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**Derived Feed Demand for Egypt's Poultry and Egg Sector to 2010--Policies
and Implications**

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Introduction and Literature Review

Rising per capita income in Egypt has a significant impact on patterns of food consumption, production, and foreign trade. McDowell et. al. analyzed food expenditures for selected food items and determined that expenditures for selected food items vary by income [4]. Analysis by Theil, Chung, and Seale confirmed that the budget share allocated to food is inversely correlated with income, and that middle- and low-income countries are more responsive to changes in food prices [6]. Initial impacts of per capita income rising from low to middle income levels start with higher demand for food and foods of greater variety and higher quality.

Consumers follow a general pattern to improve the nutritional level of the food they consume by upgrading their daily diet from basic grains and tubers toward high-protein items such as poultry, beef, pork, and dairy products, among others. In addition to natural resources and endowments, government trade policies shape the structure and efficiency of the domestic poultry industry and affect the mix between local production and imports of either meat or the feedgrains required to produce it. Income growth in Egypt during the 1980s, coupled with consumer subsidies and price controls, led to significant imports of feeds and poultry. Subsidies of domestic production led to falling poultry imports and rising domestic production, along with rising feedgrain and soymeal imports. Privatization of the poultry industry in the early 1990s, in turn, fueled more efficient production and significantly increasing imports of feedgrains and soymeal. Government liberalization and economic reform in Egypt that began in the late 1980s and ended by the

sector's privatization in 1991 boosted substantially the production of poultry and eggs. Now, as Egypt, like many other developing countries, faces the potential challenge of greater liberalization under the World Trade Organization (WTO), the efficiency of its domestic poultry industry will influence both domestic consumers and exporters competing to sell either products or immediate inputs into this growing market.

Objectives

Egypt's demands for poultry meat and egg consumption are projected to 2010. Based on that information, estimated poultry numbers (live birds and egg-layers) needed to satisfy this demand are projected, and the derived feed requirements are determined. Egypt's total production and imports of corn, soybean, and soybean meal were econometrically forecasted to assess the poultry sector's dependency rates on foreign feed markets. Econometric models were run first to provide estimates of the own-price, cross-price, and income elasticities used to project demand for poultry and eggs.

Economic Reforms and Policies

Government policies leaned more toward increasing poultry meat production over red meats, because it is more efficient feed converter. The poultry and egg sector in Egypt has developed dramatically since the early 1990s, fueled by economic reform, government policy shifts, and rising per capita GDP. In 1986, Egypt adopted new economic reforms that eliminated feed subsidies for poultry producers and started structural adjustment policies to reduce the role of government and encourage free market operations. The economic reform was designed to reduce

fiscal deficits by eliminating price distortions through the liberalization of pricing, trade, and foreign exchange policies. However, prices rose substantially, impacting both consumption and production.

Introduction of additional liberalization policies in 1991 further affected Egypt's agricultural production, competitiveness, and international trade, and created a more competitive market for feed and meat production. The commercial poultry sector became more dynamic, and rapidly overcame chronic domestic feed shortages, depending mostly on foreign supplies. The onset of the privatization process and the rapid acceleration of the commercial sector, due to economies of scale, reversed the output course to the benefit of the commercial sector, which was able to partially replace backyard operations.

Poultry and egg production increased substantially, although producers were protected from competing meat imports through high tariff barriers. From 1986 to 1997, there was a ban on poultry imports to encourage domestic production. This ban was replaced with an 80-percent tariff rate in 1997, scheduled to decline further to 70 percent on whole birds in 1998. However, customs duties remain at 80, and imports of poultry are still negligible, accounting for about 2,000 tons per year. Under the World Trade Organization (WTO) agreement, which Egypt has signed, all tariffs will have to be reduced and gradually eliminated. Further reduction of import tariffs will increase imports of poultry meat and reduce feed imports, reflecting lower domestic poultry production. The 10-year shift, which started in the early 1990s, of Egypt's poultry sector from the (mainly) public to the private domain was successful, providing a recent example for other countries.

