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DEMAND PROJECTIONS FOR POULTRY PRODUCTS AND POULTRY FEEDS IN BANGLADESH

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ABSTRACT

The analysis carries out demand projections for poultry products and poultry feeds in Bangladesh over the next 20 years. Using separate rural and urban consumption data and income elasticities of demand, the national consumption of eggs is projected to be 5,866 million for 2020. The corresponding consumption of meat is projected to be 307 thousand tons. The estimated use of grains (wheat and maize) as poultry feeds ranges from 867 to 898 thousand tons for the year 2020, depending on the approach adopted. The requirement of wheat as poultry feed is only 8 per cent of the total domestic production while the requirement of maize as poultry feed is as high as nearly 8 times its domestic production.

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DEMAND PROJECTIONS FOR POULTRY PRODUCTS AND POULTRY FEEDS IN BANGLADESH

Nabiul Islam[1]

1. INTRODUCTION

The poultry sub-sector is crucially important in the context of agricultural growth and improvement of diets of people in Bangladesh. The sub-sector is particularly important in that it is a significant source for the supply of protein and nutrition in a household's nutritional intake. It is an attractive economic activity as well, especially to women and poor population.

One of the major problems of development of the poultry sub-sector in Bangladesh relates to lack of sufficient and appropriate feeds (Mitchell 1997; Alam 1997). Relevant research suggests that a high priority is given on the improvement of feed supply in the sub-sector, which is expected to help in developing resistance to diseases, on the one hand, and production of quality products, on the other.

Poultry farms in Bangladesh are growing fast in recent times. With a high population and income growth, urbanisation and high income elasticity of demand, the demand for poultry products is expected to increase appreciably in the future. Hence, poultry farms are also expected to increase over time. Wheat and maize together constitute over half in total poultry feeds, of which a little less than four-fifths is maize and about one-fifth is wheat. Although the use of wheat and maize for livestock and poultry feed is

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growing rapidly in developing countries, in general (Sarma 1997), this has not yet reached to a significant proportion in Bangladesh. Maize in Bangladesh is still a minor crop in terms of acreage, equal to only 3 per cent of wheat area and 0.2 per cent of rice area. Although it is possible to produce maize throughout the year, maize is currently produced in the country largely in winter season.

Wheat and maize are important components of poultry feeds. The demand for wheat and maize, therefore, is expected to increase with the growth of poultry farms in the country. The demand for both livestock and poultry feeds appear to be currently met from only imports, and at seemingly relatively higher costs. In view of this, the domestic production of maize and wheat has an important role to play in the development of poultry vis-à-vis agriculture sector in Bangladesh.

Against this background and the fact that there exists a large potential (even for export) for the poultry sub-sector in Bangladesh, the major objective of this study is to carry out demand projections for poultry and poultry products, and thus address the potential of the grain (maize, in particular) economy, through carrying out demand projections for poultry feeds in Bangladesh. More specifically, the study aims to estimate the total use of feed as grain by the poultry sub-sector, through assessing the current levels of demand and supply of poultry and poultry products.

2. METHODOLOGY

EXISTING LITERATURE AND MAJOR DATA SOURCES

Research on livestock resources in Bangladesh, in general, and poultry sub-sector, in particular, is rather limited. The major contributors include Alam (1995, 1997), Mitchell (1997), Quasem (2001) and the studies conducted by the Department of Livestock from time to time.

The research by Alam (1995), which has been later updated (Alam 1997), is an useful document on livestock resources in Bangladesh, presenting the existing status and the future potential of the sub-sector. The research, concentrating more on cattle and buffaloes, estimated livestock (including poultry) population and products and their growth rates as of 1994-95. The research also delineated the socio-economic aspects of livestock including identifying the constraints to livestock production. Mitchell (1997), which is a policy paper, based on a mission to Bangladesh, outlined the problems and prospects of livestock sector. It also covered consumption and marketing aspects of poultry products in Bangladesh, largely using data generated by FAO Yearbook (1997). The paper by Haque and Raha (1997) is a research note concentrating on maize marketing in Bangladesh at the micro level. The study by Saha and Asaduzzaman (1998) discussed the present status of production organisation and technology, concentrating on the poultry sub-sector with special emphasis on disaggregated input-output structure for the sub-sector. This was a background study, aiming at estimating relevant input-output coefficients for use in the construction of the national input-output table. The study by Quasem (2001), undertaken simultaneously with

the present study under the Food Management and Research Support Project (FMRSP), discussed survey results showing the principal characteristics of poultry farms and the efficiency of their feeding practices at both household and commercial levels.

This study has also consulted other documents published elsewhere, such as Sarma (1986) and Mink (1987). Sarma (1986), a Research Report published by IFPRI (Washington), is concerned with the analysis and projections (to 2000) of use of cereals for livestock feed in developing countries. Mink (1987) has addressed the use of corn in livestock feed and the future of the corn economy in Indonesia. The study focussed on current levels of corn use and likely future growth of corn-based livestock feeds in Indonesia.

Despite the availability of the studies mentioned above, knowledge about aspects relating to supply and demand of poultry feed in Bangladesh is rather limited. In particular, data on the present poultry population and poultry products, disaggregated by commercial and scavenging nature, are not available in any of the studies mentioned above.

Data Sources

The study is largely based on information from secondary sources; Agricultural Censuses (1960, 1977; 1983-84, 1996) are the main sources of historical data on poultry population. FAO Yearbook (1997) was also a source in this respect. However, such information are supplemented by primary data generated from field surveys. A basic problem with the analysis of poultry population and feed trends relates to the lack of reliable and adequate data on their use by type of feed and by category of poultry output.

In particular, the data on poultry population, disaggregated by scavenging type and commercial farms in rural and urban Bangladesh, are sparse. The consumption data for rural households have been primarily collected from the Flood Impact Study, FMRSP (Ninno and Roy, 1999). Those for urban households have largely been based on Household Expenditure Survey.

As will be seen later, the commercial farms are the prime focus of the current analysis, as few scavenging birds are likely to have direct grain-feed requirements. The data on current poultry production system, generated by the field surveys, have been used. The data on various aspects such as feeding practices, feed requirements and farm size by type, collected from the surveys by Quasem (2001), have been used.

