prevalent in the farming and distribution related aspects of the business.

From the contractor's view point, these relationships can be very successful. In general, income is known in advance, is regular (e.g. for broiler growers every 8 weeks), and provides a reasonable return on the investment and direct costs. Care needs to be taken that the fees paid to independent contractors do not escalate beyond what is prudent.

Recommendations

Non-Integrated Markets

- Improve capital market and credit access policy in order to decrease the costs of capital for producers.
- Develop standards to quantify profitability.
- Invest in retail and processing businesses.

Semi-Integrated Markets

- Continue to progress toward capital, currency liberalization
- Invest in mass mechanizing of food products.
- Invest in firms whose business models expand from simple poultry processing to full scale integrated poultry supply companies.
- Support private sector firms that facilitate distribution of credit to processed poultry suppliers, transportation service suppliers, and mass market food retailers.

Integrated Markets

- Invest in the consolidation of the retail and poultry supply industries.
- Facilitate financing of industry consolidation.
- Carefully control working and investment capital.

Trade

The use of tariffs and non-tariff measures by governments is likely the single largest deterrent to a large increase in trade of poultry products through the PBEC region. This study reveals that with the exception of Australia and Hong Kong, all PBEC economies employ one or more tariffs of poultry, poultry products or feedstuffs.

Tariffs

The application and rate of tariffs vary considerably, as is evidenced in the attached schedules (see Appendix B for tariff rates for selected countries and a summary of tariff rates in Table 1 below). In many cases, the tariff rates applied may be considered relatively minor and not particularly trade distorting. However, in other cases, the tariffs are prohibitive to trade of poultry products into the particular economy.

The use of tariffs is an obvious impediment to trade and lower costs in the poultry value chain. Over the years, many governments have used tariff measures to protect domestic industry, gain control over imports, and to raise revenue. Generally, the higher the tariff the more likely that the tariff is being used as a 'protectionist' technique.

In order to achieve PBEC's objective of "free and open trade and investment in the PBEC region", the governments of PBEC economies must be urged to adopt a "zero tariff" policy to move towards a trading environment whereby poultry and poultry products, including poultry feed ingredients, can move between economies without attracting tariffs and being restrained by non-tariff barriers. Adoption of a "zero-tariff" policy for poultry and poultry products, including feed ingredients, will result in lower food costs for consumers in all PBEC

Table 1. Summary of Tariff Ranges for Poultry Feed Grain, Poultry and Poultry Products (see also Appendix B)

Commodity (units) [base price, US $/unit]	**"Zero"**	**"Mid-Range"**		**"Prohibitively High"**	
	Country	**Country**	**US $/ unit**	**Country**	**US $/unit**
Feed Grains					
Wheat (mt) [95]	Australia Hong Kong Indonesia New Zealand	Several Several	< 10 10.45-32.50	China Japan	171.00 443.76
Barley (mt) [85]	Australia Hong Kong New Zealand	Many Several	<10 16.58-29.09	China Japan Mexico Thailand	136.00 92.51 106.02 75.72
Corn (mt) [109]	Australia Hong Kong New Zealand	Many Several	<10 21.26-37.30	China Japan Thailand	196.20 93.20 74.95
Sorghum (mt) [92.50]	Australia Hong Kong New Zealand Russia	Many Several	<10 18.04-44.00	Thailand	92.50
Peas (mt) [87]	Australia Hong Kong	Many Several	<10 13.05-39.00	Japan Thailand	3214.90 52.2
Soymeal (mt) [188]	Australia Canada Hong Kong New Zealand Russia	Several Many	<10 12.65-39.35	Several Chile US	>50 64.33 70
Canola Meal (mt) [115]	Australia Canada Hong Kong Malaysia New Zealand Russia	Many Many	<10 12.65-39.35		
Fish Meal (mt) [621]	Australia Hong Kong Malaysia Russia US	One Many	<10 18.63-31.05	Many China	>50 498.60
Corn Gluten Meal (mt) [227]	Australia Hong Kong Malaysia	Two Many	<10 18.63-31.05	Many Chile	>50 212.51
Live Fowl					
Domestic Fowl < 185g (bird) [3.54]	Australia China Hong Kong	Several Several	<0.50 0.53-0.71	Chile Mexico Peru	1.21 1.75 1.17
Turkeys <185g (bird) [2.03]	Australia China Hong Kong	Several Several	<0.50 0.52-0.71		

