IJAS Iranian Journal of Applied Animal Science

# Comparing Estimations of Return to Scale in Mechanized and Semi-Mechanized Broiler Chick Farms Located in Gorgan City

Research Article

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Received on: 18 Nov 2011
Revised on: 14 Feb 2012
Accepted on: 1 Mar 2012
Online Published on: Jun 2013

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Online version is available on: www.ijas.ir

## ABSTRACT

Quantitative analysis of production through evaluation of inputs consumption quantity is of main principles in agricultural policies, which is followed by increasing in production through optimal use of resources. This study has been conducted to estimate different types of production functions in mechanized farms of broiler chicks located in Gorgan city. Cross-section survey data were gathered in spring of 2009 via filling in 71 questionnaires and also interviews with managers of broiler chicks farms located in Gorgan were made. Then, according to viewpoints of experts, mechanization level of each broiler chick farm was assigned and grouped into two mechanized and semi-mechanized groups. Afterward, Linear, Cobb-Douglas and Transcendental production functions were estimated and analyzed for the mentioned groups. Results showed that the best functions for mechanized and semi-mechanized farms are linear and Cobb-Douglas models, respectively. Also, return to scale in mechanized and semi-mechanized broiler chick farms showed diminishing and ascending trends, respectively.

KEY WORDS broiler chicks, mechanized and semi-mechanized farms, partial elasticity of production, production function, return to scale.

## INTRODUCTION

Preparation of daily nutrition is the first and most crucial requirement of human in order to meet physiological necessities, and a tendency to other higher necessities of human would not be seen as long as the basic requirements are not met, at least in a minimum level. Protein consumption level is an important item in food program of families, which it is obtained through consumption of meat and other meat products. On the basis of this fact, it is observed that chicken meat has high amounts of protein compared to other kinds of meat. Therefore, chicken meat is considered as a relevant feed in food program of families. The importance of broiler chicks industry is increasing via other aspects, as well, such as growth rate, genetic improvements, hygiene, limitations in natural resources, low carcass shortage compared to other domesticated animals, use of second or third grade seeds and turning them into one of most favorable meats, etc. These features result in a great development of production and increase in per capita consumption during last 50 years and it seems that this trend would keep its ascending trend, especially in developing countries. In 2007-2008, the average growth rate of chicken meat production in Iran was 5.6% and Golestan Province has experienced a growth rate equal to 10% in this period (Golestan statistics, 2009), which is due to relative advantage of the climate with four seasons, low rate of poultry diseases and a tendency of private institutions to its produc-

tion. Therefore, estimation of broiler chicks' production function and awareness of status of production inputs consumption in Gorgan can be regarded as a suitable guide for producers, programmers and decision makers in order to be aware of existed status and strategies for increasing production via optimal and better use of production factors in this industry.

## MATERIALS AND METHODS

Estimation of production function and efficiency needs information related to quantity of inputs and production of broiler chicks.

Data of this study was gathered according to sampling from farms of broiler chick in first period of brooding in 2009 and, a total number of 71 questionnaires were collected from randomly-chosen farms in different parts of Gorgan. For this, the primary questionnaire was designed through visiting 7 broiler chick farms.

And after settlement of problems, the final questionnaire was designed. Then, interviewing with hen keepers, gathering data and completing the questionnaire were realized. Afterwards, on the basis of the mark given to each mechanization level (which was given by an expert) from 0 to 10, the final mechanization marks in samples were derived which were between 4 and 10.

So, they were divided into 2 mechanized and semi-mechanized groups with 39 and 32 samples, respectively. And after settlement of defects in the questionnaire, mechanized group with 34 samples and semi-mechanized one with 30 samples were considered to estimate production functions. Using econometrics, corrected least squares and maximum likelihood methods, linear, c.d., transcendental, and random frontier production functions were estimated.

Measured variables which were included in model are as follows:

Y: meat production rate defined as ton.

X1: capital rate defined as million Rials (currency of Iran).

X2: labor defined as skills.

X3: used seeds cost defined as million Rials.

X4: technology level defined as the mark was given to each farm by the expert.

X5: weight of one-day chicks defined as grams.

X6: number of chicks defined as number of purchased chicks in each period.

X7: medicines and hygienic costs defined as million Rials.

X8: brooding period defined as the period from introduction of chicks until cleaning and disinfection of the saloon after bringing the chicks out.

D1: use of expert services defined as existence or lack of veterinarian or animal husbandry specialist.

D2: existence or lack of dissemination educations.