Egypt's Poultry Sector

In value terms, 26 percent of Egypt's total livestock products came from poultry meat and egg production, and Egypt's livestock sector contributed 27 percent of total domestic agricultural production in 1999 [1]. In 2001, poultry production, at 646,600 metric tons, amounting to 44.3 percent of total meat production and exceeded all other meats.

Poultry production in Egypt varies widely according to the adoption of modern technologies, available management skills, and the size of commercial operations that use U.S. and European breeds. In 2000, 63 percent of Egypt's chicken meat output was produced by commercial operations. The traditional operations that use domestic breeds, in contrast, produce 22 percent of chicken meat, 64 percent of ducks, and 34 percent of turkeys, and all geese and pigeons [3, 9]. Domestic breeds (Balady) are well adapted to harsh environmental conditions, resistant to disease, and can accommodate feed with low nutritional value. However, commercial broiler chicken breeds are more efficient in feed use with a feed-to-meat conversion ratio of 2.65 pounds of feed per pound of meat, compared with the Balady strains that average nearly 5 pounds [2]. In addition, the commercial strains average 7-week growth cycles and could complete an average of five cycles in one year. The Balady breeds grow more slowly and need 120 days to reach slaughter, and therefore could complete at most three cycles per year [2]. Consequently, production from broiler operations using commercial techniques is increasing faster than Balady.

Between 1990 and 2001, poultry production increased from 271,500 to 647,000 tons, and egg production rose from 141,450 to 199,600 tons. Impacts of Egypt's liberalization policies could probably be best evaluated by comparing *ex-ante* and *ex-post* production trends. During 1985-

1990, poultry production grew at an average annual rate of 1.65 percent per year compared with an average rate 8.87 percent per year during 1995-2000. This rate exceeded the world average of 4.6 percent during the same period.

Per capita poultry meat consumption in Egypt has been increasing, from 4.7 kilograms (kg) in 1990 to 9.2 kg in 2001, still under the world average of 11.2 kg [7]. Per capita consumption grew at an annual growth rate of 6.9 percent, or nearly doubles the 3.5-percent world average in the 1990s. However, per capita egg consumption rose slightly from 2.1 kg in 1990 to 2.3 kg in 2001, far less than the world average of 8.1 kg.

Forecasting Egypt's Poultry Industry Needs

Methodology

Demand is formulated as a linear function of relative prices, per capita income, and a disturbance term. Specifically, per capita consumption of poultry or eggs is hypothesized to respond inversely to own-prices and respond directly to substitute prices and per capita GDP.

$$\text{Ln (QP)}i_t = \alpha + \beta \text{Ln (P)}i_t + \gamma \text{Ln (P}^*)j_t + \delta \text{Ln (M)}_t + \mathcal{E}_t$$

$$\text{Ln (QE)}h_t = \alpha + \beta \text{Ln (P)}h_t + \gamma \text{Ln (P}^*)j_t + \delta \text{Ln (P}^*)k_t + \theta \text{Ln (M)}_t + \mathcal{E}_t$$

Where (QP) i_t and (QE) h_t represent per capita poultry meat and egg consumption in kilograms and numbers, respectively, in year t . (P) i_t and (P) h_t are domestic prices of poultry and eggs in year t , respectively, while (P*) j_t and (P*) k_t are prices for the close substitute red meat (j)

(includes beef, buffalo, lamb, goat, pork, and camel meat,) and poultry meat (k), in year t . $(M)_t$ is per capita Gross Domestic Product in year t . \mathcal{E}_t is an error term and $\alpha, \beta, \gamma, \delta, \theta$ are parameters to be estimated in the log functional form, representing intercept, own-price, cross-price (red meat), cross-price (poultry), and income elasticities, respectively. The number of observations for meats and eggs were 35 and 23, respectively. All domestic prices were measured in real 1995 Egyptian Pound terms and were deflated by the Egyptian consumer price index (CPI). A linear regression in logarithmic form was estimated after adjusting for autocorrelation.

