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ROLE OF AGRO-INDUSTRY IN BANGLADESH ECONOMY: AN EMPIRICAL ANALYSIS OF LINKAGES AND MULTIPLIERS

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Abstract

The study was undertaken to evaluate the contribution of agro-industry in the Bangladesh economy. The latest two input-output tables of the year 1993-94 and 2001-2002 in Bangladesh were used to calculate inter-industry linkage indices and multiplier effects. Agroindustry contributes a significant portion of national income and the prospect of employment generation is increasing at the higher extent for the sectors food processing, tanning and leather finishing, leather industry, saw milling and wooden furniture. Food processing, fish processing, tanning and leather finishing, leather fabrication, livestock, and poultry were the key sectors of the Bangladesh economy. Input dependence of some of the agricultural production sectors were increased from early nineties to early two thousand. Tanning and leather finishing, leather processing, edible oil, food processing and paper industry draw heavily on other primary industries across a broad spectrum of supplying industries and these sectors have powerful stimulus to the economy than the other sectors. Most of the agricultural processing sectors including some agricultural production sectors have better potential to generate more income. All the agro-processing industries except edible oil generate the higher income of which tanning and leather finishing, jute bailing, rice milling and sweeteners generate high level of income. The highest employment was generated in the sector livestock followed by poultry. The agro-industries having large multiplier values were the edible oil, leather finishing, rice milling, ata and flour milling and fish processing.

I. INTRODUCTION

Agro-industry is an industry that uses or processes agricultural products as raw materials in its production process (Hsu, 1997).The agro-industry provides the crucial farm-industry linkage which helps accelerate agricultural development by creating backward linkages (supply of credit, inputs and other production enhancement services) and forward linkages (processing and marketing), adding value to the farmer's produce, generating employment opportunities, and increasing the farmer's net income. This in turn motivates the farmer for better productivity and further opens up possibilities of industrial development. The agro-industry generates new demand on the farm sector for more and different agricultural outputs which are more suitable for processing and it is crucial for raising export earnings, generating employment and attaining food security (Babu, 2000). An agro-processing plant can open up new crop and livestock opportunities to the farmer and thus increase the farm income and employment. Particularly the food and beverages processing sector remains important at all levels of economic development (Wilkinson and Rocha, 2008). As possibilities for income generation are restricted in rural areas, rural non-farm earnings from agro-processing and its

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trading constitute a significant part of household income. In terms of employment composition, rural industries (manufacturing) account for approximately one fifth of rural non-farm employment, consisting mostly of occupations in agro-industries (UNIDO, MAD and FAO, 2008). This sector provides the small farmers the opportunities to augment their incomes through the value added generated by processing their own agricultural products (Schejtman, 1994). The importance of agro-industry for employment is further emphasized by high and increasing levels of female involvement to more vulnerable forms of work (casual, temporary and seasonal), lower paid and more labour intensive preparation and processing.

Johnston and Mellor (1961) stated that a healthy agricultural sector can be created by raising productivity by new technology, which would reduce the input usage and production costs and increase farm receipts. The agricultural sector itself requires only moderate capital outlays and hence return to investment in agricultural sector is very high, especially, in terms of technological development. Since Bangladesh is lagging behind in technological improvement in agro-industries, especially food industrial sector have no detailed data in this line. The linkage effect analysis is done using an input-output table in order to find out the key agro-industries for the Bangladesh economy which have strong backward and forward linkages. Input-output techniques are also used to study employment and income distribution and the key employment sectors are measured by those sectors whose ranking in terms of backward and forward linkage indices are in top position (Aziz and Rahman, 1985; Turker, 1999). On the other hand, the multiplier effect analysis is done to find out which sector gives highest output multiplier, income multiplier and employment multiplier effects using an input-output analysis. Siregar (1993) used inter-sectoral linkages and multiplier analyses to identify the priority sectors for development in agriculture. In conducting these two analyses it is expected to find the results that can support the hypothesis that some of the agroindustries should be promoted since they have better linkage and multiplier effects and they can also generate a better income and employment distribution in the Bangladesh economy.

For quantitative national economic analysis, the inter-sectoral (inter-industry) relation approaches is a useful dimension of analysis and research. The purpose of inter-sectoral linkage is to assist less developed countries to device agriculture and rural sector policies and programmes, reducing problems of underemployment and low levels of living of the poor. The linkage co-efficient help us to identify the sectors due to their important position in the inter-industry network. Sound planning, appropriate policy formulations and relevant programme development can be made by knowing the key agro industries and the degree of their structural interdependence. Multiplier anlysis using input-output table can be used to calculate direct and indirect sectoral output, income and employment generated in the economy as a result of increase in consumption, government expenditure, investment or exports to obtain an idea of the overall impact of their policy decisions. Among the key agro-based industries most of them are labour intensive. Some studies (Verma and Kesavan, 1986; Sivakumar *et al.* 1999) suggested that additional employment may be created by using policy measure in the agro-industry which would largely benefit the rural areas and that would reduce the mobility of labour to the urban areas. Mujeri and Alauddin (1994) investigated a weak technological position of most of the agricultural sectors but a few agricultural and industrial sectors emerged as the key sectors of the Bangladesh economy.

Bangladesh is considered as one of the least developed countries where all common problems related to output, income and employment either regionally and nationally exist. In recent years, the Government of Bangladesh has undertaken a number of poverty alleviation programmes giving especial emphasis on employment generation. The present study has been taken as an exercise for identification of different input-output indicators of the output and employment for the Bangladesh economy. The study will help to device agriculture and rural sector policies, reducing problems of underemployment and low levels of living of the poor in some extent. The techniques of analysis and findings of the research will provide a premise for the agriculturists, economist, planners and policy makers to draw a policy decision for national development. However, there is a need for selective import-substitution and export promotion policies dealing with modern farm inputs and processed agriculture. Inducing and strengthening income and employment growth linkages can accelerate the process of agricultural transformation and, hence, lead to self-sustaining economic growth in Bangladesh dominated by the agro-industry. The study is, therefore, designed to evaluate the contribution of agro industry in the economy of Bangladesh and to find out the key agro-industries those generate more income and employment.