**Production functions of mechanized and semi mechanized broiler chick farms**

Primary evaluation of derived data from the questionnaires showed that only 34 samples were reliable and well-filled out. Also, considering this fact that in semi mechanized farms, there were two untypical and incomplete samples, the quantity of samples reached 30. Using the data from the mentioned samples, three functions of linear production, c.d., and transcendental were estimated with Microsoft 4.0 software. According to specify tests, linear form of function was chosen as the most suitable form of production function for mechanized and semi-mechanized groups (Bakhshoodeh, 1998). This is consistent with the statistic of Acaeic (AIC) which is smaller than counterpart statistic in c.d. and transcendental functions for mechanized and semi-mechanized groups. Schwartz Benzene (SB) statistic in linear function is smaller than counterpart statistic in c.d. and transcendental functions which showed preference of linear and Cob-Douglas forms for production function in mechanized and semi-mechanized units, respectively.

## RESULTS AND DISCUSSION

**Production functions for mechanized units**

In estimated linear production function, six variables named capital, labor, weight of one-day chick, quantity of introduced chicks, hygiene and treatment, and use of expert services were significant. Table 1 shows the results of estimation for linear model (the chosen function) of mechanized broiler chick farms. Similar results were reported by Teymoori (2000) and Ojo (2003).

On the basis of the results from estimation of production function in mechanized units, capital variable has a negative and significant effect on production of chicken meat which shows a reverse relationship with production which is in accordance with the findings of Azaroosh (2009) and Hasanpoor and Nemat (2006). In other words, in mechanized units, capital input has been used more than optimal amount so that it is possible to gain higher production with lower capital. In fact, capital input is in the third economical area of production. So if capital amount in mechanized farms increases one unit (equals to one million Rials), 0.002 ton decrease would be seen in production.

Estimation coefficient of labor preparation factor (which equalized on the basis of number and skill) shows a positive and significant relationship with quantity of production. In other words, if labor in mechanized farms increases one unit (one person), 0.004 ton decrease would be seen in production. Beyond expectation, the variable weight of one-day chick has a negative and significant effect on production of meat. In other words, the heavier is one-day chick, the lesser production will be gained.

**Table 1** Results for estimation of linear model (the chosen function) of mechanized broiler chick farms

| Variable | Remarks | Estimated parameter | t-Statistic | Significance level |
|---|---|---|---|---|
| Fixed component | - | 68.565 | 2.54 | 0.018 |
| Capital | - | -0.002 | -2.34 | 0.028 |
| Labor | - | 0.004 | 4.36 | 0.000 |
| Seed cost | - | 0.006 | 0.87 | 0.391 |
| Technology level | - | -1.500 | -0.87 | 0.392 |
| Weight of one-day chick | - | -1.922 | -3.50 | 0.002 |
| Quantity of introduced chicks | - | 0.002 | 9.39 | 0.000 |
| Medicine and hygienic operations costs | - | -0.276 | -2.74 | 0.012 |
| Brooding period | - | 0.226 | 0.89 | 0.384 |
| Use of expert services | Existence of expert= 1<br>Lack of expert= 0 | 15.539 | 4.08 | 0.000 |
| Use of dissemination education | Existence of education= 1<br>Lack of education= 0 | -2.797 | -0.87 | 0.393 |
| F-Statistic | 57.54 | - | AIC statistic | -118.6 |
| Coefficient of determination | 96.16 | - | Durbin-Watson statistic | 1.95 |
| Adjusted coefficient of determination | 94.48 | - | Schwartz statistic | -127.05 |

It might be said that lighter chicks have greater ability than heavier ones (Latruffe *et al.* 2004; Yusuf and Malomo, 2007). Because in lighter ones, during the time those chicks are in eggs, vitamins are absorbed by chicks instead of increasing weight which depends on genus of hens. So if weight of one-day chicks in mechanized farms increases one unit (gram), 1.922 ton decrease would be seen in production.

The variables amount of introduced chicks into farms and period of brooding have positive and significant effect on production of meat so that the more amount of introduction and longer period of brooding in mechanized farms, the more production of chicken meat in these farms. Similar findings were also reported by Alrwis and Francis (2003) and Blelik and Rajcaniova (2004).

Medicine and hygiene costs have negative and significant effect on production of meat. So if medicine and hygiene costs in mechanized farms increase one million Rials, 0.002 ton decrease would be seen in production. In other words, the more medicine chicks use and the more hygienic control is done, the more sensitive chicks would appear and they would face with anorexia so that lesser seeds will be used during brooding (Oladeebo and Ambe-Lamidi, 2007) and they will not gain weight and consequently, production of chicken meat will be lowered. Expert services for managers of broiler chick mechanized farm will result in elevation of production level.