Commodity (units) [base price, US $/unit]	**"Zero"**	**"Mid-Range"**		**"Prohibitively High"**	
	Country	**Country**	**US $/ unit**	**Country**	**US $/unit**
Ducks, Geese < 185g (bird) [1.77]	Australia China Hong Kong New Zealand	Several Several	<0.50 0.52-0.71		
Fowls; 185-200g (bird) [4.06]	Australia China Hong Kong New Zealand	Several Several	<0.50 0.79-0.97	Chile Peru Thailand	1.39 1.34 1.62
Live Poultry; 185-200g (bird) [4.06]	Australia China Hong Kong New Zealand	Several Several	<0.50 0.79-0.97	Chile Peru Thailand	1.39 1.34 1.62
Live Poultry, >200g (bird) [5.14]	Australia China Hong Kong New Zealand	Several Several	<0.50 0.54	Some Thailand	>1.00 2.06
Poultry, Whole, Fresh, Chilled or Frozen					
Chickens, capons, whole, fresh or chilled (kg) [2.29]	Australia Hong Kong	Several Several	<.0.50 0.57-0.79	China Thailand	1.60 1.37
Chickens, capons, whole, frozen (kg) [1.69]	Australia Hong Kong	Several Several	<0.50 0.51-0.58	China Thailand	1.18 1.01
Chickens, capons, cuts, & edible offal, fresh or chilled (kg) [1.77]	Australia Hong Kong	Several Several	<0.50 0.53-0.72	China Thailand	1.24 1.06
Chickens, capons, cuts, & edible offal, frozen (kg) [0.89]	Australia Hong Kong	Several Several	<0.50 0.53-0.62		
Turkeys, whole, frozen (kg) [1.43]	Australia Hong Kong	Several	<0.50	China Thailand	1.00 0.86
Turkeys, cuts & edible offal, fresh or chilled (kg) [3.30]	Australia Hong Kong	Several Several	<0.50 0.83-0.99	Several China	>1.00 2.31
Turkeys, cuts & edible offal, frozen (kg) [0.73]	Australia Hong Kong	Most China	<0.50 0.51		
Ducks, geese, whole fresh or chilled (kg) [2.35]	Australia Hong Kong	Several	<0.50	China Thailand Chinese Taipei	1.65 1.41 1.07
Ducks, geese, whole frozen (kg) [2.99]	Australia Hong Kong	Several	<0.50	Several China	>1.00 2.09

Commodity (units) [base price, US $/unit]	"Zero"	"Mid-Range"		"Prohibitively High"	
	Country	Country	US $/ unit	Country	US $/unit
Ducks, geese, whole fresh or chilled (kg) [2.35]	Australia Hong Kong	Several	<0.50	China Thailand Chinese Taipei	1.65 1.41 1.07
Ducks, geese, whole frozen (kg) [2.99]	Australia Hong Kong	Several	<0.50	Several China	>1.00 2.09

economies and likely a broader selection to consumers in the region.

Non-Tariff Barriers

Unreasonable, non-scientific based sanitary and phytosanitary regulations are also effective tools implemented for protectionist reasons. In either the case of tariff or of non-tariff barriers, the consumer can be expected to pay more for the poultry product than in the circumstance where the product enters the country under a "zero" tariff arrangement.

It should be clearly understood that it is NOT recommended that governments abandon any concern or responsibility over the general health and welfare of its citizens. Thus it is recognized that governments must maintain their vigilance over the import, handling and transportation of safe and healthy food products. However, it is recommended that any regulations imposed to satisfy this responsibility be based totally on science-based data and technology and subject to agreement and review by an international body of experts in this field. The WTO (World Trade Organization) can take a leadership role in this regard.

In addition to the tariff barriers shown above in Table 1 and in Appendix B, several non-tariff barriers have been identified by companies in the business and are reported as follows:

- Chile – *Salmonella*-free certification is almost impossible to get.
- Mexico – All poultry imported is under a NAFTA quota. The U.S. has almost all of the quota while Canada has only a small portion. In addition, imports from Canada attract a 10% duty while U.S. poultry is duty-free.
- Australia – Poultry imports are subject to quarantine and health restrictions which are not scientifically justified, according to some industry participants. At issue is the extreme temperatures and time requirements for cooking of processed poultry meat.
- Hong Kong – Importer is required to pay import declaration charge.
- Japan – There are requirements to work through a Japanese broker in addition to complex and expensive sanitary and phytosanitary regulations.
- Malaysia – The amount of in-quota imports is restricted through licensing and sanitary controls.
- Philippines – Has not implemented its Uruguay Round commitments for market access. There is no protocol governing sanitary requirements and plant inspection systems to facilitate poultry imports.
- South Korea – Tariff rate quota for most poultry and poultry products.
- Taiwan – A number of unique bacteriological restrictions.

The adoption of science-based regulations for the import, handling and movement of poultry products would provide assurance to consumers and governments alike that all food products are subject to the best monitoring system available in the world. Exporting economies would be comforted to know

that sanitary and phytosanitary measures will not be indiscriminately used as a non-tariff barrier to trade.

Summary of Recommendations

The above discussion along with discussions from other aspects of the value chain (see, in particular, the logistic section above) points to recommendations for the poultry industry and governments. These recommendations are below.

- Progressively reduce tariffs in PBEC economies in order to achieve a "zero" tariff policy as already committed to by the APEC leaders.
- Eliminate unreasonable, non-scientific based sanitary and phytosanitary regulations while maintaining the vigilance over food products to maintain consumers' health and welfare.
  - Imposed regulations should be based science-based data and technology and subject to agreement and review by an international body of experts in this field.
  - It should be clearly understood that it is NOT recommended that governments abandon any concern or responsibility over the general health and welfare of its citizens.
- Develop effective legal regimes.
  - Create enforceable intellectual property rights.
  - Create mechanisms for contract enforcement.

Production and Processing

Efficiencies are gained in the poultry value chain by controlling costs of production and processing. A large portion of the production and processing costs is determined by scale especially as industry becomes more integrated. The scale of production and processing may be a source of comparative advantages, although an economy's comparative advantage may be from other sources. Examples of production in New Zealand, the Philippines and Indonesia are presented as case studies later in this report.

This section discusses costs of poultry production, economies of scale, costs of poultry processing and economies of scale in processing. Non-cost-related sources of comparative advantage are then presented, followed by a summary of recommendations for production and processing.