II. DATA AND METHODOLOGY

Secondary data were used for this research. Output, value added and workers employed for agricultural activities were taken from different statistical reports including Bangladesh Bureau of Statistics. The latest two input-output tables of Bangladesh economy constructed by Bangladesh Planning Commission were also used. The data source of this study was the input-output table consisting 79 and 86 economic sectors for the years 1993-94 and 2001-2002 respectively in Bangladesh. Inter-sectoral linkage indices were calculated using this input-output table by the Rasmussen's method. Backward and forward linkages were determined by the computer programme using SPSS Software.

The analytical framework of input-output table involves a system of equations e.g. sectoral balance equations, intermediate demand equations, final demand equations and value-added equations. Direct inputs are those purchased by the sector under consideration, indirect inputs are those purchased by all other sectors in which production has to adjust in order to supply inputs to the specific sector. Also, the backward and forward employment linkage indices among various sectors were estimated. The multiplier effect analysis was done to find out which sector gives highest output, income or employment effects. On the basis of the linkage results, sectors were ranked in each case. In the ranking procedure, equal weights were given to the size of the linkage index.

Linkage Index

The inverse of an input-output matrix in order to measure the direct and indirect repercussions of an increase in the final requirements from any one sector on the other sectors of the economy be outlined as follows:

$$X = (I - A)^{-1} F$$

Where X is the gross output level required sustaining a given vector of final demand, F, in the input-output model. I is the identity matrix, A is the technology matrix of input-output

coefficients and $(I - A)^{-1}$ is the inverse matrix. According to Rasmussen (1957) backward linkage (U_j) and forward linkage (U_i) are defined as follows:

$$U_j = \frac{\frac{1}{n} Z_{.j}}{\frac{1}{n^2} \sum_{j=1}^{n} Z_{.j}}, \qquad j = 1, 2, ..., n \qquad (1)$$

$$U_i = \frac{\frac{1}{n} Z_{i.}}{\frac{1}{n^2} \sum_{j=1}^{n} Z_{i.}}, \qquad i = 1, 2, ..., n \qquad (2)$$

Where $\sum_{i=1}^{n} Z_{ij} = Z_{.j}$ denotes the total input requirements for a unit increase in the final demand for the jth sector. Similarly, $\sum_{j=1}^{n} Z_{ij} = Z_{i.}$ indicates the increase in the output of sector i. $\frac{1}{n} Z_{.j}$ and $\frac{1}{n} Z_{i.}$ are the averages.

Since the average $\frac{1}{n} Z_{.j}$ show the requirements of inputs if the final demand of industry j increases by one unit, then $U_j > 1$ indicates that the industry draws heavily on the other industries, and the opposite also holds in the case of $U_j < 1$. In a similar way $U_i > 1$ means that industry will have to increase its output more than the other industries to obtain a given increase in final demand from the whole increase in final demand from the whole system and vice versa for $U_i < 1$. The terms U_j and U_i measure the impact of a unit increase in final demand on domestically supplied inputs and outputs. Measures of linkages based on the technology of a country's structure of production are $(I - A)^{-1}$, where A is the coefficient matrix of domestic plus imported intermediate inputs. In this case, U_j and U_i measure the impact of unit increase in final demand on total supply rather than gross domestic output.

The indices do not tell the whole story because averages are sensitive to extreme values and may also give misleading results. To overcome this difficulty, measures of variability, or dispersion, for 'backward' and 'forward' linkages were also developed as follows:

$$V_j = \frac{\sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (Z_{ij} - \frac{1}{n} \sum_{i=1}^{n} Z_{ij})^2}}{\frac{1}{n} \sum_{i=1}^{n} Z_{ij}}, \qquad j = 1, 2, ..., n \qquad (3)$$

$$V_i = \frac{\sqrt{\frac{1}{n-1} \sum_{j=1}^{n} (Z_{ij} - \frac{1}{n} \sum_{j=1}^{n} Z_{ij})^2}}{\frac{1}{n} \sum_{j=1}^{n} Z_{ij}}, \qquad i = 1, 2, ..., n \qquad (4)$$

Values of U_j greater than one indicate high backward linkages which in turn means above average response in other sectors while values of U_j less than one indicate below average response. Values of U_i greater than one indicate high forward linkages meaning that these sectors display above average dependence on the output of the sectors.

Sectors in which both U_j and U_i are greater than unity are termed as key sectors. A key sector thus generates above-average input requirements from other sectors and its output is widely used by other sectors. It is suggested that once key sectors are identified, they should be given priority in investment allocation. As mentioned above we define key sectors in which, both backward linkage (U_j) and forward linkage (U_i) exceed unity.

Multipliers

Empirical estimates of output, income and employment multipliers were measured to assess the potentiality of the agro-industries using the method formulated by Bhalla et al. (1990). The direct and indirect income generated by one unit of final demand in sector 1 will be

$$V_1A_{11} + V_2A_{21} + \ldots\ldots\ldots + V_nA_{n1} \qquad (5)$$

Where, the levels of direct and indirect output in the various sectors associated with a unit of final demand in any sector lead to the following production levels.

$$\begin{bmatrix} A_{11} \\ A_{21} \\ \\ .A_{n1} \end{bmatrix}$$

and $V = \{V_1, V_2, \ldots\ldots\ldots V_n\}$ represent value added per unit of output in the respective sectors. The direct and indirect sectoral income multipliers per unit of final demand are given by dividing (5) by the respective elements of V. Since one unit of final demand in sector i gives A_{ij} units of output in the sector $1/A_{ij}$ units of final demand would yield one unit of output in sector i. Hence, direct and indirect income generated per unit of output in sector i would be given by (Quddus et al., 2002)

$$\frac{1}{A_{ij}}\left[V_1A_{11} + V_2A_{21} + \ldots\ldots\ldots + V_nA_{n1}\right] \qquad (6)$$

Where, A_{ij} is the diagonal elements of the $(I-A)^{-1}$ matrix.

The direct and indirect sectoral income multipliers per unit of output are given by dividing each element of (6) by the corresponding element of V. Direct and indirect sectoral employment multipliers are obtained similarly.