A rapid market survey including a few key-informant interviews was also conducted. Data and information collected are, among others: (1) feeding requirements and practices of scavenging birds; (2) proportion of scavenging and commercial birds; (3) proportion of scavenging layers and broilers; (4) proportion of commercial layers and broilers; (5) average life span of various types of birds; (6) average eggs produced by scavenging layers and commercial layers; (7) average weight of live birds and meat produced by various types of birds; (8) wheat consumed by scavenging birds; (9) age and productive age of various birds; and (10) mortality rate of various types of birds. The key-informant techniques of data collection were adopted also to supplement the information collected from secondary sources to make projections of growth of poultry farms and poultry products.

ESTIMATION PROCEDURES

Demand Approach

The major theme of this study component involves carrying out projections of demand for poultry feeds and its implications for wheat and maize production. For this purpose, the projection of poultry and poultry products has to be carried out first. Two approaches can be employed to estimate the medium and long- term demand for use of grain as poultry feeds. One approach involves projecting demand derived from the consumption of poultry products (meat and eggs). The approach may be called "Demand Approach" [2]. In usual conditions, demand for poultry products is expected to increase with the increase in consumer income up to a certain time[3]. Thus, the projection of growth in demand for products requires incorporation of income growth and income elasticities of demand. Preferably, demand for poultry products should be disaggregated by income or socio-ecnomic groups, to allow differential impacts across different groups, in both rural and urban areas. Moreover, in this approach, the factors such as population and urbanisation growth have to be taken into account in the estimation of future feed demand.

The responsiveness of demand for poultry products to per capita income growth has to be estimated from some past studies. It could be ideal to have separate elasticity estimates for village and commercial poultry products, presumably because of potential variations of

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[2] The approach is largely drawn from the Indonesian study by Mink (1987).
[3] As will be seen later, the estimates are carried out under various scenarios, such as declining demand elasticites.

qualities and tastes in these two markets. With the help of these income elasticities and base year data for consumption per capita, consumption of poultry products (separately for meat and eggs) can be projected through incorporating, among others, growth in population, urbanisation and income. Such quantities of poultry products can be translated into feed requirements and finally into projected use of grain and demand for poultry feeds. These estimates are carried out, preferably disaggregated by village (scavenging) and commercial poultry birds, using appropriate feed coefficients.

Trends Approach

Future feed requirements can also be projected based on the growth in poultry population. An alternative approach, thus, involves assessing future feed requirements through estimating historical trends of growth in the poultry population. The approach may be termed as Trends Approach.

If supply constraints are more likely to dominate the demand characteristics in determining the growth of poultry, this approach may be more appropriate to project the future poultry population. In this approach, the rate of increase in the poultry population can be estimated by analysing the past trends. Both simple linear trends and log-linear trends from the time series data on poultry populations have been examined. However, the latter type of trend estimates has proven to be more appropriate.

Both the approaches require the knowledge of current poultry production system so that the number of poultry or the quantity of poultry products can be translated into feed requirements and thus determine the implications for domestic production of wheat and maize.

In the Trends Approach, the estimates for projected poultry populations have been used to project future feed requirements and subsequent use of grain (wheat and maize), through using appropriate feed coefficients. The poultry population have been disaggregated by village (scavenging) and commercial birds (layers and broilers), as the feeding practices vary significantly among these three types of birds, as observed from our field surveys.

This study employs both the approaches in order to obtain a range of demand estimates for the use of grain as poultry feeds, for the years 2005, 2010, 2015 and 2020. The year 2000 is considered as the base year. Presumably because of variations in feeding practices and hence feed consumption level (in terms of type and quality, for example) field data were collected from poultry farms of three categories: (1) village birds (household-level); (2) small commercial farms; and (3) large commercial farms. The first category is, by and large, of scavenging nature while the second and third type lives on improved feeds such as 'concentrates'. It is envisaged that, generally, the first type exists in rural areas and the other two types exist in urban and semi-urban areas. So, broadly two markets for poultry feeds exist: rural and urban. The small commercial farms, largely located in semi-urban areas, by and large, have less refrigeration and modern processing facilities while large commercial enterprises, located largely in urban areas, use relatively modern production technology. Therefore, it is envisaged that the categorisation of poultry birds into three types

will cover both rural and urban markets and enterprises. The analysis, thus, needs to be disaggregated into village (scavenging) birds and commercial birds as much as possible.

Estimate for Consumption on Poultry Products

As already mentioned, there is a serious data constraint for consumption of poultry products from secondary sources. Some data on consumption aspects, however, were compiled from the Flood Impact Study (Ninno and Roy, 1999) conducted by FMRSP-IFPRI during 1998-99. The broad objective of the Flood Impact Study was to assess socio-economic impacts on households due to the 1998 flood. The study was carried out in three rounds, at three different points of time: two months after the 1998 flood (November-December, 1998), seven months after the flood (April-May, 1999) and 14 months after the flood (November-December 1999). The survey covered 155 villages across 7 districts and generated longitudinal data sets at the three points of time, by interviewing the same set of 757 householders each time.

This study has used household data (by land categories) on consumption of poultry products generated by the abovementioned survey. The poultry products considered in this analysis include meat and eggs. For obvious reasons of potential adverse impacts on households' consumption basket in the aftermath of the flood, the consumption data collected for the third round (12 months after the flood) survey are used.

The abovementioned survey data, however, relate to consumption in rural areas. Following this, consumption data for urban households are compiled from Household

Expenditure Survey (HES), which are available from several rounds of HES including 1995-96. The consumption data for the base year 2000 are estimated from trend analysis.

Estimate for Poultry Population

Historical data for poultry populations are even more sparse. The major sources of data on poultry population are the censuses, Agricultural Census 1996, Agricultural Census 1983-84, Agricultural Census 1977 and Agricultural Census 1960. The information for the years between the censuses are collected from various sources such as Alam (1997), FAO Yearbook (1997), USAID (1991), Livestock and Poultry Survey (1988-89) and Department of Livestock Services. Trend estimates are carried out separately for chicken and duck population[4]. Later, chicken populations are combined with duck populations to represent total poultry population.

Estimate for Scavenging Birds

Poultry production is dominated by commercial farms, located in mostly urban areas, and by chicken of scavenging nature, located in rural areas. The Department of Livestock Services (DLS) keeps records for the poultry farms at the Thana level. These records form the basis for an enumeration of the total number of commercial farms rearing different species of poultry in the country. However, there is no updated published data on poultry heads or the number of poultry farms.