Estimation Results

Results of the per capita demand model using the Ordinary Least Squares (OLS) regression procedure are presented in table 1. The estimated values track the actual historical values fairly well and are within the 5-percent confidence intervals. As expected, the response of per capita consumption of poultry to its own-price is statistically significant. The estimated model indicated that the elasticity of demand for poultry meat and for eggs was negative and inelastic with respect to their own- prices, -0.47 for poultry and -0.58 for eggs. A recent study estimated the country's poultry own-price at -1.89, using different variables, including meat prices, fish prices, and Egypt's Gross Domestic Product (GDP) [7]. Despite differences in the estimated elasticity value (which is not unusual), results indicate that poultry became more desirable, mainly because poultry is less expensive than beef, buffalo, lamb, or goat meat.

The price elasticity of eggs was estimated using a poultry meat price and a red meat price as substitutes. All cross-price elasticities were estimated to be positive and inelastic. In the demand

Table 1 : Ordinary least square poultry and egg regression results

Commodity	Intercept	Own-price	Poultry	Red-meat	Income	Adj. R-square
Poultry meat	-7.71 (-6.85)**	-0.47 (-2.04)**	---	0.55 (1.86)*	1.08 (9.59)**	0.93
Eggs	-12.66 (-4.36)**	-0.58 (-4.63)**	0.62 (1.98)*	0.54 (1.73)*	1.09 (4.32)**	0.79

Note: Numbers between brackets indicate t-value

*= significant at 5-percent level.

**= significant at 1-percent level.

equation for poultry meat, the cross-price elasticity was estimated at 0.55 with respect to weighted-average price of red meats. In the demand equation for eggs, the cross-price elasticity was 0.62 with respect to the chicken meat price and 0.54 with respect to the red meat price. The income elasticity was 1.08 for poultry and 1.09 for eggs, compared with 0.8 for poultry indicated in the study cited earlier [7].

Poultry Meat and Egg Demand Projections for 2010

The regression analysis revealed declining price trends for poultry meat (1.3 percent annually) red meat (0.044 percent), and eggs (3.6 percent) annually. However, historical per capita GDP showed a rising trend of 2.2 percent per year in real terms between 1965 and 1999. Egypt's GDP is projected to increase at least 5 percent annually over the next 10 years [8]. With a 1.8-percent expected population growth rate during 2000-2010, per capita GDP will grow at a net rate of about 3.2 percent per year. Consequently, to forecast the levels of per capita consumption for poultry meat and eggs through 2010, three scenarios incorporating the trends in meat prices and

in per capita GDP are proposed:

1. Scenario I is a time-trend projection assuming historical domestic prices and per capita GDP growth of 2.2 percent annually and the continuation of current feed rations, technical production methods, and management practices.
2. Scenario II assumes a 3.2-percent per capita GDP growth rate, or approximately the rate of annual GDP forecast through 2010. It also assumes the continuation of current feed rations, technical production methods, and management practices as in scenario I.
3. Scenario III assumes poultry meat and egg prices decline at an annual rate of 1 percent, due to improved management practices and feed efficiency, and increasing adoption of new technology, with the same per capita GDP, as in scenario II.

Projection Results

Results of the regression model show that demand for poultry meat will increase in the three scenarios during 2000-2010. In 2000, per capita poultry meat consumption was 8.9 kg, and is forecast to increase to 11.3 kg in scenario I, 12.6 kg in scenario II, and 12.9 kg in scenario III by 2010. USDA's Agricultural Baseline Projections forecasts per capita poultry meat consumption for Egypt at 11.57 kg in 2010, which falls between scenario I and II [8]. Per capita poultry consumption is forecast to rise at an average rate of 4.2 percent per year in scenario I, 5.2 percent in scenario II, and 5.5 percent in scenario III. These growth rates are realistic, although they are below the average annual rate of 7.6 percent achieved between 1990 and 2000.

Per capita egg consumption is forecast to rise at an annual rate of 2.7, 3.6, and 4.1 percent under the three scenarios, respectively, by 2010. Per capita egg consumption is projected to rise from 62 eggs in 2000 to 80-92 eggs in the three scenarios. Most of the increase will result from increasing numbers of egg layers, which is forecast to increase from 17.2 million birds in 2000 to 26.2 million in scenario I, 28.7 million in scenario II, and 30 million in scenario III. Egg projections could not be compared with the USDA Baseline because the latter does not include a per capita egg consumption forecast for Egypt.

