431
Ext. Production	Tk/ha/year	E	8,339	49,044	95,904
Semi-Int. Production	Tk/ha/year	F	136,280	153,515	170,749
Int. Production	Tk/ha/year	G	439,412	498,451	557,490
Ext. Production (SW region)	Tk/year	H=B*E	861,928,196	7,618,958,305	19,732,611,865
Semi-Int. Production (SW)	Tk/year	I=C*F	2,012,178,092	5,216,813,166	975,898,716
Int. Production (SW region)	Tk/year	J=D*G	-	2,419,799,926	6,372,535,206
Ext. Production (SW region)	Million US$/year	K=H/80 /1 million	11	95	247
Semi-Int. Production (SW)	Million US$/year	L=I/80/1 million	25	65	12
Int. Production (SW region)	Million US$/year	M=J/80/ 1 million	0	30	80
Production (SW region)	Million US$/year	N=K+L+ M	35.93	190.69	338.51

N.B.: The minimum, average and maximum SP cultivated area (in ha) in the SW region of Bangladesh are reported in 'A'. This study uses the information of Paul & Vogl (2011) and NACA (2002) to divide the cultivated area under Extensive, Semi-intensive and Intensive methods ('B, C & D'). Then, it uses the information of Gammage et al. (2005), Haque (2004) and DTS (2006) to get per unit production (in Tk/ha/year) data for different methods ('E, F & G'). Finally, it assumes 1 US$=Tk 80 to calculate SP production in the SW region of Bangladesh for year 2011 ('N').

Source: Authors' compilation based on Gammage *et al.* (2005), Haque (2004), Paul and Vogl (2011), DTS (2006), and NACA (2002).

Table 11: Shrimp and prawn (SP) production in Southwest Bangladesh

Approach	Information used	Production in SW Region (Million US$ in 2011)		
		Minimum	Average	Maximum
1	Kg/year and Tk/kg	124.37	334.30	634.58
2	Kg/ha/year and Tk/kg	232.11	474.74	914.76
3	Shrimp type-wise kg/ha/year and Tk./kg	210.89	439.36	799.98
4	Shrimp type-wise kg/ha/year and Tk/ha	244.58	321.66	378.70
5	Production method-wise kg/ha/year and Tk/kg	84.99	450.84	936.37
6	Production method-wise kg/ha/year and Tk/ha	35.93	190.69	338.51
Average		**155.48**	**368.60**	**667.15**

Source: Authors' compilation based on Aftabuzzaman (2004), Ahmed *et al.* (2008), Alauddin & Hamid (1999), ATDP II (2005), Barraclough & Finger-Stich (1996), BBS (2007 & 2011), Bhattacharya *et al.* (1999), DOF (1994), DTS (2006), Gammage *et al.* (2005), Haque (2004), Hasanuzzaman *et al.* (2011), Huntington (2003), Khatun (2004), Mazid (1994), MPO (1986), Muir (2003), NACA (2002), Nupur (2010), Paul & Vogl (2011), Rahman (1999), Raux and Bailly (2002), Rosenberry (1995), Sarwar (2005), and Williams and Khan (2001).

The considered six approaches generate divergent results about SP production in the SW region of Bangladesh (Table 5-10). Therefore, this study takes a simple average to quantify SP production. The necessary adjustments are made to convert the results in present value of the year 2011. The corresponding minimum and maximum values are also reported to understand a range value of the SP production, if the calculated average value fails to represent the true scenario (Table 11). The study findings indicate that the minimum and maximum values of SP production in the SW region of Bangladesh are 155 and 667 million US$, respectively with an average value[2] of 369 (±108) million US$ for the year 2011. Following similar methodology, the study finds that the minimum and maximum values of SP production in Bangladesh are 207 and 893 million US$, respectively with an average value of 497 million US$ for the year 2011.

Conclusion

Review of available literatures finds a significant variation in the available data on shrimp cultivated area and shrimp production in Bangladesh. Diversity in reporting time, units of measurement, cultivation method, shrimp type and covered areas are the major issues that generate the variation. Moreover, dissimilarity is found among data of different sources even though reporting time and other features are similar. Therefore, the authors attempt to

[2]Value within parenthesis indicates standard deviation.

generate a representative and updated dataset of shrimp and prawn (SP) area coverage and production in the south-west region of Bangladesh. The authors try to represent the area data in ha and production data in US$. Year 2011 is the reporting year for this study. BBS and DOF are the two main sources that are consulted in this study. However, some other sources are also considered to confine into a specific number for the variables under consideration. The authors use the concept of extrapolation in this study to fill the data gap, as found to be necessary.