Any projection of poultry feed requirements requires first the estimate of total

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[4] The trend estimates are carried out by fitting semi-logarithmic models.

poultry population, disaggregated by village poultry (of scavenging nature) and grain-consuming commercial birds (layers and broilers). A basic problem of this analysis relates to lack of reliable and adequate data on poultry populations. Moreover, whatever data available, are not disaggregated by scavenging and commercial birds, let alone by layer and broiler type. In particular, there is serious lack of data on birds of scavenging nature. Official sources (e.g. Agricultural Censuses, Livestock Department and FAO Yearbook) do not have such disaggregated data. These sources only suggest the total poultry population and the number of commercial farms. Hence, the only way of estimating the scavenging birds is by subtracting the number of commercial birds from the total poultry population, through use of data collected from the field surveys and key-informant interviews.

The Livestock Department suggests that of all the private commercial farms, about 22 per cent are broiler and 78 per cent are layer farms. Our key-informant interviews and expert opinions suggest that 19 per cent of the commercial farms are broiler and 81 per cent are layer farms. Our sample survey of 71 commercial poultry farms shows that the average number of bird per broiler farm is 622 and 1544 for a small and large-scale unit, respectively. The corresponding bird size of layer type estimates as 607 and 4870 at small and large scale, respectively. These figures for the per enterprise bird size appear to be on a very high side, presumably because of the large share of the sample from in and around Dhaka city[5].

Unofficial data compiled from the Livestock Department, however, show that average (weighted) number of bird per private commercial farm is in the range of 640 and

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[5] For example, the broiler and layer farms, located in Gazipur, (near Dhaka City), have an average size of as high as 1833 and 7572, respectively.

485 for layer and broiler type respectively (Appendix Table A.3). Using these figures for average farm size, the total birds under private farms are estimated. The deduction of this from the total poultry population, estimated earlier, gives the estimate of scavenging birds for various years. Later, however, these are cross-checked with similar data collected from the field surveys and key-informant interviews.

3. ANALYSIS AND RESULTS

As already mentioned, the study employs two approaches in order to obtain a range of projection for use of grain (wheat and maize) as poultry feeds, for the years 2005, 2010, 2015 and 2020. The year 2000 is considered as the base year. The first approach, the Demand Approach, involves projecting demand for grain derived from the projected consumption of poultry products (meat and eggs). The consumption per capita, multiplied by population (urban and rural), gives estimates of rural and urban demand for poultry products. Finally, the total demand for poultry products is projected through incorporating, growth in population, urbanization, income, income elasticities, and other factors.

PER HOUSEHOLD AND PER CAPITA CONSUMPTION OF POULTRY PRODUCTS FOR 2000

Two data sources, Flood Impact Study, FMRSP (primary data) and Household Expenditure Survey (HES) (secondary data), have been used to estimate per household and per capita consumption of poultry products.

Since the demand for poultry products is likely to be income-elastic it is important to use consumption data disaggregated by various socio-economic groups to allow potential

variations among such groups. Such data disaggregations are expected to give better estimates of aggregate data at national level.

Per capita consumption estimates of poultry products for farm households in rural areas (disaggregated by land categories) are compiled from the first source[6]. Table 1 gives such data on per household and per capita consumption (by land holding categories) in selected areas of rural Bangladesh for the year 2000. It can be seen that per capita and per household consumption of poultry products, as expected, vary significantly with various land-holding households. Since these data relate to only rural areas, per capita consumption data for urban households are compiled from the second source (HES data), which are available for 1995-96. The data for the year 2000 are estimated from trend analysis.

As is evident from the Estimate 1 (FMRSP data) presented in Table 1, within the rural households per capita consumption of both poultry meat and eggs almost systematically increases with the increase in land holdings. Per capita consumption of meat for the landless households, for example, estimated as 1.13 kgs (per annum), which increases to 2.92 kgs (per annum) for the large land-holding category. Similarly, per capita consumption of eggs for the landless households estimates as 16 kgs (per annum), which increases to 25 kgs (per annum) for the large farmers. For the rural areas, as a whole, per capita consumption of chicken meat and eggs per annum estimates are 1.03 kg and 18.1 kgs respectively.

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[6] Flood Impact Study (1999), FMRSP, IFPRI. Farmers are grouped into four land holding categories: marginal, small, medium and large, according to operated land. Consumption refers to that in the previous month of the time of the survey (See Table 1).

Table 1—Per Household and Per Capita Consumption of Poultry Products in Bangladesh Diet (2000)

Farm's Category[1]	Chicken Meat		Chicken Eggs	
	Estimate 1 Per Capita Consumption (Kg/Year)	Estimate 2 Per Capita Consumption (Kg/Year)	Estimate 1 Per Capita Consumption (No./Year)	Estimate 2 Per Capita Consumption (No./Year)
Rural Farm Households				
Landless	1.13	NA	16.0	NA
Marginal	0.61	NA	14.8	NA
Small	1.24	NA	20.3	NA
Medium	1.30	NA	21.2	NA
Large	2.92	NA	25.0	NA
Rural Households	1.03	1.05	18.1	26.8
Urban Households	NA	2.49	NA	43.3

Notes: [1] Farmers are categorized according to operated land.
    Marginal - 0.01 - <0.50 acre
    Small - 0.50 - < 2.5 acres
    Medium - 2.5 - < 5.0 acres
    Large - > 5.0 acres

Sources: Estimate 1 is based on primary data on monthly per household consumption (for rural households), generated from Flood Impact Study (1999), FMRSP.
    Estimate 2 is based on several rounds of HES secondary data on per capita daily consumption. The data for Estimate 2 are based on trend estimates.

In the case of computation from HES data (Estimate 2), obtained from trend estimates, it is evident that per capita consumption of meat in rural areas (1.05 Kg) is almost equal to that estimated from FMRSP data (1.03). However, the estimate for per capita eggs based on HES data (26.8) differs significantly compared to that obtained from FMRSP data (18.1).

NATIONAL CONSUMPTION OF POULTRY PRODUCTS FOR THE BASE YEAR 2000

Based on the per capita consumption figures, national consumption of poultry meat and eggs for rural and urban households have been estimated, which are shown in Table 2. As already mentioned, two data sources have been used to estimate consumptions of poultry

products. As can be seen from the Table, the total rural demand for poultry meat in the year

2000, based on FMRSP data, is estimated as 104 thousand metric tons[7]. The estimate based

on HES data is close to this, 106 thousand metric tons. The rural demand for poultry eggs in

the year 2000 is estimated as 1831 million, based on FMRSP data. The HES source,

however, estimates the rural demand for eggs at as high as 2711 million. Since the FMRSP

consumption data for rural households are the most recent and the data for urban households

are not available from this source, it is suggested that the analysis use a combination of the

two sources in estimating the national consumption. In other words, the analysis uses

FMRSP data for rural households and HES data for urban households in estimating the

national consumption. Thus, the national consumption of meat for the year 2000 is worked

out as 172 thousand metric tons while the consumption for eggs for the year 2000 is

estimated as 3007 millions[8]. These estimates have been used as the base year figures in the

projection exercise carried out below[9].

