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Economic analysis of broiler production in Korea (1980-95)*

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ABSTRACT

The economic analysis of broiler production is investigated in this research in relation to structural changes by different size of chicken farms and Markov model analysis. The transition probability for farms with less than 5,000 broiler chickens was between 35% and 10% during the period 1980-95, while for over 30,000 chickens there were 14% to 35% remaining in business. The transition probability of chicken farms with 5,000 to 30,000 chickens was 51% to 57% during the same period. The optimal size of a broiler chicken farm with one person of labour input is 3,333 chickens and these farms average 1.6 million Won (US$ 1964.40, 1 US$=814.50 Won, October 25, 1996) income. The optimal size for two persons of labour input is 6,666 chickens with 3.2 million Won (US$ 3928.79) income. The average labour productivity of broiler chicken production is much lower than book-keeping farms. The consumption of chicken meat has been increasing by the increasing level of GNP per capita. However, the level of producer price per kg has not increased at the same rate as labour and feed cost during this time period.
Keywords: broiler, production, economic, analysis, Korea

ÖSSZEFOGLALÁS

A koreai brojlertermelés gazdasági elemzése 1980 és 1995 között

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A szerző az eltérő állománynagyságú brojlertelepek struktúrális összetételét vizsgálta a Markov-féle folyamatmodell segítségével. Az 5.000 alatti állománnyal rendelkező telepek változási valószínűsége az 1980/95 közötti időszakban 35% és 10% között volt, míg a 30.000 feletti állománynagyságú telepekre 14% és 33% közötti értékekekt kapott. Az 5.000 és 30.000 közötti kategória átmeneti valószínűsége ugyanebben az időszakban 51% és 57%-ot mutatott. Az 1 főt foglalkoztató gazdaságok optimális állománynagyságára 3.333-at kapott, ez esetben a gazdaság átlagos jövedelme 1.6 millióWon (1964.40 USD; 1 USD=814.50 Won, 1996. okt.25.), 2 főt foglalkoztató gazdaság esetén az optimum 6.666 brojler, ami átlagosan 3.2 millió Won (3928.79 USD) jövedelmet eredményezett. A brojlertermelés átlagos munkaerő hatékonysága sokkal kisebb, mint az adatgyűjtésbe bevont mintagazdaságoké. A csirkehúsfogyasztás a GNP növekedésének megfelelően emelkedett, bár a felvásárlási ár emelkedése elmaradt a munkaerő és a takarmányárak növekedési ütemétől.

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INTRODUCTION

The consumption level of animal products, such as chicken meat, is increasing in the Republic of Korea (hereafter Korea) at a rate similar to increasing per capita level of gross national product. The total numbers of chickens on farms also increased during the period of 1980-95. Changes in the structure of chicken farms, in terms of the number of chickens produced on a farm, has resulted in an expansion in farm size. This adjustment has increased in recent years since the ratification of the new World Trade Organisation (WTO) agreement.

An analysis of broiler production in Korea requires analysis according to size of enterprise. The quantity of frozen chicken meat imported from abroad is increasing, and Korean producers will have to compete with imports. The structure of the chicken producing farms is changing, particularly the number of chickens produced on a farm. The broiler industry is under rapid adjustment to meet the challenges of freer trade. An analysis of the structure of the broiler producers and the changing structure will facilitate adjustment and provide an indication of the future structure of broiler production in Korea.

This analysis will contribute to understanding of the present economic situation in broiler production and the competitive relationship with other countries. There are already many specialised types of broiler chicken farm management systems in Korea. The changing structure and concentration of agriculture will require harmonisation of development with that of farms of other types, such as those engaged in the production of rice, vegetables, fruit, dairy or beef cattle, or pigs.

MATERIALS AND METHOD

Broiler production functions were estimated over 40 years ago in the United States (*Heady et al.,* 1956). A good cross section of data on broiler production is required for the purposes of reliable estimates of the production function being obtained. The production function was utilised for the determination of gain isoquants, marginal rates of substitution, optimal input combinations, and other quantities related to broiler production. Minimum cost feed rations can also be determined. In Korea there is a need for information on minimum cost feed diets in the broiler industry since feed is the major production cost (65-75%) and most feed grains are imported. *Ko* (1991) reported that in 1987-88 feed cost was 73.5% of total production cost. Chicken production in the US has become concentrated in the south-east of the country, and most chickens are produced under contract for processors.