Live Poultry Projection to 2010

Forecasting per capita and total consumption of poultry meat and eggs is the starting point for projecting derived feed demand for poultry production. For Egypt to fill these forecast amounts through domestic production, feed must be provided for live birds, which will also be forecast. First, total numbers of live broilers, layers, and other poultry types that correspond or produce the total amount of poultry meat and eggs forecast in each of the above three scenarios are forecast. These calculations are based on average bird weight, given slaughter-dressing percentages, number of cycles per year, and adjustments for mortality rates throughout the lifespan in each poultry type per year. Simulation models are developed to estimate numbers of live birds by species in 2010 for each scenario, assuming that basic carcass characteristics and consumer preferences for average bird weight remain unchanged from the 2000 base year. Results indicate that the total number of live poultry birds increases from a calculated 852 million birds in 2000 to 1.272 billion birds in 2010 in scenario I, 1.412 billion birds in scenario II, and 1.444 billion birds in scenario III. Other poultry, essentially ducks, geese, turkeys, and

pigeons, are forecast to decrease from 22 to 16 percent during the same period.

In addition, for a more detailed forecast of the derived poultry sector demand for metabolizable energy and crude protein requirements, breeding stocks for both commercial and Balady operations are also forecast. Commercial broiler breeding stocks, estimated at 6.72 million birds in 2000, are forecast to increase between 54.5 and 77.3 percent in 2010, while commercial layer breeding stocks, estimated at 0.44 million in 2000, are expected to grow between 23.9 and 40.8 percent in 2010. Likewise, breeding stocks of Balady broilers were 2.13 million in 2000, and are forecast to reach 2.64, 2.93, and nearly 3 million birds in the three scenarios, respectively, in 2010. No published data are available for Balady layer parents, but they are assumed to decline as the number of commercial layer parents increases by year 2010.

Forecasting Derived Feed Requirements

Forecast energy and protein requirements are derived for the total forecast live bird numbers estimated above. The forecast will include broiler and layer inventories as well as the breeding stock for both commercial and Balady operations. The procedure begins with a determination of required metabolizable energy (ME) and crude protein (CP) needed per bird during its lifespan. A simulation model, based on fundamentals of physiology and nutrition sciences, was also used to calculate total ME and CP for individual poultry types. Quantity measures of ME and CP were converted to yellow corn and soybean meal using conversion factors and tables supplied by the National Research Council [5]. This simulation model is superior to the usual approach of utilizing a feed-to-meat ratio, because results were extracted through experimental trials on individual poultry types [5]. Total aggregated metabolizable energy (ME) were estimated to

increase from 10,330 million mcal (million calorie) in 2000 to 15,593 million mcal in 2010 in scenario I, to 17,262 million mcal in scenario II, and to 17,729 million mcal in scenario III. ME requirements are largely supplied by yellow corn and soybean meals, as well as minor items such as fish and meat meal and wheat bran. On a dry-matter basis, total corn and soybean meal requirements will rise from 3.12 million tons in 2000 to 4.72 million tons, 5.22, and 5.36 million tons for the three scenarios, respectively, in 2010 (Table 2). These amounts composed of 79 percent yellow corn and 21 percent soybean meals in all three scenarios.

To evaluate the reasonableness of these feed requirement forecasts, the feed-to-meat conversion rate for Egypt's commercial operations was calculated, from forecast feed requirements and forecast commercial poultry production at 2.59 feed-to-meat ratio. This result is comparable to that of a previous study undertaken in Egypt, estimating the rate at 2.65 [2]. Also, it is comparable with another estimate's range of between 2.4 and 2.5 for commercial broilers [7]. Most recently, the feed conversion rate for poultry in Egypt was reported at 2.5 [9]. These citations indicate that this study's projections are comparable with previous studies and consistent with expectations. Currently, the feed-to-meat conversion rate in the United States is estimated between 1.9 and 2.0, which indicates the U.S. sector's scale of efficiency compared with Egypt's poultry industry.