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[7] The population for 2000 is estimated as 128.31 million, of which 101.14 million are rural and 27.17 million are urban.
[8] This figure includes duck eggs, The FAO Production Year Book (1997) estimates the hen eggs to be in the range of 104 metric tons for 1997, about 2167 million eggs. The trend estimate of hen eggs for 2000 is found to be 2658 million.
[9] As will be seen below, in sensitive analysis, the projection is also carried out using exclusively HES consumption data.

Table 2—National Consumption of Poultry Products (2000)

Farm's Category	Total Consumption of Meat (000 Tons/Year)		Total Consumption of Eggs (Million No/Year)	
	Estimate 1[(1)]	Estimate 2[(2)]	Estimate 1[(1)]	Estimate 2[(2)]
Rural Farm Households				
Landless	7.34	-	103.91	-
Marginal	30.07	-	729.46	-
Small	38.37	-	628.21	-
Medium	11.82	-	181.57	-
Large	16.66	-	142.66	-
Rural Households	**104.26**	**106.20**	**1831**	**2711**
Urban Households	**NA**	**67.65**	**NA**	**1176**
TOTAL	**171.91**	**173.85**	**3007**	**3887**

Notes: Poultry include duck population.

Land category proportions, collected from Bangladesh Economic Review, are taken as proxy for population proportions (in corresponding categories).

Population in 2000 is estimated as 128.31 million, of which 101.14 million are rural and 27.17 million are urban.

Source: [1] Estimate 1 uses primary data from FMRSP (Flood Impact Study) for rural consumption, and HES secondary data for urban consumption.

[2] Estimate 2 uses HES data for both rural and urban areas.

PROJECTIONS OF CONSUMPTION OF POULTRY PRODUCTS
(DEMAND APPROACH)

The Demand Approach of the projection exercise (for selected years) requires that the responsiveness of demand for poultry products to income growth be incorporated. Alam (1995) estimated income elasticities as 1.23 for meat (all types) and 2.00 for eggs for the late 1990s. This study uses these figures of income elasticities in the projection exercise[10]. The elasticity for meat (all types) has been used for chicken. Average annual income growth per capita, estimated on the basis of past trends, is 2.83 per cent (See Appendix Table A.1 for estimated equations). Projection for human population, total rural, and urban, is carried out

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[10] Alam (1995) suggested the elasticities to be tentatively 1.14 for meat and 1.67 for eggs for the year 2000, which was suggested to be approximately further declining, by the year 2010, to 0.83 and 1.30 for meat and eggs, respectively. As will be seen later, the two sets of elasticities have been used in carrying out a sensitivity analysis. Shahabuddin and Zohir (1995) estimated income elasticity of meat (all types) in rural and urban Bangladesh as 1.2 and 1.4, respectively. The estimated income elasticities for Indonesia are 2.2 for chicken meat and 1.6 for chicken eggs (Mink 1987).

and presented in Table 4.

Starting from the base year (2000) data, consumption of poultry products over the years are projected incorporating growth in population, income, and income elasticities, for poultry products. Table 3 presents projected total consumption of poultry products in Bangladesh (Demand Approach) by poultry and poultry product type. Disaggregations by poultry type and products are made using information collected from the market survey and key-informant interviews.

As can be seen from Table 3, the projected national consumption of eggs are 4347 million, 4878 million, 5397 million and 5866 million for the years 2005, 2010, 2015 and 2020, respectively. Thus, the total consumption for eggs is projected to increase by 62 per cent in year 2010 and by 95 per cent in year 2020.

The corresponding national consumption of meat are projected to be 227, 255, 283 and 307 thousand metric tons for the four selected years, respectively[11]. Thus, the total consumption of meat is expected to increase by 48 per cent in year 2010 and by 78 per cent in year 2020.

The projected quantity of poultry products can be converted into feed requirements and finally, into use of grain (maize and wheat), which is discussed later in this Section.

The projection exercise carried out in this study involves substantial estimation procedures, with many supporting assumptions. In fact, more precise estimates require much detailed and practical knowledge about poultry production systems and feed coefficients,

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[11] Employing the IMPACT model, Mark Rosegrant (2002) has shown that the projected consumption of poultry meat in Bangladesh is 349 thousand metric tons in 2020.

according to types of poultry such as scavenging and commercial layers and broilers, ducks

and swine. It is also imperative to obtain details of demand characteristics, which depend on

quality and tastes of scavenger and commercial poultry meat and eggs. While such detailed

information are lacking or quite demanding,[12] there are other shortcomings as well. It is

difficult to assess how much of the domestic demand for poultry products are met from

domestic production and how much from imports.

Table 3—Projected Consumption of Poultry Products in Bangladesh (Demand Approach)

Poultry Products by Type	Base Year 2000	Projection for Poultry Products Over the Next 20 Years			
		2005	2010	2015	2020
Poultry Eggs (Million No)					
Scavenging	1323.08	1912.57	2146.10	2374.59	2581.15
Layer (Commercial)	1683.92	2434.18	2731.40	3022.20	3285.10
Total	**3007.00**	**4346.75**	**4877.50**	**5396.79**	**5866.25**
Poultry Meat (`000 Tons)					
Scavenging	90.42	119.60	134.27	148.62	161.62
Layer (Commercial)	67.22	88.91	99.81	110.48	120.14
Broiler (Commercial)	14.27	18. 87	21.19	23.45	25.50
Total	**171.91**	**227.38**	**255.27**	**282.55**	**307.25**

Note: Poultry include duck population.
Source: Estimates of total consumption of poultry products are based on Table 2, incorporating income
         growth and income elasticity of demand for products. Base year figures for total consumption (for
         both eggs and meat) are obtained from rural estimate based on FMRSP data, and urban estimate
         based on HES data. The disaggregations by poultry type and products are made on the basis of
         data collected from market survey.

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[12] The relevant assumptions in this analysis are based on a quick market survey and a few key-informant interviews.

PROJECTIONS OF POULTRY POPULATION (TRENDS APPROACH)

The second approach, the Trends Approach, involves estimating the rate of increase in the population of poultry on the basis of past trends. Semi-log models are employed to estimate trends using time series data. Table A.1 (Appendix Table) presents trend equations for poultry population and private commercial farms. Trend equations are estimated separately for chicken and duck population. As can be seen from the table, almost all the equations fit well at a highly acceptable level of statistical significance.