Costs of Production in Different Countries

Broiler cost of production (per kg) for selected countries is presented in Table 2. Costs of production capture relative costs at a specific time. In this case, most of the data were gathered in late 1993 and early 1994. Since then relative costs and exchange rates have changed; however, these figures are indicative of broad trends. In all countries, feed cost at the broiler level and as a component of chick cost is the major cost of production. The unit cost of labor and labor productivity, including grower labor, is the next most important cost item and all other costs are relatively small in comparison. There are substantial differences among countries in total cost of production of chicken meat ex-plant. The United States is an appropriate benchmark to compare relative performances. The U.S. poultry industry has the most extensive technology, a secure market position, and per capita consumption at levels higher than virtually all other countries. Industry structure is mature, and concentration in the industry is such that large companies have captured all of the efficiencies that scale brings. In addition, the United States is a large exporter of feed ingredients, and its domestic feed market is a reasonable indicator of international feed prices.

Other countries that are cost-competitive with the United States are also in a strongly competitive raw material cost position. In the case of countries such as Brazil, China and Thailand, where the overall cost of production is less ex-plant, the cost advantage is gained in areas other than bird production (for

Table 2. Poultry Cost of Production in Selected Countries

	Argentina '94	Brazil '93	China '94	France '93	Hungary '94	Netherlands '93	Peru '94	Poland '93	Thailand '94	Turkey '94	U.S. '94
Live Cost (US c/kg liveweight)											
Chick Cost	14.6	9.4	10.0	14.3	12.7	16.0	11.4	15.3	9.8	12.0	8.3
Feed Cost	46.7	35.9	42.9	57.1	55.6	55.2	76.0	65.6	51.5	47.7	36.8
Grower Payment	13.8	5.3	5.8	19.2	20.3	25.8	5.0	15.2	6.3	21.4	8.8
Vet & Medication	3.3	0.1	2.0	1.3	0.8	1.5		0.9	1.7	1.5	1.1
Service & Grower Admin.	9.2	0.0									1.1
Farm Cost	87.5	50.7	60.7	91.9	89.3	98.4	105.0	97.0	69.3	82.7	56.1
Livehaul		1.5	1.0	1.8				1.0	2.0	1.0	2.8
Live Cost at Plant	87.5	52.2	61.7	93.6	89.3	98.4	105.0	98	71.3	83.7	58.8
Meat Cost at Plant (US c/kg RTC)	109.4	68.9	81.4	123.6	117.9	129.8	131.3	129.4	94.2	110.5	77.4
Condemnations											1.0
Offal Credit											-2.2
Net Meat Cost at Plant	109.4	68.9	81.4	123.6	117.9	129.8	131.3	129.4	94.2	110.5	76.2
Plant Costs (US c/kg RTC)											
Labor		6.3			16.2			9.8	8.2	7.9	15.4
Packaging		3.3						4.3		4.0	4.6
Utilities		1.7									2.6
Office, Supplies, Misc.		2.0			8.6			7.1	4.1	3.2	2.9
Fixed Costs		3.2			2.8			1.6		1.0	3.3
Non Labor		10.1			11.4			13	4.1	8.3	13.4
Total Nondisaggregate	22.0		11.8	35.0		33.5	21.0				
Total Nonmeat Cost	22.0	16.5	11.8	35.0	27.6	33.5	21.0	22.8	12.4	16.1	28.9
Total Operating Cost	131.4	85.4	93.2	158.6	145.5	163.4	152.3	152.2	106.5	126.6	105.0
Overhead and Interest	8.0				4.8		4.0				4.2
Total Cost (US c/kg RTC)	141.0	85.4	93.2	158.6	150.3	163.4	156.3	152.2	106.5	126.6	109.2
Production Parameters											
FCR (Feed Conversion Ratio)	2.3	2.0	2.3	2.0	2.3	1.9	2.2	2.4	2.0	2.0	2.0
Weight at Slaughter (kg)	2.4	1.9	2.6	1.9	1.9	1.8	2.2	1.8	1.9	1.9	1.9
RTC weight (kg)	1.9	1.4	2.0	1.4	1.4	1.4	1.7	1.4	1.4	1.4	1.5
Age (days)	44-52	41.9	56.0	43.0	46.0	42.0	49.0	49.0	45.0	41.8	42.0
European Broiler Index	209	227	201	225	182	232	204	153	211	299	230
Feed Cost (US $/Ton)	204	181	186	291	242	298	353	270	258	246	184

(Source: IFC. The World Poultry Industry, 1995.)

example, low labor costs and lower grower-related costs, which inevitably are related to labor cost).

The cost of feed is the most important cost in broiler production, not only because of the cost of broiler feed but also because of the influence of the cost of breeder feed on day-old-chick cost. Feed cost per kilo of live weight produced is a function of the cost of feed itself but also of the feed conversion ratio (FCR), which is defined as the amount of broiler feed required to produce one kilo of live weight. The underlying genetic potential of the broiler grow-out is basically the same for all countries because penetration of the modern breeding companies is virtually universal. Therefore, variations among countries in feed cost per kilogram of live weight are influenced by differences in feed costs and efficiency of broiler grow-out management.

The grower payment variation among countries is significant. The components that contribute to grower payments are labor cost, the capital cost of housing (sheds), labor productivity, and the cost of other inputs such as litter, gas, utilities, etc. Low-labor-cost countries tend to have low grower payments (Brazil, China, Thailand) and high-labor-cost countries tend to have high grower payments.