II. RESULTS AND DISCUSSION

Contribution of Agro-Industry in the Economy of Bangladesh

Agro-industry can play a strategic role in pro-poor growth strategies, particularly in developing countries, like Bangladesh where 75 percent of the poor live in rural area (UNIDO, IFAD and FAO, 2008). As possibilities for income generation are restricted in rural areas, rural non-farm earnings from trading, agro-processing, manufacturing, commercial and service activities constitute a significant part of household income. For developing countries as a whole, non-farm earning account for 30 to 45 percent of rural household income (UNIDO, IFAD and FAO, 2008). The development of agro-industry have an important impact on the local agricultural sector as well as the livelihoods of small holder farmers, provided they can produce on a stable basis, supplying regular quantity and quality. According to the International Standard Industrial Classification (ISIC), agro-industry consists of i) food and beverages; ii) tobacco products; iii) paper and wood products; iv) textiles, footwear and apparel; v) leather products; and vi) rubber products. Bangladesh agriculture contributed only around *19* percent to the GDP in 2007-08, represents a decline from 59.4 percent in 1973-74 to 46.7 percent in 1980-81, 30.4 percent in 1990-91 and 24.1 percent in 2000-01, while the contribution of industry rose from 6.3 percent in 1973-74 to 20.3 percent in 2007-08 and the contribution of construction and service sectors rose remarkably during these years (Table 1). Meanwhile, employment in the agricultural sector fell from 78.7 percent in 1973-74 to 51.2 in 2000-01.

Table 1. Percentage share of major economic sectors and employment involved

Year	Gross Domestic Product (GDP) at current market price			Employment		
	Agriculture	Industry	Other economic sectors	Agriculture	Industry	Other economic sectors
1973-74	59.4	6.3	34.3	78.7	4.8	16.5
1980-81	46.7	10.1	43.2	72.7	9.3	18.0
1990-91	30.4	15.8	53.8	66.4	12.5	21.1
2000-01	24.1	18.0	57.9	51.2	10.3	38.5
2007-08	19.1	20.3	60.6			

Source: BBS of different years

The available evidence estimating the performance of the agro-industries remain inadequate because of underreporting of the small and rural industrial sector, much of which falls within the informal sector. In the early 1970s manufacturing output in Bangladesh was concerned heavily on textiles and tobacco. At that time, textiles production accounted for 44 percent of the total manufacturing output was itself concentrated heavily on processing of jute, the major cash crop (Huq and Love, 2000). With well-documented displacement of jute in overseas markets the share of textiles exhibited a downward trend (13.19 percent) in 1995-96 over two and a half decades. There has also been a decline in the share of tobacco manufacturing from 13.87 percent in 1973-74 to 2.3 percent in 2001-02 (Table 2). Most of the agro-industries were found having high share in the early 1990s but their share were decreased dramatically

in the early *2000s.* But the share of beverage and wooden furniture were increased sharply in the early *2000s* compared to early *1980s.*

Table 2. **Contribution of major agricultural manufacturing sectors in relation to total manufacturing of Bangladesh**

Major Agricultural Manufacturing Sectors	Contribution in percent					
	1973-74	1979-80	1985-86	1991-92	1995-96	2001-02
Food manufacturing	10.65	11.03	11.59	20.40	14.44	12.06
Beverage industries	0.68	0.51	0.25	0.32	0.35	0.47
Tobacco	13.87	0.67	7.63	4.98	8.92	2.30
Textiles	44.98	32.27	28.73	23.79	13.19	14.74
Leather and leather products	1.75	4.25	4.14	4.19	2.22	2.25
Processing of fibers	00	1.0	1.77	0.73	0.30	0.02
Wood and Furniture	0.12	0.35	0.96	0.71	1.19	1.52
Paper and paper products	2.21	3.11	3.36	3.18	1.75	0.47
Rubber and Plastic products	.050	0.53	0.72	0.89	0.30	0.51
Total Agricultural Manufacturing	**74.76**	**53.72**	**59.15**	**59.19**	**42.66**	**34.74**

There are large value-adding opportunities in agro-industry relative to agriculture. According to World Bank, in low and middle income countries the food processing sector is typically one of the largest industrial activities in terms of value-adding. Agro-processing value added as a share of GDP amount to 4.3 percent for low income countries and 5 percent for lower middle and upper middle income countries (UNIDO, 2005). Combined share of 15 agroprocessing sectors show 15.96 percent gross output which corresponded to 6.28 percent of the national income in 1993-94 whereas this share was increased to 18.48 percent and national income to 9.63 percent in 2001-02. Thus, the share of gross value of output was increased by 2.52 percent whereas national income was increased by 3.35 percent for the contribution of agro-industries in eight years. Out of 15 agro-processing sectors, rice milling had highest contribution in both the periods and within agro-industries its contribution was around 50 percent as a gross output and below 50 percent as a value added. Fish processing, food processing, leather industry and wooden industry show remarkable increase in the contribution of gross output and value added in eight years (Table 3).

Table 3. Share of agro-industries in the gross value of output and value added in Bangladesh

Major Agro-Industry	Gross Output				Value Added			
	Share in Economies		Share within Agro-Industries		Share in Economies		Share within Agro-Industries	
	1993-94	2001-02	1993-94	2001-02	1993-94	2001-02	1993-94	2001-02
Rice Milling	8.80	8.32	55.1	45.0	2.64	3.16	42.0	32.8
Ata and Flour Milling	0.74	1.10	4.6	6.0	0.31	0.52	4.9	5.4
Fish Processing	0.68	2.19	4.3	11.9	0.36	1.51	5.7	15.7
Edible Oil	0.92	0.52	6.0	2.8	0.37	0.22	5.9	2.3
Sweetener Industry	1.04	1.04	6.5	5.6	0.41	0.52	6.5	5.4
Tea Processing	0.17	0.11	1.1	0.6	0.13	0.07	2.1	0.7
Salt Refining	0.09	0.08	0.5	0.4	0.18	0.06	2.9	0.6
Food Processing	0.46	.80	2.9	4.3	0.24	0.31	3.8	3.2
Tanning and Finishing	0.52	0.66	3.2	3.6	0.12	0.24	1.9	2.5
Leather Industry	0.12	0.90	0.8	4.9	0.07	0.36	1.1	3.8
Jute Bailing	0.07	0.10	0.4	0.5	0.02	0.09	0.3	0.9
Jute Fabrication	0.77	0.81	4.8	4.4	0.31	0.73	4.9	7.6
Paper Industry	0.52	0.58	3.2	3..1	0.33	0.56	5.3	5.8
Wooden industry	0.53	0.90	3.3	4.9	0.27	0.98	4.3	10.2
Tobacco Products	0.53	0.37	3.3	2.0	0.52	0.30	8.3	3.1
Total of Agro-Industries	**15.96**	**18.48**	**100**	**100**	**6.28**	**9.63**	**100**	**100**
Production Agriculture	29.22	17.80	-		26.36	17.98		
Other economies	54.82	63.72	-		67.36	72.39		