There are presently a number of problems in the broiler production industry in Korea. Many of these became more serious after the liberalisation of trade in livestock products. One problem is inappropriate policy for livestock production. The Ministry of Agriculture has introduced policies in an endeavour to produce a more efficient industry, but these policies have been either not effective or not implemented, or else the industry has changed and they are no longer relevant.

Knoeber et al. (1995) found that the main risk in broiler production was seasonal price variation. In Korea, there has been no research on risk in broiler production. This kind of research would contribute in the future to price and income stability via the development of appropriate management strategies. Risk behaviour on the US aggregate supply response of broiler chickens was analysed within a rational expectation framework (*Aradhyula* and *Holt,* 1989). There is the potential for reducing price and income risk by establishing contracts with processors. Most broiler producers in the US have contractual agreements with processors. In the United States contract production had begun by 1930. There is an economic advantage to contracting, such as some protection from price risk (*Aust,* 1997). Processing firms provide young chicks, feed, technology and other kinds of technical advice; they also deliver the chickens and subsequently transport them away. There can be an economic advantage to broiler producers when the processing firms supply many of the materials, to be paid for after delivery of the chickens. Currently, about 82 per cent of broiler production in the United States operates in the form of contracted accounts, while the remaining 8 per cent of chickens are raised on firm-owned farms.

A *Markov* model is applied for the analysis of the transition probability of chicken flock sizes during the period 1980-95. The *Markov* chain model can be expressed as follows:

$$n_{it} = \sum_{j=1}^{s} p_{ij}\, n_{j,t-1}\,, \quad i = 1,\ldots s \qquad \textbf{(A)}$$

where n_{it} is the flock size i in time t, and p_{ij} is the probability of transition from flock size n_j at time $(t-1)$ to size n_i at time t (*Chavas et al*., 1988, p. 316).

The Cobb-Douglas form of production function is used to derive the elasticity of input materials, including feed, hired labour and family labour. The Cobb-Douglas form of production function has the following form:

$$Y = a X_1^b X_2^c X_3^d \qquad \textbf{(B)}$$

where Y is production, X_i represents inputs, and a, b, c and d are the estimated coefficients.

$$Y = a + bX_1 \qquad \textbf{(c)}$$

Linear programming is used for the purposes of calculating optimal farm size, with respect to number of chickens, for a given set of resources. The linear programming model has the following form:

$$\text{MAX } Z = \sum_{j=1}^{n} c_j x_j \qquad \textbf{(D)}$$

subject to

$$\sum_{j=1}^{n} a_j X_j \leq b_i \quad i = 1,2,\ldots,m \qquad \textbf{(E)}$$

$$X_j \geq 0 \quad j = 1,2,\ldots n \qquad \textbf{(F)}$$

where Z is the net return, c is the price or cost of activity X_j, a represents the resources required for activity X_i, b is the resource constraint, i represents the resource constraints, and j represents the production activities.

The National Livestock Cooperative Federation (NLCF) began livestock book keeping in 1980, and still maintains this activity today. Chicken production data were obtained from the NLCF for the period 1980 to 1995 (NLCF 1996). The NLCF had book keeping records from 1980 to 1995 with respect to 4 classes of flock size: fewer than 10,000; 10,000 to 20,000; 20,000 to 40,000; and more than 40,000 birds. In 1995 this classification was modified to the following classes: fewer than 5,000; 5,000 to 20,000; and more than 20,000 birds. Therefore, only the data on broiler production from 1980 to

1995 were used in the analysis. The sample of broiler households included a total of 90 farms, of which 76 were used in this analysis. The sample size was adequate for analysis with time series analysis, 16 years of data having been available. First, the *Markov* model is applied for the analysis of structural change in terms of the number of broilers produced, e.g. under 5000, 5000 - 30,000 and over 30,000 chickens. The sample broiler farm shows the same difference between 1980 and 1995; therefore it is impossible to analyse production function in terms of flock size due to the shortage of input-output data. However, it is possible to analyse average flock size for the book keeping farms. The production function analysis also determined the elasticity of production factors and income per chicken.

Integer programming is used to calculate optimal flock size with one or two units of labour input. This type information may well provide a better understanding of labour productivity in chicken farming in Korea.