Estimated semi-log models show that chicken population is growing at an average rate of 5.3 per cent per annum (which is more than three times the current population growth rate) while duck population is growing at an average rate of 0.5 per cent per annum. Production of meat (all types) is growing at a 2.8 per cent rate annually. However, disaggregated chicken and duck were not available.

Current government policies in Bangladesh are based on open market economy where private sector plays a vital role. This is also true for the private poultry farms in general the farms are experiencing a significant growth in recent time. It can be seen from Table A.1 that chicken farms are growing at an annual rate of 1.5 and 6.1 per cent for fowls and rearing categories, respectively. Duck farms are growing even rapidly, at an average annual rate of 3.4 per cent and 10.4 per cent for fowls and rearing categories, respectively.

Projections of poultry and duck populations and commercial farms, based on the current growth rates, for the selected years (2005, 2010, 2015 and 2020) are presented in Table 4. The projected number of private chicken farms (fowls) are 29,202; 31,414; 33,743

and 36,352 in the years 2005, 2010, 2015 and 2020, respectively. The corresponding projections of chicken farms (rearing) are 21,775; 29,555; 40,115 and 54,448 in the four selected years, respectively.

The number of private duck farms (fowls) is estimated to be 19,149, 22,720, 26,957 and 31,984 in the four selected years, respectively. The corresponding duck farms (rearing) are estimated to be 16,831, 28,311, 47,620 and 80,098, respectively.

Table 5 presents projections of the total poultry population, based on the trend rates of growth, for the four selected years, 2005, 2010, 2015 and 2020. Poultry includes duck population. Two estimates are carried out, based on two methods: poultry population trend method and per capita (of poultry) trend method. One can use either of the two, or the mean of the two estimates. In this analysis, mean of the two estimates is calculated, which has subsequently been used in the projection of grain use as poultry feeds. The projected poultry populations are 218, 279, 356 and 451 million for the four selected years, respectively. Thus, the Trends Approach, based on past trend, suggests that the poultry population is expected to increase by 64 per cent in year 2010 and 165 per cent in year 2020 compared to that of 2000.

Table 4—Projections for Supply Indicators for Poultry
(Based on Past Trend Growth Rates)

Indicators	Base Year 2000	Projections for Years			
		2005	2010	2015	2020
Duck Population (Million Heads)	13.777	14.101	14.432	14.771	15.118
Chicken Population (Million Heads)	156.96	204.91	267.49	349.20	455.87
Private Chicken Farms (Fowls) (Number)	27,146	29,202	31,414	33,743	36,352
Private Chicken Farms (Rearing) (Number)	16,043	21,775	29,555	40,115	54,448
Private Duck Farms (Fowls) (Number)	16,139	19,149	22,720	26,957	31,984
Private Duck Farms (Rearing) (Number)	10,007	16,831	28,311	47,620	80,098
Human Population ('000)	128,310	139,911	151,890	162,682	171,420
Rural Population ('000)	101,138	105,960	110,127	112,609	113,103
Urban Population ('000)	27,172	33,951	41,763	50,073	58,317

Notes: Projections for poultry population and farms are based on past trend growth rates. Projection for human population is adopted from UN(1998a) and Islam (1997).

Sources: Estimates are based on data collected from (1) Agricultural Census 1960; (2) Agricultural Census 1970; (3) Agricultural Census 1983-84; (4) Agricultural Census 1996; (5) Livestock and Poultry Survey; (6) Department of Livestock Services, GOB; (7) Alam (1997); (8) FAO Yearbook (1997); (9) UN (1998a); (10) UN (1998b).

Table A. 1—Estimated Trend Equations for Relevant Indicators

Estimated Model	Annual Growth (%)	Adj R^2	F sig. Level
Duck Population: LOG (DCKPOP) = -6.669 + .004646 T	0.5	.95	.00
Chicken Population: LOG (DENACRE)= -101.564 + .05331 T	5.3	.99	.00
Production of Meat (All Type): LOG (PRODMEAT) = -50.548 + .02846 T	2.8	.99	.00
Per Capita Availability of Meat: LOG (CAPMEAT) = -12.538 + .00698 T	0.7	.99	.00
Chicken Farms (Fowls): LOG (PFARM1) = -18.991 + .0146 T	1.5	.26	.38
Chicken Farms (Rearing): LOG (PFARM2) = -112.517 + .0611 T	6.1	.69	.05
Duck Farms (Fowls): LOG (DFARM1) = -58.711 + .0342 T	3.4	.77	.03
Duck Farms (Rearing): LOG (DFARM2) = -198.789 + .1040 T	10.4	.88	.01
National Per Capita Income Growth LOG (CAPINC) = -47.934 + 0.0283 T	2.83	.98	.00

Note: T=Time

Sources: Estimates are based on data collected from: (1) Agricultural Census 1960; (2) Agricultural Census 1977; (3) Agricultural Census 1983/84; (4) Agricultural Census 1996; (5) Livestock and Poultry Survey; (6) Department of Livestock Services, GOB; (7) Alam (1997;1995); (8) FAO Yearbook (1997); (9) UN (1998a); (10) UN(1998b); (11) BBS(1998); (12) Household Expenditure Survey (1997);

Table 5—Projections of Poultry Population (Trends Approach)

Method	Base Year 2000	Projections of Poultry Population for Selected Years (Million)			
		2005	2010	2015	2020
Trend Estimate (on Poultry Population) Method	170.737	219.011	281.922	363.971	470.990
Trend Estimate (on Per Capita Poultry) Method	169.369	216.862	276.440	348.139	430.264
Average [1]	170.053	217.937	279.181	356.055	450.627

Notes: Projections of Poultry Population are based on past trend growth rates. Poultry include duck population.
[1] Average represents mean from two estimates, based on two methods: poultry population and per capita poultry trend method.
Sources: Estimates are based on data collected from (1) Agricultural Census 1960; (2) Agricultural Census 1970; (3) Agricultural Census 1983-84; (6) Agricultural Census 1996; (5) Livestock and Poultry Survey; (6) Department of Livestock Services, GOB; (7) Alam (1997); (8) FAO Yearbook (1997); (9) UN (1998a).