Broiler farm productivity is an important component of grower cost and is a function of the rate of throughput of a broiler farm, of average farm size, and the basis of the negotiated growing fee that is paid to a grower by the integrator. This varies significantly with the U.S. averaging over 40,000 birds per farm compared to around 10,000 in Thailand.

In general, broiler grower contracts are established between the growers and the processor on a per-bird basis with performance incentives. The integrator provides the day-old chicks, feed and service and support. The grower provides labor, sheds, litter and utilities. The fees are negotiated and are based, to some extent, on industry structure and local conditions. Therefore, the issue that is more important than farm size or annual throughput in determining the growing costs is, in fact, the negotiated fee.

Economies of Scale in Production

The steady supply of live broilers to a processing plant requires careful coordination of placement of multiplication flocks and balancing of capacities at all levels of farming operations. A typical flow is summarized in Figure 12. Typically, unit shed sizes for broiler and breeder sheds are around 1,000 square meters holding 4,500 breeders or 20,000 broilers. Farms are made up of multiples of these units and the maximum farm size is a function of placing livestock of the same age.

In the example shown in Figure 12, the placement of breeders is likely to be every seven weeks, which would require four rearing farms and eight breeder farms of 50,000 birds (11 sheds each). This would ensure age segregation, which has animal health benefits, and a consistent flow of fertile eggs to the broiler hatchery.

Shed design varies according to climate, with warmer climates having open, low-cost shedding and colder climates having closed, ventilated shedding with heating and artificial light. A number of locations which have typically used open low-cost shedding are converting breeder-rearing sheds to closed sheds to take advantage of the ability to control light in order to control sexual maturity and the onset of production. The control of light during rearing has become a critical management tool in recent years and is an example of the continual technical progress the industry makes.

Because broiler growing is often contracted to independent operators, farm sizes are more varied. The unit shed size generally is consistent within

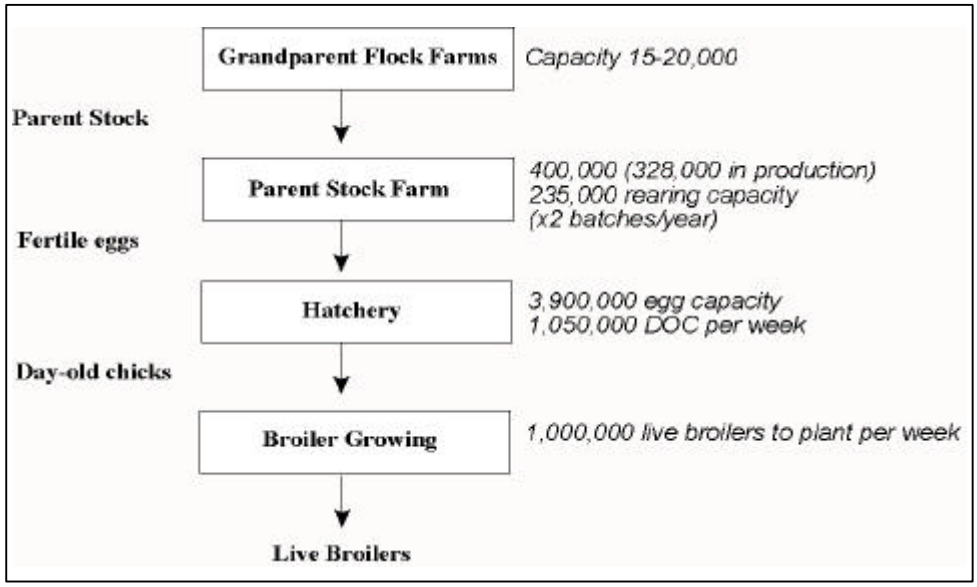

Figure 12. Typical product throughput in the poultry industry.

countries but tends to vary among countries. This is often determined by the resources available to small contractors to construct and equip shedding, and policies of the integrators in relation to grower management.

Hatchery capacity is based on standard-size setters and hatchers that are common worldwide, and hatchery volume is a function of multiples of machine units. Scale is significant in terms of overhead recovery and, to a certain extent, labor efficiency.

Processing Costs

Comparisons among countries in plant processing costs are confounded by product mix. In some cases, particularly in countries that export to Japan, the manual labor input into product preparation is intensive. For example, China and Thailand export a full range of ready-prepared products that have a very high labor input. On the other hand, the United States exports bone-in legs to Japan that have little labor input other than the standard labor required for the slaughter and automatic cut-up process.

The major cost of operating a poultry slaughter plant is labor, but for the reasons mentioned, the cost of labor per kilogram of final product does not totally reflect the differences in unit costs of labor or labor productivity, although it is apparent that the cost of labor per kilogram is lower in low-labor-cost countries.

The weight of birds at slaughter does influence processing costs per kilogram as most of the costs in plant are incurred on a per bird basis. To some extent, the savings in slaughter costs are overcome by inefficiencies in live-bird cost when birds are taken too heavy (such as 2.6 kilograms). There is always a trade-off between market requirements for bird size and the efficiencies that can be gained by optimizing biological efficiency and processing cost.

Economies of Scale in Processing

The U.S. scale may seem large but experience suggests that this will continue to increase overtime in relative terms and apply to all countries. In the U.S., the competitive size of integration has increased significantly over time and Rabobank quotes the following efficient unit sizes (shown in Table 3).