**Production functions for semi-mechanized units**

In estimated Con-Douglas production function, the six variables named capital, labor, weight of one-day chick, quantity of introduction of chicks, hygiene and treatment, and use of expert services were significant, also Unang (2003) and Timothy *et al.* (2004) had similar findings. Table 2 shows the results of estimation of linear model (the chosen function) of semi-mechanized broiler chick farms.

On the basis of the results from estimation of production function in semi-mechanized units, labor variable (which equalized on the basis of number and skill) shows a direct relationship with quantity of production. In other words, if labor in semi-mechanized farms increases one unit (one person), 0.21 ton decrease would be seen in production. Also, seed variable shows a positive and significant relationship with meat production. It means that with higher cost seed (which results in higher seed consumption or using high-quality seed); higher meat production in the farms is expectable.

Period of brooding shows a positive and significant effect on production; in other words, with longer production period (production period is usually defined as more time for brooding and increasing production volume), higher production is reached.

Whereas, beyond expectation, expert services variable shows a negative relationship with production, it seems that in such units, experienced and educated experts have not been used. So, it is recommended to use experienced experts or elevate the experience of managers and decrease the use of inexperienced experts which would result in elevation of quantity of production. Also, use of dissemination education variable shows a reverse relationship with production. It seems that there is a need to study the defects to make scientific and collegiate results more practical. Otherwise, the reverse effect will result in a justification for less use of dissemination education.

**Partial production elasticity in production factors**

After choosing linear model as a suitable production function for broiler chick mechanized farms located in Gorgan, elasticity coefficients are estimated and analyzed. Partial production elasticity of each production factor in this function was estimated with Shazam 9.0 software and the results were shown in the following table.

**Table 2** Results of estimation of Cob-Douglas model of semi-mechanized broiler chick farms

| Variable | Remarks | Estimated parameter | t-Statistic | Significance level |
|---|---|---|---|---|
| Fixed component | | -3.286 | -1.25 | 0.224 |
| Logarithm of capital | | 0.040 | 0.64 | 0.529 |
| Logarithm of Labor | | 0.212 | 2.69 | 0.015 |
| Logarithm of seed cost | | 0.719 | 5.79 | 0.000 |
| Logarithm of technology level | | 0.580 | 2.31 | 0.032 |
| Logarithm of weight of one-day chick | | -0.342 | -0.60 | 0.558 |
| Logarithm of quantity of introduction of chicks | | -0.002 | -0.08 | 0.939 |
| Logarithm of medicine and hygienic operations costs | | -0.052 | -0.84 | 0.413 |
| Logarithm of brooding period | | 0.689 | 2.11 | 0.048 |
| Use of expert services | Existence of expert= 1<br>Lack of expert= 0 | -0.189 | -2.99 | 0.008 |
| Use of dissemination education | Existence of education= 1<br>Lack of education= 0 | -0.135 | -2.25 | 0.036 |
| F-Statistic | 57.54 | | AIC statistic | 13.98 |
| Coefficient of determination | 96.16 | | Durbin-Watson statistic | 2.08 |
| Adjusted coefficient of determination | 94.48 | | Schwartz statistic | 6.27 |

**Table 3** Elasticity of production inputs in broiler chick mechanized farms

| Variable | Capital | Labor | Weight of chicks | Introduction of chicks | Medicines and hygiene | Expert |
|---|---|---|---|---|---|---|
| Elasticity of production | -0.12 | 0.004 | -1.45 | 0.99 | -0.17 | 0.21 |

It is seen that some coefficients are between 0 and 1; it means that managers of broiler chick mechanized farms are in the second grade from the aspect of using mentioned production factors. The highest production elasticity was for amount of chicks introduced into farms (0.99), which shows its direct and strong effect on production so that 1% increase in introduction of chicks results in 0.99% increase in production. Expert services input with 0.21 production elasticity is in the second grade so that 1% increase in expert services results in 0.21% increase in production. Labor input is in the last grade with 0.004 production elasticity so that 1% increases in labor results in 0.004 increases in production. In the case of weight in one-day chicks, medicines and hygienic control, and capital inputs (elasticity lower than 0; third area of production), 1% increase in these inputs result in 1.45, 0.17 and 0.11 decrease in production, respectively. After choosing Cob-Douglas model as a suitable production function for broiler chick semi-mechanized farms located in Gorgan, elasticity coefficients are estimated and analyzed. Considering this fact that Cob-Douglas model is chosen as a suitable production function for broiler chick semi-mechanized farms located in Gorgan, so, the coefficients of variables are partial elasticity. It is noteworthy that in interpretation of partial elasticity of production, 1% increase in a variable input, while other factors are fixed, shows an increase in production. Table 4 shows production elasticity for each input in semi-mechanized broiler chick farms.