Table A. 2—Household Structure and Proportions of Sample Households Consuming Poultry Birds and Products by Land Holdings

Farm's Category	No. of Sample Farmers	% of Total	HH Size	% HH Owning Chicken	% HH Owning Duck	% HH Consuming Chicken Meat	% HH Consuming Egg
Landless	236	32.2	4.8	69.5	25.8	16.8	36.6
Marginal	160	21.8	5.1	84.4	39.4	24.3	47.1
Small	280	38.1	5.5	86.4	50.4	25.0	41.1
Medium	43	5.9	6.5	86.0	60.5	26.7	46.7
Large	15	2.0	7.1	73.3	33.3	45.5	81.8
Total	734	100.0	5.3	80.2	39.1	21.9	40.8

Notes: Farmers are categorized according to operated land. Consumption refers to that in the previous month of the time of the survey.
Land Categories: Marginal - 0.01 - < 0.50 acre
                       Small   - 0.50 - < 2.5 acres
                       Medium - 2.5 - < 5.0 acres
                       Large   - > 5.0 acres
Source: Flood Impact Study (1999), FMRSP.

The figures for average farm size (shown in Appendix Table A.3) give the estimate for total birds under private farms (disaggregated by layer and broiler type)[13]. The deduction of the commercial birds from the total birds gives the estimate of scavenging birds.

At this stage, it is pertinent to say a few words on the use of trend growth rates in the current projection exercise. As will be seen in the sensitivity analysis (Tables 8 and 9), the use of such high rates of past trend growth in the projection exercise has led to severe overestimation of poultry, poultry farms and, hence, feed requirements. The main reason behind this is the lack of a sufficiently large time series data from which trends have been estimated. On the other hand, it is more likely that the high trend growth rates, which require appropriate and adequate policy supports to sustain, may not be applicable over the next twenty years. In these circumstances, this analysis uses the current population growth rate, instead of using past trend growth rates, for the projection of poultry population and poultry farms.

Taking the current population growth rate as a proxy to the past trend growth rate, the projected poultry populations, disaggregated by type (scavenging, layers and broilers), are shown in Table 6. Finally, these disaggregated figures of poultry populations are used in the projections of grain use as poultry feeds, which is discussed in the next Section.

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[13] Estimates from the Livestock Department shows that of all the commercial farms, 78 per cent are layer and 22 per cent broiler farms. Our market survey and key-informant interviews indicate that the corresponding proportions to be in a close range, 81 per cent for layers and 19 per cent for broilers. The current analysis uses the estimates provided by the Livestock Department. Taking into account of the average farm size (Table A.3), layer poultry population accounts for 82.4 per cent and broiler accounts for 17.6 per cent in the total commercial birds.

Table 6—Projections of Poultry Population by Scavenging (Village) and Commercial Type in Bangladesh (Trends Approach)

Poultry Type	Base Year 2000	Projections of Poultry Population for Selected Years (Million Birds)			
		2005	2010	2015	2020
Village (Scavenging)	128.043	138.62	150.07	162.47	175.88
Layer	34.612	37.479	40.57	43.92	47.54
Broiler	7.398	8.018	8.67	9.39	10.16
Total	170.05	184.10	199.31	215.78	233.59

Notes: The current population growth rate has been taken as a proxy to the past trend growth rate. Poultry includes duck population. Mortality is not considered in these estimates. For the approach of deriving the distribution of poultry population among poultry type, see text.

Table A. 3—Farm Size by Chicken Type by Division

Division	Average Number of Birds Per Commercial Farm	
	Layer	Boiler
Dhaka	800	500
Chittagong	600	500
Barisal	300	200
Khulna	300	250
Rajshahi	300	200
Average[1]	640	485

Notes: [1] Averages represent weighted average, the weights being the number of farms in each Division. Data for Sylhet Division is not available
Source: Compiled from Livestock Department.

PROJECTED USE OF GRAIN (WHEAT AND MAIZE) FOR POULTRY FEEDS

Table 7 presents projected use of grain (wheat and maize) for poultry feeds, by poultry type, for the four selected years. Two separate estimates are carried out by adopting two approaches, Demand Approach and Trends Approach. The Demand Approach uses rural consumption from FMRSP and urban consumption from HES source (Table 2), and fixed income elasticities for eggs and meat for the projection of demand for poultry products. Since the estimates of trend growth rates were very high, the Trends Approach uses the current population growth rate as a proxy to past trend growth rate for the projection of poultry population and poultry farms. The data derived from these projections have subsequently been used in the projection of grain use as poultry feeds.

The projected uses of grain for poultry feeds are estimated by use of feed ingredients and feed coefficients shown in Tables A.4 and A.5 (Appendix Tables). As field survey suggests, an average rate of 10 per cent mortality has been assumed. For both layers and broilers, consumption figures are adjusted for annual level. For layers, feed consumption (per week) level applies for the life cycle of 78 weeks, from which that for 52 weeks is estimated. For broilers, average feed consumption (per week) applies for the life cycle of 6 weeks. Six batches of broilers in a year are considered. In other words, feed demand for 36 weeks is considered in a year. As estimated from field survey, the wheat consumption by scavenging birds is equivalent to 20 per cent of average quantity consumed by commercial layers and broilers. No maize consumption is considered for scavenging birds. Half of the scavenging birds are estimated to lay eggs in four seasons of the year.

As can be seen from Table 7, adopting Demand Approach, the projected use of total grains as poultry feeds is 665, 746, 826 and 898 thousand metric tons for the years 2005, 2010, 2015 and 2020, respectively. That is, starting from the base-year requirements, the projected use of grain for poultry feeds is expected to increase by 18 per cent in year 2010 and by 42 per cent in year 2020.

As can be seen from Table 7, according to the Trends Approach, the projected feeds are 683, 740, 801 and 867 thousand metric tons for the years 2005, 2010, 2015 and 2020, respectively. In terms of growth, the projected use of grain for poultry feeds is expected to increase by 17 per cent in year 2010 and by 37 per cent in year 2020.

Table A. 4—Use of Grain (Wheat and Maize) for Producing Eggs and Meat in Bangladesh (2000)

Type of Poultry	Average Use of Grain Per 1000 Eggs (Kg)			Average Use of Grain Per 1 Ton of Meat (Kg)		
	Wheat	Maize	Total	Wheat	Maize	Total
Scavenging	14.310	-	14.310	615.56	-	615.56
Layers	5.877	77.130	83.007	267.50	3518.75	3786.25
Broilers	-	-	-	457.14	877.55	1334.69

Notes: The wheat consumption by scavenging birds is estimated to be 20 per cent of average quantify consumed by layers and broilers. No maize consumption is considered for scavenging birds.
Sources: Field Survey and Quasem (2001).