Table 3. Efficient Poultry Processing Sizes in the U.S. For Selected Years

Year	Birds per Annum (million)	Birds per Hour (thousand)
1959	7	3
1982	18	9
1997	65	32.5
2005	125	62.5

There are differences among countries in automation in both the primary whole bird processing (slaughter, defeathering, evisceration) and in secondary processing (cut up, deskinning, deboning). In areas where plants are moderate in size and labor costs are low, there is manual evisceration, whereas in large plants, regardless of labor rates, automatic primary processing is the norm. In low-labor-cost countries the degree of automation in secondary processing is minimal with manual cutting, deskinning, and deboning. In high-labor-cost countries the degree of automation is very high in primary and secondary processing, packing, labeling, and distribution. The throughput of a plant tends to be set by the speed of the primary processing line. A standard line speed is 8,000 birds an hour.

Processing technology is freely transferable, so there is little difference among countries in the technology inside a slaughter and processing plant. On a single-shift basis, one line has a capacity of 16 million broilers a year. Tyson Farms, the world's leading poultry company, has based its business and expansion program on 1.3 million birds a week integrated business units. This approximately coincides with a plant with two 8,000 bird-an-hour lines running two shifts a day. Newer developments in the USA have moved to higher levels already with Choctaw Maid leading the way producing 2.4 million per week in one plant (125 million per annum).

The decision to enter the further-processed product business is largely determined by the market. Although economies of scale in processing will still be gained over time and across all economies, at one point in time, the optimum scale of a processing plant differs across countries as each one is faced with different market constraints.

Non-Cost-Related Sources of Competitive Advantage

Climate

The most cost competitive countries in poultry production tend to have a significant part of their industry located between thirty and thirty-five degrees latitude. The requirements for shelter, supplementary heating or cooling, and general environmental control are not as great in those areas as in other climates, and chickens are physiologically comfortable in intensive conditions at temperatures somewhere between 20^0C and 30^0C degrees. Therefore the latitude between thirty and thirty-five degrees provides a natural comfort zone.

Land Availability and Environmental Issues

Availability of land is not generally a problem for intensive poultry production. Specialized farms practicing intensive livestock husbandry produce a surplus of minerals such as phosphorus, potassium, sodium, and nitrogen. In addition, they contribute to the emission of ammonia. Increasing regional concentration of poultry production in some densely populated countries is forcing authorities to enact environmental legislation designed to limit emissions from farms.

Local Market Structure

Local production is better able to meet local demand in markets which tend to be based on live and freshly produced products, while international

production is traded as frozen whole, parts, or further-transformed products. Opportunities always exist for local companies to respond quickly—and quicker than international companies—to the changing local demand.

Economic Environment

The economic environment is a key factor in the development of a competitive industry. Experience indicates that the economic, legal and social environment may accelerate or postpone the emergence of a competitive poultry industry. The existence of free market, investor friendly policies and legislation are equally important in this respect. Free and open trade and investment allows local production to take advantage of lower cost resources and technological advancements, which in turn strengthen long term competitive positions locally and internationally. Government supports and subsidies on the other hand, only give the illusion of competitive advantages. They are short-term solutions which slow down the emergence of sustainable growth.

The quality and stability of macroeconomic policy also plays a significant role in the sustainable development of the industry. Because its main products, that is frozen broilers and parts, are internationally traded products, the poultry industry is particularly sensitive to real exchange rate variations that directly affect its competitiveness. This is mitigated to some extent by the fact that feed ingredients are themselves generally traded. In some countries, however, trade and agricultural policies have in fact decoupled the domestic feed market from the world market, which leaves the poultry industry extremely exposed to real exchange rate fluctuations.

In some countries, however, trade and agricultural policies have in fact decoupled the domestic feed market from the world market, which leaves the poultry industry exposed to real exchange rate fluctuations, such as those occurring during the recent Asian financial crisis. However, as further trade liberalization occurs and inputs, as well as all goods, are allowed to move more freely, the effects on domestic industries will be moderated.

Biosecurity

Biosecurity is a key factor for industries considering the sustainable competitive establishment of an efficient industry that provides value to consumers. It has been shown that excellent biosecurity status such as enjoyed by New Zealand (see the New Zealand case study), where the three major economically significant poultry diseases are not present, can overcome cost disadvantages in raw material costs and economies of scale, whilst also ensuring the protection of the environment, including native birds. This translates to a net cost/benefit for consumers.

To achieve this, it is essential that biosecurity plans and programs be adopted by respected governments and implemented by regulatory agencies and industry participants. This is achieved by justifiable quarantine, sanitary and phytosanitary conditions for imports and a cautious rational approach to public health issues. The implications of not having proper biosecurity plans for each nation are significant.

Biosecurity plans need to be supported by properly documented processes and systems to ensure traceability of product. The HACCP approach provides such a tool that and those tools are becoming vital to ensure public and industry health.

Valid quarantine protection should not be confused with invalid tariff protection which is practiced by a number of countries, driven, in many cases, by the political power of the special interest groups involved. This provides an impediment to

consumers receiving poultry meat at the world's best practice prices. An example of this is the current EU policy of not allowing fresh poultry meat imports from the USA due to the use of spin chilling technology and chlorine, which, when properly managed, produces a totally acceptable and healthy product.

Summary of Production and Processing Recommendations

- Facilitate the availability of low cost feed raw materials.
- Upgrade the nutritional value of raw feed materials.
- Support measures to mitigate high financing rates.
- Encourage sources of reliable farm housing and housing equipment coupled with good after sales service.
- Help resolve environmental concerns.