Source: Calculated from input-output tables of 1993-94 and 2001-2002

Agro-industry plays a fundamental role in employment creation and income generation. Particularly food and beverages processing sector remains important at the level of development. In developing countries an estimated average of 60 percent of workers in food and beverages are employed in the informal economy (UNIDO, IFAD and FAO, 2008). Above one million people was engaged in the agro-industries in 1993-94 and this figure was increased to 1.32 million in 2001-02, which indicates that about one percent of the total population of this country depend directly on agro-industries each year. Table 4 indicates that rice milling, food processing, jute fabrication and saw milling and wooden furniture are the major labour absorption agro-industries. On the other hand, prospect of employment generation is increasing at the higher extent for the sectors food processing, tanning and finishing, leather industry and saw milling and wooden furniture.

Table 4. Employment by major agricultural manufacturing sectors (in thousand numbers)

Major Agro-Industry	Person engaged	
	1993-94	2001-02
Rice Milling	340.0	252.4
Ata & Flour Milling	24.3	16.8
Fish Processing	13.2	15.4
Edible Oil	13.3	14.7
Sweetener Industry	57.0	56.0
Tea Processing	17.3	11.7
Salt Refining	14.7	7.6
Food Processing	60.5	412.0
Tanning and Finishing	14.7	43.6
Leather Industry	7.8	35.8
Jute Baling	4.1	3.1
Jute Fabrication	130.2	125.8
Paper Industry	20.0	18.2
Saw Milling and Wooden Furniture	146.0	234.5
Tobacco Industry	78.8	75.6
Total of Agro-Industries	**1017.1**	**1323.2**

Source: Calculated from input-output tables of 1993-94 and 2001-2002

Inter-Industry Linkages of Agriculture and Agro-industry

Agricultural sectors in general had very low ranking with respect to backward linkages. Obviously, these sectors have very low input dependence as compared to other sectors of the economy. Forward linkages provide an indication of the direction of supply. High linkage indices will typically indicate sectors produce relatively more for intermediate demand. The economy-wise Rasmussen's backward and forward linkage measures and coefficients of variation (CV) with their corresponding ranks of the agricultural production (numbered from 1 to 20) and agro-processing (21 to 37) sectors of the years 1993-94 and 2001-02 were computed and summarized in Table 5 and Table 6.

The agricultural production sectors excluding wheat have the lower values of backward linkages (less than 1) of which pulses, fruits and spices have least backward linkages with higher coefficient of variation in 1993-94. It is also observe that most of the agricultural production sectors such as paddy, other grains, jute, potato, vegetables, pulses, oilseeds, fruits, cotton, tobacco, tea, others crops and forestry in general had very low ranking with respect to backward linkages in both the periods. Out of the agricultural production sectors only wheat shows higher value (greater than 1) of backward linkage index in both the periods. Value of backward linkage of some of the agricultural production sectors such as sugarcane, livestock, poultry, shrimp and other fish were increased in 2001-02 compared to 1993-94, which means that input dependence of these sectors were increased by eight years. This implies that these sectors had a high dependence on intermediate goods, which are typically capital-intensive. Some of the production sectors, such as paddy, wheat, jute, cotton, livestock and forestry in 1993-94 and paddy, wheat, oil seeds, livestock and forestry in 2001-02 had low ranks by backward linkage but they had higher ranks by forward linkage, which means

that these sectors provide an indication of the direction of supply. Some of the agricultural sectors such as other grains, potato, vegetables, pulses, fruits, tea, major spices, poultry, shrimp and other fish had a relatively lower forward linkage indices than the others because a major part of them goes to final demand as exports.

Table 5. Classification of agro-industries according to high and low backward and forward linkages, 1993-94

	Low Backward			High Backward		
	Sectors	Backward linkages	Forward linkages	Sectors	Backward linkages	Forward linkages
		I			II	
Low Forward	Other grains	0.8779	0.4734	Wheat	1.0139	0.9954
	Sugarcane	0.8496	0.7689	*Rice milling	1.1631	0.5845
	Potato	0.8614	0..6098	*Ata & flour milling	1.1953	0.6700
	Vegetables	0.8528	0.4607	*Fish processing	1.1028	0.4424
	Pulses	0.7250	0.5048	*Edible oil	1.2700	0.7805
	Oilseeds	0.9270	0.9046	*Sweetener	1.2171	0.5712
	Fruits	0.7194	0.4584	*Tea processing	1.0150	0.4472
	Tobacco	0.8750	0.6403	*Food Processing	1.2674	0.6153
	Tea	0.8662	0.5836	*Leather finishing	1.2893	0.5586
	Major spices	0.7870	0.6164	*Leather products	1.2551	3.4403
	Other crops	0.8412	0.5743	*Jute bailing	1.1588	0.4420
	Poultry	0.9654	0.5282	*Jute Fabrication	1.1370	0.5031
	Shrimp	0.9517	0.7739	* Wooden Furniture	1.2221	0.5046
	Other fish	0.8056	0.5220			
	*Salt Refining	0.5447	0.5106			
	*Cigarettes	0.8925	0.4443			
	*Bidi	0.8325	0.4462			
	*Saw Milling	0.9302	0.7863			
		III			IV	
High Forward	Paddy	0.8689	1.1824	*Paper Industry	1.2468	1.1200
	Jute	0.8134	1.0099			
	Cotton	0.8097	1.4121			
	Livestock	0.8887	1.6942			
	Forestry	0.8220	1.4778			