RESULTS AND DISCUSSION

Table 1

Broiler production in terms of flock size (no. of birds)

Year (1)	**<5,000**		**5,000-30,000**		**<30,000**		**Total(4)**	
	Number (2)	Index*	Number	Index (3)	Number	Index	Number	Index
1980	15,779	100	19,131	100	5,220	100	40,130	100
1981	13,916	88	22,920	120	6,163	118	42,999	107
1982	18,040	114	22,176	116	6,371	122	46,596	116
1983	9,721	62	28,976	151	10,542	202	49,239	123
1984	11,963	76	23,120	121	11,400	218	46,483	116
1985	11,519	73	24,754	129	14,808	284	51,081	127
1986	9,991	63	28,520	149	17,584	337	56,095	140
1987	8,665	55	31,092	163	19,563	375	59,324	148
1988	7,659	49	31,237	163	19,571	375	58,467	146
1989	7,156	46	34,635	181	20,098	385	61,689	154
1990	7,546	48	44,662	233	22,275	427	74,463	186
1991	6,792	43	44,531	233	23,532	451	74,885	187
1992	5,584	35	44,288	231	23,452	449	73,324	183
1993	5,934	38	41,375	216	25,636	491	72,945	182
1994	4,973	32	43,934	230	31,661	607	80,569	201
1995	4,369	28	43,711	228	37,720	723	85,800	214

* Index: 1980=100

Source (*Forrás*): NLCF. 1996. Monthly Report, August

1. táblázat: Brojlertermelés állománynagyság szerinti megoszlása (1000 brojler)

Év(1), Gazdságok száma(db)(2), Változás(3), Összesen(4)

Structural changes in terms of number of chickens produced

Table 1 shows structural changes in broiler production in terms of flock size during the period 1981-95. The number of farms with fewer than 5000 birds, i.e. the number of smaller flocks, has decreased rapidly since 1981. The transition probability is presented in *Table 2* in terms of different flock size during the years 1980 to 1995. The probability of a <5,000 bird flock continuing in business in 1980 was 0.35, but by 1991 this had declined to 0.10. The transition probabilities for medium-sized flocks changed very little over the 16-year period, and increased for large flocks over time.

Table 2

Transition probability in terms of size of flock

Year(1)	≤5,000	5,000-30,000	≤30,000
1980	0.35	0.51	0.14
1981	0.36	0.50	0.14
1982	0.37	0.49	0.15
1983	0.27	0.52	0.21
1984	0.22	0.54	0.24
1985	0.20	0.52	0.28
1986	0.16	0.52	0.32
1987	0.16	0.52	0.32
1988	0.16	0.52	0.32
1989	0.14	0.54	0.33
1990	0.11	0.58	0.32
1991	0.10	0.57	0.33
1992	0.10	0.56	0.34
1993	0.10	0.56	0.34
1994	0.10	0.54	0.36
1995	0.10	0.57	0.35

2. táblázat: A gazdaságok átalakulási valószínűsége állománynagyság szerint

Év(1)

Production function analysis

Feed is the main cost in broiler production, and proper management of feed inputs is required in the interest of the minimisation of production costs and the maximisation of profits. Feed expenditures have a negative impact on income (*Table 3*). Expenditure on hired labour is low on most farms, since labour is supplied by the family, but increased hired labour expenditures will reduce income, although the estimated coefficient does not deviate significantly from zero. Family labour input is important and contributes to the level of income achieved from broiler production.

A one per cent increase in feed cost will decrease income by 0.82%. The marginal value for hired labour was also found to be negative. Additional family labour hours will increase broiler production income.

Table 3

Income from broiler production

Item(1)	Coefficient(2)	t value(3)
Constant(4)	7.5076	2.32**
Feed(5)	-0.8187	-1.61*
Hired labour(6)	-0.5059	-1.22
Family labour(7)	0.7167	3.96**
R^2	0.5936	
F	5.8434*	

*, ** indicates significance of P < 0.05 or P<0.10, respectively,
using a one-tailed test (*P < 0.05, P<0.10-en szignifikáns, t-próba alkalmazásával*)

3. táblázat: Brojlertermelés jövedelmezősége

Megnevezés(1), Együttható(2), T-érték(3), Állandó(4), Takarmány(5), Bérmunka(6), Család munkája(7)

Table 4

Optimal structural solution for chicken farms

Content(1)	Value reduced cost(2)	
One person(3)		
Chickens(4)	3.333	-475
	slack & surplus(5)	**dual price(6)**
Income (7) (millions of Won)	1.583	1.0
Family labour(8)	2.000	0.0
Hired labour(9)	267	0.0
Mixed feed(10)	12 tonnes	0.0
Two persons(11)		
Chickens(4)	6.666	-475
	slack & surplus(5)	**dual price(6)**
Income(7) (millions of Won)	3.166	0.0
Family labour(8)	4.000	0.0
Hired labour(9)	533	
Mixed feed(10)	24 tonnes	