Food Safety

Eggs, poultry, and meat can become contaminated in any of the steps of the food production chain. On the farm, poultry and eggs may become infected because of contaminated feed, misuse of veterinary drugs, or poor farming practices. Poultry can also become contaminated during processing, due to malfunctioning or improperly sanitized equipment, misuse of cleaning materials, rodent and insect infestations, and improper storage. It can become contaminated also in retail facilities and in homes through poor food-handling practices.

There are different sources of food borne contamination. *Salmonella* is the most common contamination problem and is not only a problem with poultry meat. Milk, uncooked eggs, such as homemade mayonnaise, eggnog, and desserts containing uncooked eggs may also cause the source of an outbreak of salmonellosis. Bacteria controls should be implemented in all steps of the chain from the producer level to the private consumer.

Proposed System for Poultry Food Safety

An integrated food-safety system that is successful and protects the public is complex and diverse. A good example of such a system is the proposed "from farm to table " food-safety program by the USDA. It may be summarized in the key points outlined below.

1) Consumer education on food handling and storage in the home is the primary responsibility. Government agencies should provide consumers with sufficient media and information: web sites, network of extension agents across the country, informative programs for consumers, etc.

2) At home, consumers have the responsibility for proper handling and storage of food. Proper food-handling practices can prevent many cases of food borne diseases on raw meat and poultry products.

3) On the farm, production practices should be regulated to ensure that pesticides are approved for safe use, use of drugs and feed in milk- and food-producing animals are approved and that other hygienic regulations, including clean water, are enforced.

4) Food processing facilities for foods such as meat, poultry, and egg products (including shell eggs) should be inspected frequently. Inspectors should be present in slaughter and processing establishments to ensure that these products are safe, wholesome, and properly labeled. State and local governments should also inspect food processors, with varying frequencies and under varying standards.

5) Meat, poultry, seafood, eggs, and other foods susceptible to microbial contamination during transportation should be subject to regulations. Such regulations may include performance standards for temperature control, providing information on prior cargo, and cleaning information for the food-shipper's use, to ensure a safe food at its destination.

6) Restaurants, supermarkets, and institutional food services (such as schools and hospitals)

should fall under certain retail food-protection programs.

7) If an imported food is suspect, it should be tested for contamination before entering the country.

Other similar systems of food control have been implemented very successfully in countries such as Canada. In spite of its complexity, a food protection system across all steps of the vertical food chain seems to be a plausible approach.

Overview of Worldwide Food-Borne Disease

Since 1980, many European and some other countries have participated in an early reporting system of food-borne disease, coordinated by the FAO/WHO in Berlin. Recently, the number of countries reporting data about this topic has increased, but there are still relatively few countries reporting data about food-borne diseases. Also, the data that is available may be reported according to different criteria; therefore caution is recommended when comparisons between countries are to be made.

Within the APEC members, there are large differences regarding the amount and quality of surveillance of food-borne diseases. In the case of the Asian countries (with the exception of Japan), relatively little surveillance of food borne diseases is carried out.

A comparative study of food-borne disease outbreaks in the Republic of Korea and Japan, between 1971 and 1990, showed different patterns of infection and contamination between both countries. In Korea, most incidents occurred in the workplace and home, while in Japan, the major places of outbreaks occurred at restaurants and at hotels. Seafood was often the cause in both countries, but food from animal origin was much more frequently associated with outbreaks in Korea. In the recent years, it seems that *Salmonella* outbreaks have increased in Japan. The major reason for the increase in outbreaks is that the Japanese diet has incorporated more eggs and products prepared with eggs. One study has been conducted in Taiwan from 1987 to 1993, showing that the number of outbreaks reported per year ranges from 57 to 93.

In Australia, the U.S. and Canada, disease surveillance is more complete. Salmonellosis seems to be the major problem in the three countries. In the US and Australia, salmonellosis has increased in the last few years, while in Canada it has decreased. In 1995, the total number of cases reported in the three countries was 5,895, 40,000, and 9,000 per year respectively for Australia, the U.S. and Canada.

Food-borne disease surveillance seems to be increasing in Central and South America. The spread of cholera in Peru in 1991, with a total of 600,000 cases, has increased the sensitivity toward food safety issues. *Salmonella* may be an important problem in Mexico, where according to the WHO (World Health Organization), 4.5% of chocolate samples in Guadalajara tested positive.

In conclusion, surveys show that food of animal origin (especially meat and eggs) and egg products (desserts, cookies) are usually implicated in food-borne disease outbreaks. An increasing incidence of contamination in a product occurring in one country and affecting persons or tourists in another countries, has been also reported. As an example, the United States and Europe were affected with an outbreak involving a kosher snack item imported from Israel in 1994 and 1995. However, in general, the available information is still insufficient to conduct international comparisons with respect to food-borne illnesses.

International Trade and Food-Borne Diseases

As the WHO points out, traditionally there have been three major means used by governments to regulate microbiological hazards of foods: education and training, inspection of facilities, and microbiological testing.[4]

Microbiological testing should distinguish between acceptable and unacceptable products, processing and handling practices. However, microbiological testing may not provide conclusive evidence that food safety measures were followed by the producer in the country of origin. One of the major reasons for this is that microbiological composition of some products such as meat, poultry and fish, may change during shipping and international transportation.