* indicates agro-industry

High backward linkage was largely occupied by most of the agro-processing industries. The values of linkage indices presented in Table 5 and Table 6 show that almost all of the agro-processing sectors excluding salt refining, cigarettes, bidi and saw milling in 1993-94 and excluding saw milling, wooden furniture and paper industry in 2001-02 had backward linkage greater than 1. These sectors depend heavily on input supplies from other sectors and the major parts of its input come from its own supplies according to the matrix of technical coefficient. The food processing, tanning & leather finishing, leather processing and paper industry may be considered as notable dominant sectors with the higher backward linkage index (within top 15) and least coefficient of variation in 1993-94. On other hand the poultry, other food, tanning and leather finishing and leather products had greater values of backward linkage indices with lower values of coefficient of variation suggesting that these sectors draw heavily on other industries across a broad spectrum of supplying industries. In 2001-02,

out of 17 agro-processing sectors, 9 were with high backward linkage index (within top 15) and lower coefficient of variation and leather processing, tanning & leather finishing, food processing, sweeteners, rice milling and fish processing were fallen in top seven positions. Most of the agro-processing sectors had lower values of forward linkage index but in a few cases (ata and floor milling, edible oil, tanning & leather finishing and paper industry) in 2001-02 had comparatively upper rankings of forward linkages.

Table 6. Classification of agro-industries according to high and low backward and forward linkages, 2001-02

	Low Backward			High Backward		
	Sectors	Backward linkages	Forward linkages	Sectors	Backward linkages	Forward linkages
		I			II	
Low Forward	Other Grains	0.8491	0.6653	Poultry	1.3249	0.6432
	Potato	0.9475	0.7324	Shrimp	1.1235	0.8819
	Vegetables	0.9190	0.6119	Other fish	1.0028	0.8996
	Pulses	0.8862	0.8764	*Rice milling	1.2497	0.8089
	Fruits	0.8817	0.6328	*Fish processing	1.2456	0.7845
	Cotton	0.8530	0.9716	*Sweeteners	1.2691	0.6474
	Tea	0.9612	0.8442	*Tea processing/ blending	1.1772	0.5979
	Major spices	0.9892	0.7136	*Salt Refining	1.1233	0.6685
	*Wooden Furniture	0.9273	0.7856	*Food Processing	1.2901	0.6442
				*Leather Industry	1.7023	0.5453
				*Jute baling	1.0488	0.6213
				*Jute Fabrications	1.0079	0.5596
				*Cigarettes	1.0643	0.5467
				*Bidi	1.1696	0.5450
		III			IV	
High Forward	Paddy	0.8807	2.0642	Wheat	1.0242	1.4600
	Jute	0.8987	1.0932	Sugarcane	1.0083	1.0551
	Oil seeds	0.8843	1.1345	Livestock	1.1855	3.3143
	Tobacco	0.9572	1.0694	*Ata & flour milling	1.1946	1.1496
	Other crops	0.8930	1.0567	*Edible oil	1.1131	1.1857
	Forestry	0.8428	1.2939	*Tanning & Leather Finishing	1.4932	1.1367
	*Saw Milling	0.9281	1.1242			
	*Paper Industry	0.9760	1.2009			

* indicates agro-industry

The highest priority should be given to those sectors which possess high backward and forward linkages and lowest priority to sectors which posses low backward and forward linkages. The second priority goes to the sectors having high backward and low forward linkages and the third priority to the sectors having low backward and high forward linkages. We observe in Table 5 and Table 6 that industries in quadrants II and IV had high backward

linkages. These sectors depend heavily on other sectors, which provide them with intermediate inputs and can be termed as secondary production sectors. Similarly, sectors in quadrants III and I had low backward linkages and can be termed as primary sectors. The primary input content of these sectors tend to be high. Other things being equal, an expansion of output in the sectors in quadrants II and IV would have a greater impact on the economy than output expansion in other sectors. Sectors in III and IV with high forward linkages would be affected more by a change in overall economic activity than those sectors in quadrants II and I. The sectors of quadrant I had low backward and forward linkages which indicate that these sectors are relatively less dependent on other sector for their input requirements and for the disposition of their products. These sectors have more direct links between final demand and primary factors of production. Some of the agricultural sectors, such as poultry, shrimp and other fish possessed high backward linkages (> 1) due to equipped with modern technology but they possessed low forward linkages (< 1) due to lack of processing.

Key Sectors of the Agro-Industries

If we consider industries in quadrant IV where both backward and forward linkages were higher, they would play the most prominent role in the sense that these sectors were more responsive than other sectors to change in economic activity of the whole economy as well as exerting more impact on the rest of the economy. These were the key sectors in the Bangladesh economy and should, on this criterion, figure prominently in development plans. The sectors showing high backward linkage indices and forward linkages indices along with their corresponding indices of low coefficient of variation termed as key sectors (Diamond, 1975) are shown in the Table 7. The study of this table indicates that the sectors food processing, tanning and leather finishing, leather fabrication in 1993-94 and paddy, livestock, poultry, sweeteners, fish processing, food processing in 2001-02 were the key sectors which had fulfilled the requirements prescribed in the definition of the key sectors. On the other hand, sweeteners, food processing, fish processing, tanning & leather finishing, leather fabrication were the key sectors with a strong backward linkage which depend on input supplies from other sectors. The sectors paddy, livestock, forestry and paper industry were the key sectors with a strong forward linkage and they produce more for intermediate demand. The livestock sector was identified as the most important beneficial sector to the economy and had great potential for generating employment (Goswami, 1994, and Pablo and Cespedes,1996).

These results interpret that sectors with higher forward linkages have smaller coefficient of variation than those having low linkage indices. Thus the choice of sectors with larger linkages as key sectors will result in a more uniform spread of inducements. The original intention was to rank sectors in terms of their potential stimuli to growth via the inducement mechanism and to select key sectors for promotion corresponding to those with the highest backward and forward linkages (Hirschman, 1958). Sectors with high backward linkages had a high dependence on intermediate goods, which were typically capital intensive. There is no consideration of efficiency or comparative costs in the selection of key sectors in reference to linkage indices. The inducement which remains as measured by the backward and forward linkage analysis would then be a better guidance to the selection of key sector. On the basis of

Rasmussen's approach, livestock, Ata and flour milling, tanning and leather finishing, sectors emerged as the leading sectors for the Bangladesh economy. Some agro-based industries, such as ata and flour milling, edible oil, tanning and leather finishing, provided more powerful stimulus to the economy than the other sectors.