Table 7—Projected Use of Grain (Wheat and Maize) as Poultry Feeds (by Poultry Type) in Bangladesh

Grain by Poultry Type	Base Year 2000	Projected Use of Grain for Poultry Feeds (000 Tons)			
		Demand Approach			
		2005	2010	2015	2020
Scavenging					
Wheat	-	100.99	113.36	125.47	136.42
Maize	-	-	-	-	-
Layer					
Wheat	-	38.09	42.75	47.31	51.44
Maize	-	500.59	561.87	621.85	676.11
Broiler					
Wheat	-	8.63	9.69	10.72	11.66
Maize	-	16.56	18.59	20.58	22.38
Wheat	**140.56**	**147.71**	**165.80**	**183.50**	**199.52**
Maize	**490.51**	**517.15**	**580.46**	**642.43**	**698.49**
Total Grain	**631.07**	**664.86**	**746.26**	**825.93**	**898.01**
		Trends Approach			
Scavenging					
Wheat	79.70	86.28	93.41	101.13	109.48
Maize	-	-	-	-	-
Layer					
Wheat	34.02	36.83	39.87	43.16	46.73
Maize	438.98	475.24	514.49	556.99	602.99
Broiler					
Wheat	26.85	29.06	31.46	34.06	36.88
Maize	51.53	55.79	60.40	65.39	70.79
Wheat	**140.56**	**152.17**	**164.74**	**178.35**	**193.08**
Maize	**490.51**	**531.03**	**574.89**	**622.38**	**673.78**
Total Grain	**631.07**	**683.20**	**739.63**	**800.73**	**866.86**

Notes: The trend growth rates of both poultry population and commercial farms is taken as equal to current population growth rate (1.6%). A 10 per cent mortality rate is assumed. For both layers and broilers, consumptions are adjusted for annual level. For layers, feed consumption (per week) level applies for the life cycle of 78 weeks, from which that for 52 weeks is estimated. For broilers, average feed consumption (per week) applies for the life cycle of 6 weeks. 6 batches of broilers in a year are considered. This means feed demand for 36 weeks is considered in a year. As estimated from field survey, the wheat consumption by scavenging birds is equivalent to 10 per cent of average quantity consumed by layers and broilers. No maize consumption is considered for scavenging birds. Half of scavenging birds are estimated to lay eggs in the whole year.

Table A. 5—Consumption of Grain (Wheat and Maize) as Poultry Feeds in Bangladesh (2000)

Feeds	Average Consumption (Grams/Per Week/Bird)	% of Grain Consumption
<u>Scavenging</u>		
Wheat	13.3	100.0
Maize	-	-
Total Grain	13.3	100.0
<u>Layer</u>		
<u>During First 20 Weeks</u>		
Wheat	12	7.2
Maize	155	92.8
Total Grain	167	100.0
<u>Remaining 32 Weeks</u>		
Wheat	26	7.0
Maize	343	93.0
Total Grain	369	100.0
<u>Average Over 52 Weeks</u>		
Wheat	21	7.2
Maize	271	92.8
Total Grain	292	100.0
<u>Broiler</u>		
Wheat	112	34.3
Maize	215	65.7
Total Grain	324	100.0

Notes: For scavenging birds, only wheat consumption is applicable.
For layers, feed consumption (per week) level applies for the life cycle of 78 weeks, from which that for 52 weeks is estimated. For broilers, average feed consumption (per week) applies for the life cycle of 6 weeks. 6 batches of broilers in a year are considered. That means, feed demand for 36 weeks is considered in a year.

Sources: Field Survey and Quasem (2001).

4. CONCLUSIONS

The two estimates involving the two approaches are within a reasonable range (Table 7). In order to derive more concrete conclusions, a sensitivity analysis for various alternative scenarios is carried out. The results are shown in Tables 8 and 9. Four estimates under four scenarios have been compared. The first scenario for each of the two approaches relates to the basic scenario referred to in Table 7.

At this stage, it is pertinent to say a few words on the results of the four alternative scenarios, including merits and demerits of the two methods adopted. In the first approach, i.e. Demand Approach, demands derived from the consumption of poultry products are dependent on factors such as income growth and income elasticities, urbanization, and population growth. Ideally, separate elasticities for scavenging and commercial poultry products, and separate income growths for rural and urban areas should have been estimated and used. Moreover, in this analysis, the factors such as tastes and, more importantly, relative product prices could not be incorporated. In Bangladesh, this issue is particularly important. Seasonal price fluctuations following non-availability of grain as poultry feeds throughout the year should be taken into account to estimate the total poultry feed requirement. Because, grains are very often replaced by substitute feeds as a result of a rise in prices. Hence, non-incorporation of price elasticity of demand is a limitation of this analysis.

Unfortunately, data on these aspects are neither available nor reliable. Particularly, the data that can identify the demand characteristics for commercial, as opposed to

scavenging poultry meat and eggs, are not available. In rural and even in urban areas, it is still a widespread notion that the scavenging poultry meat and eggs are superior in terms of tastes and nutritional contents. On the other hand, there appear to have constraints for the supply of commercial birds in rural areas, as the commercial farms are largely concentrated in urban areas. The fact that the scavenging birds are imperfect substitutes for commercial birds has not been incorporated, which is another limitation of this approach.

The second approach, i.e. the Trends Approach may be more appropriate in projecting the use of grain for poultry feeds when the supply constraints are more likely to dominate demand in determining the growth of poultry. However, the major drawback of this approach is the lack of large enough, continuous and reliable time series data. The trend estimates carried out using a discrete data series with a small number of observations are likely to lead to overestimation of growth rates. Moreover, the trend growth rates, which require appropriate and adequate policy supports to sustain, may not be applicable to a projection over the next twenty years. Under these circumstances, despite its limitations, the first approach (the Demand Approach) might be more appropriate in projecting the use of grain for poultry feeds in Bangladesh.

As can be observed from the sensitivity analysis presented in Table 8, the alternative scenarios for the Demand Approach use consumption data (for poultry products) from two sources, FMRSP (primary data) and HES (secondary data), and fixed and declining income elasticities. The four projection estimates of poultry feeds under four alternative scenarios are within a reasonable range, differing by 15 per cent. One can also use the mean of the four estimates derived from the four scenarios.