These traditional evaluations of safety criteria are changing, basically because of the GATT Uruguay Round Agreement and the application of sanity and phytosanitary measures. The implementation of this agreement is intended to facilitate the free movement of foods across borders, by ensuring that means established by countries to protect human health are scientifically justified, and not used as unfair trade barriers. The GATT agreement states the necessity that SPS measures based on appropriate standards, codes, and guidelines developed by the FAO's *Codex Alimentarious* Commission should be implemented to protect consumer's health.

At this point of time, there is no international regulation for carrying out microbiological risk assessment, although a working group of the *Codex* has drafted some guidance. Even when it is quite vague, it seems that the proposed guidance will follow the "The General Principles of Food Hygiene" that are described in the Annex to the *Codex*. The General Principles stated in the *Codex* are based on the implementation of the HACCP food safety tool in all stages of the food chain, from "farm to fork". Completion of the *Codex* seems to be urgently needed to establish specific and clear legislation related to international trade of foodstuff.

[4] World Health Statistics. Quarterly Report, 5, no. 1/2 (1997).

Recommendations

Recommendations for food safety issues are as outlined below.

- Encourage collection of reliable information about food safety issues.
- Set performance standards in poultry products for food borne diseases such as *Salmonella*, and *E. coli*.
  - Standards similar to those in suggested by HACCP could be implemented.
  - Standards should allow industry to place different priorities on price of the product, quality and health aspects of the product in response to consumer demand.
- Modernize production processes.
- Develop more rigorous product labeling guidelines that follow international standards.
- Provide consumers with better information about food safety issues in the home.

Grain Distribution, Poultry Transportation, and Distribution

In this section, best practices in this link of the value chain are highlighted and recommendations about implementing the best practices are made. These recommendations will result in a more efficient, lower cost and safer food system.

Poultry Distribution

It was formerly a general distribution practice in Asia that chickens were shipped live from farms to the market. However, after the spread of broiler breeding, most chickens are now processed before shipment. In Japan, mass production of chicken is

widespread as a result of progress in poultry breeding and processing. As a result, today broilers (which account for 95 percent of chicken meat) are delivered directly to supermarkets, meat retailers and restaurants from processing factories without going through markets.

Chickens require a short breeding period and the return of capital in chicken breeding is favorable. Because of this, the Sogo-Shosha (Japanese general trading companies) which supply feeds, operate their integrated-systems covering production and distribution. The Sogo-Shosha employs their own breeders to operate large-scale farms and processing factories. Processed chicken products are directly distributed to wholesalers, meat retailers, supermarkets and restaurants (see Figure 13).

Feed Grain Distribution

Grain feed materials such as corn are imported by the Sogo-Shosha from the United States, Argentina, South Africa and other countries, and are carried by elevators from ships' holds to silos. These imported grain materials are moved on-line to nearby compounded feed mills. At the same time, domestic feed materials such as soybean cakes are carried from oil mills by truck to feed mills to produce compounded feeds. Compounded feeds are shipped to poultry farms directly by compounded feeds mills (see Figure 14).

The most appropriate feeds are those with a compounding ratio designed for improved production efficiency. As an example, in the case of broilers, feeds may be compounded as:

- 1st Stage; corn 45%, soybean cake 36%, milo or sorghum 10%, fish meal, etc. 9%
- 2nd Stage; corn 56%, soybean cake 22%, milo or sorghum 10%, fish meal, etc.12% .

Feeds should also be easy to use, uniform in nutrition levels, and consistent in quality and grain size. Feeds should be tasty and satisfying for the poultry, efficiently digestible, and made from safe feed ingredients (not contaminated by *Salmonella* or agricultural chemicals).

Chicken Products Warehousing, Refrigeration and Distribution

It is desirable that chicken products should be effectively distributed from processing facilities to supermarkets in consuming areas as quickly as possible, at optimum temperatures, and with proper quality and freshness maintained. Temperature control guidelines are shown in Figure 15.

Fresh and chilled chicken are shipped from processing factories at temperatures of 0 to 2^{o}C (32 to 36^{o}F) to be delivered to supermarkets, meat retailers and restaurant chains. The temperature in storage houses is - 8 to -10^{o}C (19 to 14 ^{o}F), and in the showcases of supermarkets and retailers 0^{o}C (32^{o}F).

If the supply of fresh chicken exceeds demand, or if there is a surplus of certain cuts of meat, chicken meat is refrigerated and kept in storage houses to be shipped according to market demand. In the case of frozen chicken meat that is pre-frozen at processing factories at -8 to -10 ^{o}C (19 to 14 ^{o}F), it is quick-frozen at -35^{o}C (-31^{o}F) and kept in refrigeration storehouses at -20 ^{o}C (-4^{o}F) or below for shipment. It is delivered to refrigerated storehouses or distribution centers in cold-storage vans at below -20^{o}C (- 4 ^{o}F) and kept in refrigeration storehouses below -30 ^{o}C (-22 ^{o}F) for medium and long-term storage.