It is seen that all coefficients (except the elasticity of two virtual variables) are between 0 and 1; it means that managers of broiler chick semi-mechanized farms are in the second grade from the aspect of using mentioned production factors. The highest production elasticity was for period of introduction (0.69) which shows it's direct and strong effect on production so that 1% increases in period of production (Shadbolt *et al.* 2004; Tauer and Belbase, 1987), while other factors are fixed, resulted in 0.69% increase in production.

After e period of production variable, seed, technology and labor variables have the most effects on production with 0.72, 0.58, and 0.21 production elasticity, respectively. So that, 1% increase in each of them will result in 0.72, 0.58 and 0.21% increase in production. In the case of expert services and dissemination education variables, 1% increase in use of them will result in 0.18 and 0.13% decrease in production, respectively. So, studying the defects of such phenomena is necessary for programmers and decision makers.

**Return to scale**

In linear function of production, return to scale in broiler chick mechanized farms is calculated via sum of all elasticity as follows:

Total production elasticity E= 0.22 - 0.11 - 1.45 + 0.98 - 0.16 + 0.21= 0.31 < 1

**Table 4** Elasticity of production inputs in broiler chick mechanized farms

| Variable | Labor | Seed | Technology | Period of production | Expert | Education and dissemination |
|---|---|---|---|---|---|---|
| Elasticity of production | 0.21 | 0.72 | 0.58 | 0.69 | -0.19 | -0.13 |

Despite the fact that total production elasticity in broiler chick mechanized farms located in Gorgan has been derived smaller than 1, decreasing return to scale (DRS) is settled. It means that simultaneous 1 percent increase in all production inputs results in 0.31percent decrease in production.

Return to scale in semi-mechanized broiler chick farms (Cob-Douglas function) is estimated via sum of the coefficients of variables (elasticity of production factors).

Total production elasticity E= 0.21 + 0.71 + 0.58 + 0.89 - 0.18 - 0.13= 2.08 > 1

Despite the fact that total production elasticity in broiler chick semi-mechanized farms located in Gorgan has been derived bigger than 1, increasing return to scale (DRS) is settled. It means that simultaneous 1 percent increase in all production inputs results in 2.08 percent increase in production.

## CONCLUSION

On the basis of estimation of the functions in the mechanized and semi-mechanized farms, labor variable has a positive effect on broiler chicks' production and as explained before, labor is defined as skills of workers. In each production process, skillfulness of labors is a crucial item which was characterized in this function. It means that with higher skillfulness mark and experience of workers, higher production is reached in the farms.

The results also showed that capital variable has been used more than the limit of optimal use in mechanized farms. In semi-mechanized farms, the average investment is in each 10000 unit.

As the results showed, in semi-mechanized farms, seed variable has a positive effect on production. That means that with higher seed cost (or in other words, higher seed consumption) it is reached higher meat production; this is normal, but it is important to mention that this is not just in mechanized farms.

Weight of chicks has a reverse effect on production and introduction variable has a positive effect on production function and increase. So the number of chicks, not the weight of them, result in an increase in production. Of course, this can be explained in different ways due to 69% of the genus used in Golestan Province have been Ras. Choosing this genus may results in a decrease in production which shows inconsistency of this genus to the area.

In other words, use of this genus results in less conversion of seed to meat. As explained in first section, broiler chicks' production in Golestan Province equals to conversion ratio and the average weight of chicks equals the total average of Iran. But, the goal is to produce the same volume with shorter period compared to the total average of Iran. And, as it was shown in Cob-Douglas function of semi-mechanized farms, period of production variable has a positive effect on broiler chicks' production. It means that if the managers of semi-mechanized farms lengthen the period of production and approach the average of Iran, they will have increased production in their farms.

On the basis of the results of linear function in mechanized farms and negative effect of capital in production function, because the mechanized farms have extra capital, they are in a quite clean area and there is no need to extra costs of medicines and hygiene. So medicines and hygiene costs should be lowered in these farms.

In relation to the results of estimation of Cob-Douglas function in semi-mechanized farms and linear function in mechanized farms, expert service variable was significant, but, it has a direct effect on production in mechanized farms that resulted in an elevation in production, whereas, in semi-mechanized farms, it has a negative effect on production, that resulted in a reduction in production. This means that when experts are chosen by managers, they are not effective or liable and there is a need to use more liable experts.

Dissemination education variable has a negative effect on production in semi-mechanized farms. This shows that disseminators have thought well to managers or liable disseminators have not been used which it has resulted in a reduction in production.