For the obvious reason of relatively much higher grain-consumption, the figures for commercial farms account for the main difference in the total feed requirements in the case of Trends Approach. As can be seen from the sensitivity analysis presented in Table 9, the alternative scenarios for this approach relate to various trend growth rates of poultry population and commercial farms. Keeping aside the projection under the fourth scenario (which is clearly an outlier), which incorporates the past trend growth of poultry population and commercial farms, the three projections of poultry feeds under the other three alternative scenarios differ by up to nearly one-third. Under these circumstances, one can also use the mean of the three estimates derived from the three scenarios.

The use of grain for poultry feeds for the base year 2000 is estimated to be 631 thousand metric tons. Of this amount, wheat accounts for 141 thousand metric tons and maize accounts for 491 thousand metric tons, i.e., 22 and 78 per cent of total grain requirements in the base year, respectively. Current production levels for wheat and maize in Bangladesh are in the range of 1800 thousand and 65 thousand metric tons, respectively. Thus, total poultry feed requirement is approximately one-third of the total wheat and maize production in Bangladesh. The requirement of wheat as poultry feed is nearly 8 per cent of the total domestic production and the requirement of maize as poultry feed is as high as about 8 times of its domestic production.

Our market survey (results not presented here) indicates that there is no marked difference in quality between domestic and imported maize except that the former has a little higher moisture and fiber content. Although, the import price of maize is reported to be often higher, no significant difference in domestic and import prices has been

observed. Nonetheless, the issue of moisture and fibre content is not a serious problem, as reported by respondent traders in our field survey.

The demands for both poultry feeds are currently met largely by imports, at seemingly relatively higher costs. Domestic maize is available only in a particular season of the year whereas demands for maize by poultry farms exist throughout the year. Sustainable supply of domestic maize throughout the year would contribute significantly for the development of the poultry sector.

The poultry sub-sector has significant linkage effects, both backward and forward. There has been tremendous growth of poultry farms over the last few years. Maize forms the major component in total grain requirement (78 per cent) as poultry feeds. Why then the production of maize in the country is not picking up? Maize ranks second to wheat in world cereal production, but in Bangladesh, it is still a minor crop in terms of acreage, accounting for only 3 per cent of wheat and 0.2 per cent of rice area. From the viewpoint of both human food and livestock feed, and its role in agro-ecological balance maize production is critically important in a country like Bangladesh. Although it may be possible to produce maize throughout the year, maize is currently produced in the country largely in winter. The major constraint of maize production could be the lack of incentives on the part of the cultivators, which was also observed by Quasem (1999). He suggested a series of motivational steps and market interventions. It is also observed that maize production is relatively unprofitable presumably because of low productivity.

Why are the poultry farms not encouraged to use domestic maize as poultry feeds? Is it because of irregular and unsustainable supply? It appears from our market survey

that the poultry farm-owners are not sufficiently aware of the quality and supply of domestic maize? Then, is there any need for market intervention? Do the farms need some orientation in feed-mixing know-how and technology? Why has there not been any significant growth of feed mills? Although some large farms buy ingredients, largely imported ones, for mixing their own feed, small poultry farmers do not generally have the know-how or a large enough scale of operation for feed mixing to be feasible. Thus, a substantial number of farms are using ready feeds, which are often of lower quality. These are some of the issues, which deserve significant attention in future research.

Table 8—Projected Use of Grain (Wheat and Maize) for Poultry Feeds in Bangladesh (Demand Approach): Under Various Scenarios

Scenario	Grain	Base Year 2000	Projected Use of Grain for Poultry Feeds (000 Tons)			
			Demand Approach			
			2005	2010	2015	2020
1	Wheat	140.56	147.71	165.80	183.50	199.52
	Maize	490.51	517.15	580.46	642.43	698.49
	Total Grain	631.07	664.86	746.26	825.93	898.01
2	Wheat	140.56	145.04	162.80	173.16	188.27
	Maize	490.51	506.75	568.78	604.70	657.47
	Total Grain	631.07	651.79	731.58	777.86	845.74
3	Wheat	140.56	157.12	175.35	185.45	200.62
	Maize	490.51	559.54	623.65	658.45	711.45
	Total Grain	631.07	716.66	799.00	843.90	912.07
4	Wheat	140.56	160.21	178.79	196.79	212.86
	Maize	490.51	571.84	637.30	700.55	756.87
	Total Grain	631.07	732.05	816.09	897.34	969.73

SCENARIO 1: Using rural consumption from FMRSP and urban consumption from HES source (Table 2) and fixed income elasticities:
EGG: 2.00 (during 2000-2020)
MEAT: 1.23 (during 2000-2020).

SCENARIO 2: Using rural consumption from FMRSP and urban consumption from HES source and declining income elasticities:
EGG: 1.67 (during 2000-2010); 1.30 (during 2010-2020)
MEAT: 1.14 (during 2000-2010); 0.83 (during 2010-2020).

SCENARIO 3: Using both rural and urban consumption data from HES source and declining income elasticities as above.

SCENARIO 4: Using both rural and urban consumption from HES source and fixed income elasticities:
EGG: 2.00 (during 2000-2020)
MEAT: 1.23 (during 2000-2020).

Table 9—Projected Use of Grain (Wheat and Maize) for Poultry Feeds in Bangladesh (Trends Approach): Under Various Scenarios

Scenario	Grain	Base Year 2000	Projected Use of Grain for Poultry Feeds (000 Tons) Trends Approach			
			2005	2010	2015	2020
1	Wheat	140.56	152.17	164.74	178.35	193.08
	Maize	490.51	531.03	574.89	622.38	673.78
	Total Grain	631.07	683.20	739.63	800.73	866.87
2	Wheat	140.56	149.20	158.37	168.10	178.43
	Maize	490.51	520.66	552.65	586.62	622.67
	Total Grain	631.07	669.85	711.02	754.72	801.10
3	Wheat	140.56	159.51	181.03	205.45	233.17
	Maize	490.51	561.77	643.38	736.85	843.90
	Total Grain	631.07	721.29	824.40	942.30	1077.07
4	Wheat	140.56	179.19	229.85	295.96	382.06
	Maize	490.51	615.18	792.35	1050.41	1435.29
	Total Grain	631.07	794.37	1022.20	1346.37	1817.35

SCENARIO 1: Trend growth rate of both poultry population and commercial farms taken as equal to current population growth rate (1.6%).

SCENARIO 2: Trend growth rate of both poultry population and commercial farms taken as equal to future population growth rate (1.2%).

SCENARIO 3: Half of past trend growth rate of poultry population (2.5%) & half of that of commercial farms (2.75%).

SCENARIO 4: Past trend growth rate of poultry population (5%) and past trend growth rate of commercial farms (5.5%).

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