Egypt's Imports of Coarse Grains, Oilseeds, and Oilseed Meals

A close look at Egypt's feed availability and nutritional requirements reveal substantial supply shortages of major feed items, especially those providing high energy and crude protein. During

Table 2: Forecast total feed requirements (dry matter basis) for Egypt's Poultry Sector, 200-2010

Year	Feed requirements for poultry meat			Feed requirements For egg-layers			Feed requirement for parents & grandparents)			Grand totals		
	Scenario			Scenario			Scenario			Scenario		
	I	II	III	I	II	III	I	II	III	I	II	III
	1,000 tons			1,000 tons			1,000 tons			1,000 tons		
2000	1,979	1,979	1,979	589	589	589	557	557	557	3,124	3,124	3,124
2001	2,035	2,056	2,061	599	605	607	573	579	580	3,207	3,240	3,248
2002	2,103	2,148	2,157	631	642	647	593	606	608	3,327	3,395	3,413
2003	2,188	2,257	2,273	656	674	683	617	637	641	3,461	3,569	3,597
2004	2,284	2,381	2,402	687	712	725	645	672	678	3,615	3,765	3,806
2005	2,388	2,516	2,545	718	751	769	674	710	718	3,781	3,978	4,032
2006	2,496	2,657	2,693	752	794	815	705	750	761	3,952	4,201	4,269
2007	2,611	2,807	2,851	786	837	863	738	793	805	4,134	4,436	4,519
2008	2,726	2,963	3,017	822	883	916	770	837	853	4,318	4,684	4,785
2009	2,848	3,129	3,192	860	933	971	805	885	903	4,514	4,946	5,067
2010	2,975	3,303	3,377	899	984	1,029	842	934	956	4,716	5,221	5,362

1989-2000, Egypt's total feedstuff imports rose from 1.71 million tons to 6.66 million tons. (from \$270.5 million to \$797.8 million in nominal value terms. Yellow corn imports rose from 1.36 million tons in 1989 to 5 million tons in 2000, of which 76 percent was shipped from the United States. Likewise, Egypt's total oilseed imports rose from 38,400 tons in 1989 to 235,000 tons in 2000, while total oilseed meal imports, composed mostly of soybean meal, rose from 189,300 tons to 1,025,000 tons during 1989-2000.

Egypt's Dependency on Feed Imports Rising

Assessment of Egypt's increasing dependency on world markets to 2010 focuses only on yellow corn, soybeans, and soybean meal. Egypt imports both soybeans and soybean meal. Almost all soybean imports are crushed to produce soybean meal and oils, and only a few thousand tons are used to produce other food items. Thus, meal is converted into soybean-equivalent so that both imports can be related to domestic production to measure import dependency rates. Measuring the dependency rate this way assumes constant stock levels and negligible export volumes, assumptions that are realistic for Egypt. Results show that the soybean and meal equivalent import dependency rate has substantially increased from 74 percent in 1990 to 99 percent in 2000, indicating only a 1 percent self-sufficiency (SS) rate. This is mainly due to rapidly declining domestic production and increasing demand for soybean meal to expand domestic poultry and other livestock production. Using USDA's Baseline, Egypt's soybean-equivalent import dependency rate will continue to increase to an estimated 99.6 percent in 2010.

In the case of corn, Egypt's import dependency rate is much lower, 48.3 percent in 2000, but still substantially up from 29.7 percent in 1990. The corn dependency rate is forecast to rise to 50.1 percent in 2010.

Factors Affecting Prospects for Egypt's Poultry Sector

Productivity is low in Egypt's poultry sector and great advances could occur with improvement in management practices, feed efficiency, and the adoption of new technology. These include modernization of feed manufacturing plants and improvement of feed rations. Efficiency could increase further with increased private sector adoption of advanced production techniques and management skills. Also crucial would be substitution of recognized breeds of broilers and egg-layers for Balady breeds, which would reduce the amount of feed per bird and increase the number of broiler cycles per year, improving the offtake rate. Higher offtake rates contribute to higher levels of efficiency and reduced production costs. For example, a commercial-breed broiler in Egypt needs about 50 days to reach a live weight of 1.63 kg, consuming 3.8 kg of feed (dry-matter basis). In contrast, a Balady broiler needs 120 days to reach the same weight and consumes 8.1 kg of feed. Risk-averse farmers prefer to raise Balady breeds because they are more resistant to heat and diseases compared with commercial birds, and farmers are ready to pay for extra feed as a premium. Consumers, also pay a price premium (10-15 percent) for Balady chicken. Broiler offtake rate in Egypt is low compared with other countries, but could rise by 20-30 percent.