Based on the results in semi-mechanized farms (Cob-Douglas function), technology variable has a positive effect on production. In other words, managers can increase their production via elevating mechanization level. It means that mechanization should be conducted to the level of mechanized farms.

Also return to scale is increasing in semi-mechanized farms. In other words, production is in the second grade in semi-mechanized farms. This means that production inputs can be used more until maximum profit point (VMPx=Px). Also return to scale is diminishing in mechanized farms. And it means that production is in the third grade in mechanized farms (VMPx<Px). Therefore, production inputs have been used more than the optimal limit which resulted in decrease in production.

Of these inputs, capital variable can be mentioned which has been used more than optimal limit while it was not necessary. As noted in the last results, the expert services have had negative effect on production in semi-mechanized farms, so managers should make use of liable experts with high experience in this case.

A basic conclusion from all the results is that the selected production function for affecting variables in mechanized and semi-mechanized broiler chick farms is different, which it is consistent with the results of this research. Majority of researches in Iran are carried out in one level of mechanization and in one province and in some cases, in all parts of country, but the results of such researches are not attributable to all areas. Each province has different areas and climates so that sometimes, it is impossible to use the results of a research in a province to all cities of that province.

According to the results of this research, in addition to the above-mentioned points, the followings recommendations should be a point of attention for related organizations and authorities:

Considering lack of a comprehensive and documented data bank, it is recommended that a new system of analyzing documental data should be presented by authorities in different economical parts in order to be used by authors, programmers and decision makers.

Considering this fact that the negative effects of expert services and dissemination educations and also inefficient use of some inputs were seen in estimated models, there is a significant gap between the results and discussion section and production units, so, there is a need to study the defects and make the best use of expert forces in the units. Meanwhile, practical courses of education and dissemination to improve the knowledge of managers should be considered. In education and dissemination courses, preventive strategies to decrease poultry's diseases, rationing and seed distribution, supplementary nutrition, vitamins and new equipments (ventilation, bed, etc) need to be considered. Also, the results of new researches, technical points of brooding, the time between bringing the chick out and introduction of new chicks and even hygienic operation should be taken into account. To improve knowledge and awareness of managers, it is necessary to hold education and dissemination courses, before and during the operation by Agriculture Jihad Organization and to encourage the managers to participate in the courses and to perform educational programs.

Considering the results of this study, the most effective variable in production of broiler chicks in mechanized farms is introduction of chicks into farms which can result difficult and expensive for some farms so that sometimes. Moreover, some farms with capacity of 40 thousands chicks are not able to prepare their needed chicks. This problem results in a black market for this important input and even for seed, being this situation true. Capital input is in the third area (non-economical) of production. So proper site selection for establishing hen farms and strategy of inputs preparation by traders guilds and supporting corporation for cattle is necessary.

Considering the fact that weight of one-day chick has shown a negative effect, use of other domestic, resistant and corrected genera (such as Cab in comparison with Ros), which are more consistent with the climate, is suggested to managers. Nowadays, around 70% of farm managers use Ras genus and others are forced to use other genera because of lack of chick in the market. So it is suggested that corrected and economical genus are prepared on the basis of investigations by authors for farms.

On the basis of the results of this research, return to scale is diminishing in the mechanized farms, which is due to the use of capital more than its optimal limit. Therefore, it is suggested that production scale of mechanized broiler chicks are lessened or enough inputs are prepared for them. Put differently, return to scale is increasing in the semi-mechanized farms. Therefore, it is suggested that production scale of semi-mechanized broiler chicks are increased.

Considering low technical efficiency in non-mechanized farms, it is necessary that government devises brilliant tricks such as presenting low-interest long-term encouraging loans and studying the feasibility of establishment of new farms with higher-tech facilities.

Considering high efficiency of the specialist managers in cattle and poultry industry and also a better use of production factors in farms with animal husbandry experts, it is recommended that issuance of operational certificate is preferred for experts. In this case, it is benefiting that inexpert investors who are interested in this case, make use of expert managers and forces services.

It is necessary that government controls on time preparation of inputs and irregular and unexpected fluctuations in them (especially seed, one-day chick, and energy) through adoption of effective policies in the case of price and trade, and also it should be in charge of marketing of products (broiler chicks and fertilizers) via adoption of coordinated and destined policies.

To study more on economical aspects of poultry brooding, authors should put more emphasize on the following matters:

In this work, only one period of production has been studied. Nevertheless, it is recommended that in the future different periods of year should be considered.

1) It is recommended that bio-economy production functions should be analyzed via panel data and more developed methods.

2) It is also recommended that in addition to technical efficiency, allocation, economical and operational efficiency variables should be taken into account.

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