Table 7. Sectors showing high backward and forward linkage and low coefficient of variation in 1993-94 and 2001-02

Sectors	1993-94			Sectors	2001-02		
	Backward Linkage		CV		Backward Linkage		CV
	Index	Rank			Index	Rank	
*Ata & Flour Milling	1.1953	20	4.0450	Livestock	1.1855	10	4.6662
*Sweeteners	1.2171	17	3.6584	Poultry	1.3249	3	4.3726
*Food Processing	1.2674	12	3.2601	*Rice Milling	1.2497	6	5.1716
*Tanning & Leather Finishing	1.2893	10	3.6765	*Ata & Flour Milling	1.1946	9	4.9436
*Leather Fabrication	1.2551	14	3.4403	*Fish Processing	1.2459	7	4.8549
*Wooden Furniture	1.2221	16	3.7588	*Sweeteners	1.2691	5	4.7210
*Paper Industry	1.2468	15	3.7389	*Tea Processing / Blending	1.1772	11	5.0907
				*Food Processing	1.2901	4	4.0497
				*Tanning & Leather Finishing	1.4932	2	4.7074
				*Leather Fabrication	1.7023	1	4.1028
				*Bidi	1.1696	12	4.7341
	Forward Linkage		CV		Forward Linkage		CV
	Index	Rank			Index	Rank	
Cotton	1.4121	13	3.6236	Paddy	2.0642	8	3.5270
Livestock	1.6942	6	2.8666	Wheat	1.4600	12	4.4561
Forestry	1.4778	12	2.9753	Livestock	3.3143	2	2.2663
*Paper Industry	1.1200	20	3.9686	Forestry	1.2939	15	4.3333
				*Ata and Flour Milling	1.1496	20	4.5168
				*Paper Industry	1.2000	17	4.3524

* indicates agro-industry

Multiplier Effects of Agro-Industries

Output multiplier of a sector is calculated by measuring the total change in output for a unit change in sales to final demand by a given sector. The multiplier is the number of times the direct change in output (as measured by the change in final demand sales) must be multiplied to obtain the total change in output. Hence a multiplier value of 3 for a sector means that the total change in output will be thrice the direct change in final demand sales of that sector. Type I output multipliers are derived with households excluded from the intermediate sector, while Type II multipliers are derived with households included in the intermediate sector. Type I and Type II output multipliers for Bangladesh are presented in Appendix 1 for the

input-output table 1993-94 and 2001-02. The output multipliers are of limited usefulness, their main function being to give a summary statistic of the degree of local interdependence of each sector.

Of more interest to planners and policy-makers is the degree to which variations in final demand will affect the levels of household incomes. This information can be obtained by calculating sectoral income multipliers. The introduction of consumption in the structural matrix captures the induced effects of consumption activity along with that of indirect income. In terms of indirect income, all the agro-processing industries except edible oil generate the higher income per unit of output than the agricultural primary sectors. The highest values of income multipliers both per unit of final demand and output were obtained in some of the agro-processing sectors such as tanning and leather finishing, jute bailing, rice milling and sweeteners (Appendix 1). The other sectors, which were behind but recorded relatively large multiplier values, were ata and flour milling, fish processing, edible oil, food processing, leather industry, jute textiles, wooden furniture and paper industry. However, most of the agro-processing sectors were ranked more or less same for both the direct and indirect multipliers.

Direct and indirect employment multiplier impact on the Bangladesh economy is shown in Appendix 2. The highest indirect employment was generated in the sector livestock followed by poultry. Some of the agriculture (Paddy, wheat, other grains, jute, vegetables and oilseeds) and agro-industries (Ata/flour milling, leather finishing and jute bailing) show higher employment generation. The higher and the second highest values of employment multipliers both per unit of final demand and output were obtained in the edible oil and leather finishing, respectively. The sectors rice milling, ata and flour milling, fish processing and cigarettes were recorded relatively large multiplier values. The multiplier values were relatively much smaller for most of the primary agricultural sectors.

III. CONCLUSION AND POLICY IMPLICATIONS

Rice milling, fish processing, food processing, leather industry and wooden industry had higher contribution of gross output and value added as well as labour absorption. From the latest results of input output and key sector analysis it may be concluded that paddy, poultry and livestock of agricultural production sectors and tanning and leather finishing, leather fabrication, food processing, rice milling and sweeteners of agro-industry are the top ranked key sectors for the economy of Bangladesh. This means that investigating more in these sectors will help to stimulate the economy better through the backward and forward linkage effects. Agro-industry and high value-added agricultural sectors are proposed as the key sectors to improve inequality problems, smoother employment transformation, generate high growth and induce high output production. Results of strong multiplier effects from the agricultural related sectors confirm that growth of the economy of Bangladesh lies in the potential of the country's agro-industries, especially, high value added agricultural sectors and agro-industry. A strong interrelation exists between the agro-industries having high value of output multipliers and the primary agricultural sectors which supply the basic raw materials (i.e. livestock, forestry, jute, fruits and sugarcane) to agro-processing sectors. Some of the agricultural production sectors and most of the agricultural processing sectors have

better potential to generate more income to different households to create better income distribution and to induce more savings in the country. The high value of multipliers in the case of agro-industries indicates that the knock on effects are relatively large compared with the initial impact of increased output.

Farm sectors, specially, paddy, wheat, jute, livestock and poultry show high backward and forward linkage on account of employment inducements. Agro-processing industries are the major source of employment and income providing access to food and other necessities to large groups of population and they are, therefore, essential elements in the attainment of food security goals. These sectors, therefore, should assume employment generation capacity for the people of Bangladesh and may focus for future agricultural development and will also diversify farm income that will help reduce the incidence of poverty. Agro-based manufacturing activity would be widening through formulation of new manufacturing activities or through the development of new technologies. Need to research on agricultural policies to induce the process of agricultural modernization. Moreover, there is a need for selective import-substitution and export-promotion policies dealing with modern farm inputs and processed agriculture.