4. táblázat: Broilertelep optimalizált mutatói

Megnevezés(1), Költség(2), Egy fő(3), Csirkelétszám(4), Maradvány(5), Árnyékár(6), Jövedelem(7), Családi munka(8), Bérmunka(9), Keveréktakarmány(10), Két fő(11)

Optimal numbers of chickens

The integer programming model was used to determine the optimal size for one and for two units of labour input. The optimum number of broiler chickens for one unit of labour input was determined to be 3,333 (*Table 4*). The objective function value was 1,583,000 Won. With two labourers, the optimum number of chickens was 6,666. The objective function value was 3,166,000 Won. These income levels were much lower than average income from the book keeping farms. The average level of farm income was 4,591,692 Won per labour unit on book-keeping farms in 1995.

The structure of broiler production in Korea changed very rapidly during the period 1980 to 1995. The proportion of farms with flock sizes below 5,000 birds was about 39% in 1980, and had declined to 5% by 1995. The size of flocks in broiler production has increased greatly in recent years. However, the return on labour in broiler production is much lower than that on general book-keeping farms from other sectors of agriculture. Broiler returns on labour are only 34% of those of other agricultural sectors. There is presently widening income disparity between crop and livestock production. It may be necessary to ensure harmonised development in agriculture in the future.

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REFERENCES

Aradhyula, S. V. and M.T . Holt. (1989). Risk behavior and rational expectations in the US Broiler Market. Amer. J. Agric. Econ., 71. 11. 892-902.

Aptech Systems, Inc. (1994). GAUSS, Maple Valley, Washington

Aust, P. (1997). An Institutional Analysis of Vertical Coordination Verses Vertical Integration: The Case of the US Broiler Industry, Staff Paper 97-24, Dept. of Agricultural Economics, Michigan State University, East Lansing

Beattie, B. R. and C. R. Taylor. (1985). The Economics of Production, John Wiley & Sons, New York

Chambers, R. G. (1991). Applied Production Analysis, A Dual Approach, Cambridge University Press, Cambridge

Chavas, J. P. and G. Magand. (1988). A dynamic analysis of the size distribution of firms: the case of the US dairy industry. Agribusiness, 4. 4. 315-329.

Heady, E. O., S. Balloun and R. McAlexander. (1956). Least-Cost Rations and Optimum Marketing Weights for Broilers. Agricultural Experiment Station, Iowa State College, Research Bulletin 442, Ames, Iowa

Heady, E. O. and J. L. Dillon. (1966). Agricultural Production Functions. Iowa State University Press, Ames, Iowa

Kim, J. M. (1990). Korean Livestock Farming Under International Pressure. Prof. Ro, SoonHi 60th Anniversary Collection of Thesis, Seoul Municipal University, Seoul, 475-495.

Kim, J. M. (1996). Internationalisation and Korean Agriculture. Sung Kyun Kwan University, Seoul (Korean), 481.

Kim, J. M. (1997). Economics of Sustainable Agriculture and the Linear Programming Method. Sung Kyun Kwan University Press, Seoul, 510.

Knoeber, C. R. and W. M. Thurman. (1995). "Don't Count Your Chickens": Risk and Risk Shifting in the Broiler Industry. Amer. J. Agr. Econ., 77. 8. 486-496.
Ko, J. K. (1991). Direction of Development and Problems of Livestock Integration. in Proposals to Increase International Competition of Livestock Production against UR, Ministry of Agriculture, Seoul, 137-161.
Ministry of Agriculture, Forestry and Fisheries. (1996). Major Statistics on Agriculture, Forestry and Fisheries. Seoul
Ministry of Agriculture, Forestry and Fisheries. (1997). Report on the Farm Household Economy Survey. Seoul
National Livestock Cooperative Federation. (1996). Monthly Review, 16. 8. Seoul, August.
National Livestock Cooperative Federation. (1996). Materials on Price, Supply & Demand of Livestock Products, Seoul
National Livestock Cooperative Federation. (1996). Report of Livestock Production Cost Survey. Seoul
Schrage, L and Cunningham. (1991). Lingo, Optimisation Modeling Language, Lindo Systems, Inc. Chicago
Seaver, S. K. (1957). An Appraisal of Vertical Integration in the Broiler Industry. J. Farm Econ., 39. 4. 1487-99.

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