Another possibility for the Egyptian poultry sector to improve performance would be to increase the average weight per bird. Consumers currently prefer a carcass weight of slightly over 1 kg., yet, heavier birds produced over a shorter time period would provide a major vehicle for increasing sector performance.

Factors that could reduce feed requirements per pound of meat for Egypt's poultry include breeding programs to improve characteristics of the traditional Balady birds and/or replacing them with commercial operations using imported breeds. In addition, better managers with improved resources are the ones most likely to shift from Balady to commercial poultry meat and egg production. This would lead to higher efficiency and lower production costs, particularly as improvement translates to lower total metabolizable energy and crude protein requirements.

Implications for Other Countries

Egypt presents an interesting example of the way in which domestic and trade policies, as well as resource constraints interact to affect the mix between domestic production and imports of either meat or feed. Poultry meat production is receiving great attention worldwide, because it is the meat most likely to fill the gap for animal protein at low prices. Consequently, what is happening in Egypt has implications for many countries with similar conditions. These include the following.

1. Rising Dependency on Feed Imports

Rising dependency on feed imports will ultimately require a government decision to continue increasing imports to feed domestic poultry, or to lower high poultry meat import tariffs to allow more meat into the country, or a combination of both options. A government decision on the issue based on economic and welfare loss and gain considerations might benefit the lower income population, who would purchase the less-expensive frozen poultry. Although other

countries may not have strong consumer preferences for live birds, they are faced with the policy decision of whether to foster feed imports or poultry meat imports.

2. Privatization Boosts Poultry and Egg Production

The end of feed production subsidies, liberalization of feed imports, and start of privatization in 1991 fostered commercial operations to adopt new technologies, improved feeding systems, and acquired new management skills. These changes spurred gains in physical productivity and economic efficiency and have led to expanding production at lower prices. Consumers, in turn, responded by expanding poultry meat purchases in an upward spiral, rising 113 percent from its pre-privatization level 10 years ago. Countries like Egypt, with unmet meat demand, can expect poultry industry expansion and modernization under similar policy scenarios.

3. Feed Industry Lagging

Modernization of feed manufacturing can improve feed production efficiency and reduce poultry production costs. Based on Egypt's experience, stalled feed industry could be revitalized in two major ways. First, there needs to be accelerated specialization and differentiation efforts in manufacturing processes to produce a nutritionally balanced feed-mix for various poultry types, ages, breeds, and broiler and egg production. Second, mills need to apply the principle of relative value analysis to develop highly nutritional least-cost formulations for standard recommended rations. Substitution among ingredients should be viewed in terms of price and nutritional value. For example, under different prices, the absolute advantage of sorghum,

barley, or any other energy-supplying feed could shift, causing substitution for corn in feed mixes. Unfortunately, information on daily feed prices is not available on a regular basis, and commodity futures markets do not exist in Egypt. If price information were available, and least-cost ration formulation technology was widely adopted, competition would result in lower feed prices.

4. WTO Impact on Egyptian Poultry Production

Egypt's poultry producers currently import feedstuffs to raise their growing flocks while high tariffs restrain meat imports. Although the poultry import ban was lifted in 1997 and replaced by an 80-percent import tariff, imports remained negligible (about 2,000 tons per year). However, Egypt, as a WTO member, has to reduce and gradually eliminate all tariffs, opening up the market for imported poultry. Further reduction of import tariffs will increase imports of poultry meat and reduce feed imports. Liberalization will also intensify competition between domestic and world poultry producers, decreasing prices to consumers' advantage and benefit.

5. Applying the Methodology to Other Countries

The model represented here can provide an analytical basis to project derived feed demand for poultry and eggs using endogenous indicators that reflect a country's actual production and price trends. The methodology achieved its goal of estimating feed demand in the poultry sector and could be applied in other countries, providing the availability of statistical data.

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