Data used in this research were collected in the year 2008 when the latest 2001-02 inputoutput table was available for Bangladesh which was compiled and published in July 2003 by Sustainable Human Development Unit of Planning Commission that did not contain employment matrix. The results of this research might be more effective for the present situation if it had recent data. Thus, a further research should be undertaken by comparing the past input-output tables and the next available table that would give an important insight into the dynamics of changes in terms of employment linkages in Bangladesh. There is scope for further work on agro-industry research and development to be geared up towards definite goals of production for the alleviation of poverty.

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REFERENCES

Aziz A. and A. Rahman (1985). "Key sectors of the West Malaysian economy with emphasis on agriculture", *Malaysian Journal ofAgricultural Economics, 2(1):* 20-38.

Babu, S. (2000). "Food and agricultural policies for the 21" century", *Food Policy, 25:* 105-109.

Bhalla, G.S., G.K. Chanda, S.P. Kashyap and R.K. Sharma (1990). Agricultural growth and structural changes in the Punjab economy: An input-output analysis. Research Report 82, International Food Policy Research Institute, 1-119.

Diamond, L(1975). "The analysis of structural constraints in developing economics: A case study",*Oxford Bulletin of Economics and Statistics,* 36(2): 95-108.

Goswami, S. N. (1994). "Sectoral interdependence and block level planning in West Garo Hills District of Meghalaya", *Indian Journal ofAgricultural Economics,* 49(2): 217-225.

Hirschman, A. (1958). The Strategy of Economic Development. New Haven, Yale University Press P. 217.

Hsu, S. (1997). "The agro-industry: A neglected aspect of the location theory of manufacturing", *Journal of Regional Science*, 37: 259-274.

Huq, M. and J. Love (2000). Strategies for Industrialization: The Case of Bangladesh. The University Press Limited.

Johnston, B. and J. Mellor (1961). "The role of agriculture in economic development". *American Economic Review*, 51: 566-593.

Mujeri, M. K. and M. Alauddin (1994). "Trade and linkages using input-output approach: An empirical investigation of Bangladesh", *The Pakistan Development Review*, 33(1): 75-92.

Pablo, V. J. and L. J. Cespedes (1996). "An analysis of the Andalusian food and agricultural production complex using input-output tables (1980-1990)", *Revista Espanada De Economia*, 175: 87-117.

Quddus, M.A., K. Sen and M. Salimullah (2002). "Structural interrelationships of various sectors of the economy of Bangladesh with special emphasis on agriculture", *Bangladesh Journal of Agricultural Economics*, 25(2): 33-61

Rasmussen, P. N. (1957). Studies in Inter-Sectoral Relations. North-Holland Publishing Company, Amsterdam P. 134.

Schejtman, A. (1994). "Agro-industry and changing production patterns in small-scale agriculture", *Cepal Review*, 53: 147-157.

Siregar, M. (1993). "Income and employment impacts of Indonesian agricultural sectors", *Ekonomi dan Keuangan Indonesia*, 41(4): 425-440.

Sivakumar, S.K., R. Bajasubramanian and N. Srinivasan (1999). "Growth linkage effects of agro-industrialization", *Indian Journal of Agricultural Economics*, 54(3): 412-419.

Turker, M. F. (1999). "The determination of the importance of the forestry sector in national economy using input-output analysis", *Turkish Journal of Agriculture and Forestry*, 23(1): 229-237.

UNIDO, IFAD and FAO, (2008). The impact of agro-industry for socioeconomic development and poverty reduction. Discussion paper: UN Commission on sustainable development, 16th session, New York, 5-16 May 2008.

UNIDO. (2005). UNIDO Industrial Statistics Database 2005 (Vienna: UNIDO).

Verma, N. K. and V. K. Kesavan (1986). "Agro-based industries in Haryana: Growth in input and employment", *Agricultural Situation in India*, 41(4): 213-215.

Wilkinson, J. and R. Rocha (2008). The agro-processing sector: Empirical overview, recent trends and development impacts, Plenary Paper for Global Agro-Industries Forum, April 2008.

Appendix 1. Type I and Type II output multiplier impacts on the Bangladesh economy

SL No	Agro-Industrial Sector	1993-94				2001-02			
		Type I Multiplier		Type II Multiplier		Type I Multiplier		Type II Multiplier	
		Index	Rank	Index	Rank	Index	Rank	Index	Rank
1	Paddy	1.9657	51	1.8314	59	2.3231	47	2.5313	55
2	Wheat	2.2938	38	2.3673	35	2.5038	43	2.9673	47
3	Other Grains	1.9861	49	1.6044	66	1.7262	58	1.5604	76
4	Jute	1.8401	61	1.8537	56	1.3401	61	1.3537	78
5	Sugarcane	1.9220	56	1.9877	51	2.7212	39	2.7877	51
6	Potato	1.9488	53	1.8809	54	1.7484	56	1.9810	67
7	Vegetables	1.9293	54	1.9959	49	2.4294	44	1.9952	66
8	Pulses	1.6401	69	1.6253	65	1.8064	55	1.9253	69
9	Oilseeds	2.0972	45	2.1461	46	2.7972	37	2.1565	64
10	Fruits	1.6275	70	1.5024	69	1.3275	74	1.3024	79
11	Cotton	1.8318	62	1.8500	57	1.4312	59	1.6522	72
12	Tobacco	1.9795	50	2.1868	43	1.5795	50	2.4867	56
13	Tea	1.9596	52	1.5607	67	2.6593	40	2.5617	54
14	Major Spices	1.7662	66	1.6843	63	1.6762	66	1.8430	72
15	Other Crops	1.9031	57	1.9726	52	1.8032	57	1.8626	71
16	Livestock	2.0106	47	1.9092	53	4.2106	12	2.6092	53
17	Poultry	2.1841	39	2.2690	39	4..8941	9	2.9690	46
18	Shrimp	2.1531	41	2.1707	45	3.2535	41	2.1217	60
19	Other Fish	1.8225	63	2.0721	48	3.9205	28	1.7721	73
20	Forestry	1.8596	59	2.2879	38	1.9896	59	2.8792	49
21	Rice Milling	2.6314	23	6.5966	4	3.7214	23	6.6976	9
22	Ata & Flour Milling	2.7041	20	4.6078	16	3.7041	25	4.3678	30
23	Fish Processing	2.4950	28	3.6996	22	4.3295	15	4.2996	32
24	Edible Oil	2.8732	11	4.9208	14	3.4733	27	4.9208	23
25	Sweeteners	2.7536	17	5.0696	9	3.7506	18	5.0696	22
26	Tea Processing	2.2962	37	2.6671	30	3.2552	23	4.7671	26
27	Salt Refining	1.2323	78	1.1284	78	2.2023	65	1.8280	70
28	Food Processing	2.8674	12	3.8011	20	3.9874	12	4.8120	24
29	Tanning & L. Finishing	2.9168	10	8.6938	1	5.8321	6	8.7629	1
30	Leather Processing	2.8394	14	3.2990	25	4.4265	11	6..2890	15
31	Jute Baling	2.6217	24	7.9364	3	2.1256	24	7.3364	6
32	Jute Fabrication	2.5722	25	4.9934	13	2.3215	25	4.3934	29
33	Cigarettes	2.0192	46	2.1042	47	2.0102	67	1.3410	83
34	Bidi	1.8835	58	1.7644	60	2.8935	58	2.0645	65
35	Saw Milling	2.1044	44	2.3848	34	2.5142	44	2.8848	48
36	Wooden /Furniture	2.7648	16	4.5521	17	3.8648	17	5.6521	18
37	Paper Industry	2.8208	15	3.7846	21	2.6238	15	3.0856	45