The study finds that the calculated SP cultivated area in the south-west region of Bangladesh is 0.19 million ha with 0.15 million ha minimum and 0.23 million ha maximum values for the year 2011. Similarly, the calculated SP cultivated area in Bangladesh is 0.26 million ha with 0.20 million ha minimum and 0.30 million ha maximum values for the year 2011. The calculations of this study under six approaches generate a wider variation in SP production data ranging from 36 to 936 million US$ for the south-west region of Bangladesh. Considering the simple average of these six approaches, this study confines the production value to 369 (±108) million US$ with 155 million US$ minimum and 667 million US$ maximum values for the year 2011 in the region. Similarly, the study findings indicate that the minimum and maximum values of SP production in Bangladesh are 207 and 893 million US$, respectively with an average value of 497 million US$ for the country in the year 2011.

This study calculates the shrimp and prawn area coverage and production using secondary information. It also makes some crucial assumptions, if relevant information are not available. Therefore, the accuracy of the study findings depends on the validity of those information sources and assumptions. For the very reason, the results of this study need to be carefully interpreted. Since there is no consensus yet in the literature about the shrimp area coverage and production data, the findings of this study may be a benchmark for future studies on shrimp sector of Bangladesh.

Disclaimer

The views expressed in this paper are those of the authors and do not necessarily reflect the views and policies of the Asian Development Bank (ADB), its Board of Governors, or the governments they represent. ADB does not guarantee the accuracy of the data included in this paper, and accepts no responsibility for any consequence of their use.

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Annex

Table A1: Shrimp and prawn (SP) cultivated area in southwest region and Bangladesh

	SW Region (ha)			Bangladesh (ha)		
Year	Minimum	Average	Maximum	Minimum	Average	Maximum
1980	35,320	44,505	51,961	44,150	58,105	68,361
1981	37,060	46,670	54,486	46,325	60,966	71,727
1982	38,885	48,940	57,133	48,606	63,969	75,260
1983	38,427	51,105	59,909	51,000	67,119	78,966
1984	40,319	53,590	62,821	53,512	70,425	82,855
1985	42,305	56,197	65,873	56,147	73,893	86,936
1986	44,389	58,930	69,074	58,912	77,532	91,217
1987	46,575	61,796	72,431	61,814	81,351	95,710
1988	48,868	64,802	75,950	64,858	85,357	100,423
1989	51,275	67,954	79,641	68,052	89,561	105,369
1990	53,800	71,259	83,511	71,404	93,971	110,558
1991	56,450	74,725	87,569	74,920	98,599	116,003
1992	59,230	78,359	91,824	78,610	103,455	121,716

	SW Region (ha)			Bangladesh (ha)		
Year	Minimum	Average	Maximum	Minimum	Average	Maximum
1993	62,147	82,171	96,286	82,481	108,550	127,710
1994	65,208	86,167	100,965	86,543	113,896	134,000
1995	68,419	90,364	105,937	90,805	119,506	140,599
1996	71,789	94,766	111,155	95,278	125,391	147,524
1997	75,324	99,393	116,629	99,970	131,566	154,789
1998	79,034	104,252	122,373	104,893	138,046	162,412
1999	82,926	109,349	128,400	110,059	144,845	170,411
2000	87,010	114,695	134,723	115,479	151,978	178,803
2001	91,295	120,303	141,358	121,167	159,463	187,609
2002	95,792	126,184	148,320	127,134	167,316	196,849
2003	100,509	132,354	155,624	133,395	175,556	206,543
2004	105,459	138,833	163,289	139,965	184,202	216,715
2005	110,653	145,640	171,330	146,858	193,265	227,388
2006	116,103	152,788	179,768	154,090	202,773	238,587
2007	121,820	160,288	188,622	161,679	212,749	250,337
2008	127,820	168,156	197,911	169,642	223,217	262,666
2009	134,115	176,420	207,658	177,996	234,199	275,602
2010	140,720	185,090	217,885	186,762	245,721	289,175
2011	147,650	194,186	228,615	195,960	257,810	303,417

Source: Authors' compilation based on Ahmed *et al.* (2008), Alauddin & Hamid (1999), ATDP II (2005), Barraclough & Finger-Stich (1996), BBS (2007 and 2011), DOF (1994 and 2011), DTS (2006), Huntington (2003), Khatun (2004), MPO (1986), NACA (2002), Nupur (2010), Raux & Bailly (2002), Rosenberry (1995), Sarwar (2005), and Williams & Khan (2001).