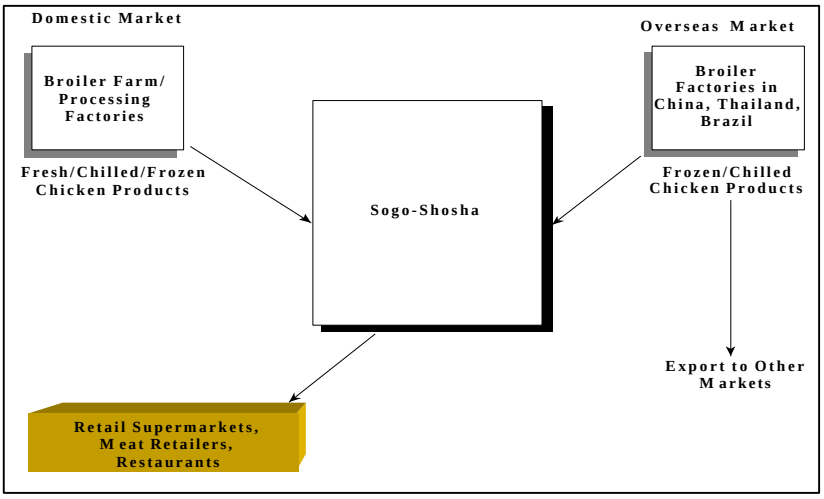

Figure 13. Sogo-Shosha integrated chicken product operation.

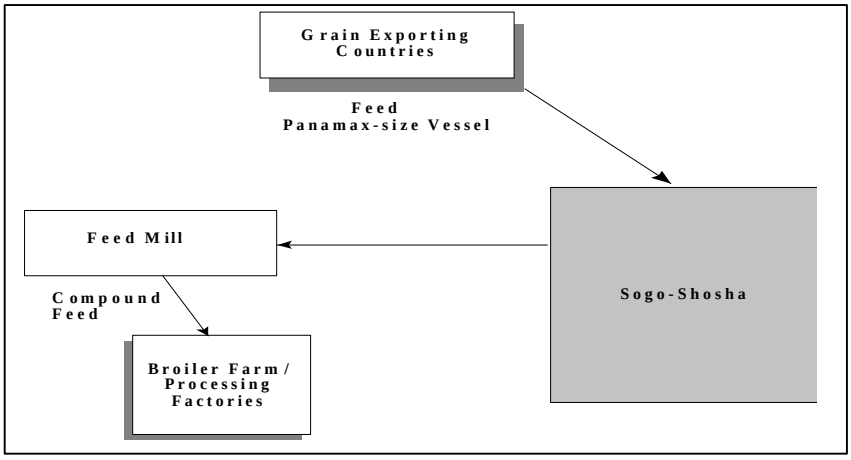

Figure 14. Japanese feed grain distribution system.

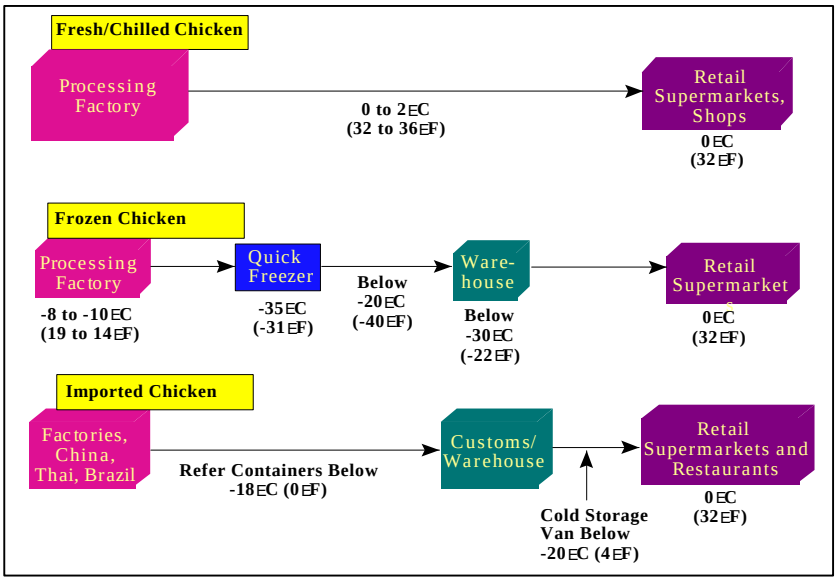

Figure 15. Temperature control in warehousing, refrigeration, and distribution.

Imported frozen chicken shipped from producing areas in China, Thailand, Brazil and the United States is put in reefer containers which can maintain an inside temperature lower than -18° C (0°F). It is then loaded on ships and carried to storehouses and processing factories after going through customs clearance procedures at importing ports. It is finally delivered to supermarkets, meat retailers and restaurant chains in cold-storage vans at below -20 °C (-4 °F).

There are some impediments to greater efficiency in the distribution of chicken products. These include regulations concerning imports, standards and certification and regulations concerning restrictions on distribution. For example, there are quarantine, customs and customs clearance systems for the import of chicken meat. These systems sometimes result in delays in clearing customs which may create difficulties when importing chicken products. The lack of international standards for issues such as carton sizes between countries also results in lower distribution efficiency. Examples of government regulations which restrict distribution include such regulations and restrictions such as the Japanese Cargo Transportation Law and City Planning Acts that affected efficient distribution.

Recommendations

Recommendations for poultry transportation distribution and feed production to improve efficiencies are below. Some benefits of broad adoption and implementation of best distribution practices that accrue to consumers include: fresher product, lower priced product, and a wider selection of product.

- Set policies and do research to encourage the supply of feeds that are:
  - Easy to use, uniform in nutrition levels, and constant in quality and grain size.
  - Tasty, satisfying and easily digestible for poultry.
  - Made from safe feed ingredients (not contaminated by salmonella or agricultural chemicals).
  - Inexpensive, based on, for example, increased investment in deep-water ports.
- Distribute poultry and poultry products in such a way that maintains freshness and quality.
  - Make distribution channels as simple as possible
  - Invest in cold storage transportation infrastructure.
  - Streamline quarantines, customs, and clearance systems.