Appendix 2. Direct and indirect income and employment multiplier impact on the Bangladesh economy 1993-94

Sl No	Sectors	Income generation per Tk. 10,000 of output		Index and rank of multipliers							
				Income multipliers per unit of				Employment multipliers per unit of			
				Final Demand		Output		Final Demand		Output	
		income	employ	Index	Rank	Index	Rank	Index	Rank	Index	Rank
1	Paddy	9082	48.807	1.8314	59	1.6588	60	1.6156	63	1.4633	64
2	Wheat	8876	65.309	2.3673	35	2.0923	41	1.6608	62	1.4679	63
3	Other Grains	9774	44.924	1.6044	66	1.5607	63	1.5175	65	1.4761	62
4	Jute	9704	59.253	1.8537	56	1.7970	55	1.4982	66	1.4524	65
5	Sugarcane	8910	27.491	1.9877	51	1.7672	56	2.0244	50	1.7998	51
6	Potato	7335	20.076	1.8809	54	1.3758	72	2.3605	41	1.7267	53
7	Vegetables	9872	41.539	1.9959	49	1.9646	49	1.7210	58	1.6940	54
8	Pulses	9079	26.358	1.6253	65	1.4743	66	1.9140	53	1.7362	52
9	Oilseeds	9515	61.216	2.1461	46	2.0357	46	1.7402	57	1.6506	58
10	Fruits	9749	15.487	1.5024	69	1.4613	68	2.3087	42	2.2455	41
11	Cotton	9974	26.371	1.8500	57	1.8413	53	1.9615	52	1.9522	49
12	Tobacco	9970	38.289	2.1868	43	2.1760	39	1.8459	56	1.8368	50
13	Tea	9971	18.366	1.5607	67	1.5477	64	1.5829	64	1.5697	61
14	Major Spices	7489	30.733	1.6843	63	1.2587	75	1.8623	55	1.3918	68
15	Other Crops	8330	27.897	1.9726	52	1.6404	62	1.9921	51	1.6566	57
16	Livestock	9696	101.18	1.9092	53	1.8451	52	1.2320	76	1.1907	76
17	Poultry	9180	82.935	2.2690	39	2.0731	43	1.3505	70	1.2339	73
18	Shrimp	8570	24.221	2.1707	45	1.8514	50	1.8753	54	1.5994	60
19	Other Fish	9847	31.908	2.0721	48	2.0395	45	1.6769	59	1.6506	59
20	Forestry	9972	19.411	2.2879	38	2.2787	33	3.8017	27	3.7864	24
21	Rice Milling	10045	38.465	6.5966	4	6.5784	4	24.415	7	24.348	7
22	Ata & Flour Milling	9995	49.946	4.6078	16	4.5826	12	37.214	5	37.011	5
23	Fish Processing	10051	20.419	3.6996	22	3.6994	18	25.746	6	25.745	6
24	Edible Oil	7229	31.164	4.9208	14	3.5451	20	73.365	3	52.855	4
25	Sweeteners	10066	25.820	5.0696	9	5.0636	6	4.2052	22	4.2003	20
26	Tea Processing /Blen.	10094	15.011	2.6671	30	2.6626	28	3.6860	31	3.6798	28
27	Salt Refining	10029	9.4617	1.1284	78	1.1281	77	1.3550	69	1.3546	69
28	Food Processing	10033	31.592	3.8011	20	3.7861	17	5.9505	17	5.9270	16
29	Leather Finishing	10067	70.920	8.6938	1	8.6937	1	61.838	4	61.837	3
30	Leather Industry	10085	30.235	3.2990	25	3.2989	23	11.522	13	11.522	13
31	Jute Baling	10024	51.482	7.9364	3	7.9364	3	21.821	10	21.821	10
32	Jute Fabrication	10025	37.695	4.9934	13	4.9631	10	5.4885	19	5.4552	17
33	Cigarettes	10022	14.522	2.1042	47	2.1041	40	22.727	9	22.726	9
34	Bidi	9939	34.436	1.7644	60	1.7480	57	1.6747	60	1.6592	56
35	Saw Milling	10040	19.583	2.3848	34	2.3786	31	2.2348	43	2.2291	43
36	Wooden Furniture	10046	26.276	4.5521	17	4.5394	13	2.2342	44	2.2279	44
37	Paper Industry	9235	13.098	3.7846	21	3.4538	22	5.8340	18	5.3241	18