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Determination of Economic Efficiency in Production Traits and Herd Life of Dairy Cattle in Iran

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Abstract: One deterministic model that show flock dairy cattle agreement with fixing prices milk team in Iran and parities of economic efficiency in milk product and fat percent and milk protein percent and long life of flock in two tendency (profit maximizing and cost minimizing), 3 kind of limitation in team dimensions (number of cattle, input and milk product) and 2 kind of fix flock cost (independent of number of cattle and to be changeable of all cost per cattle) were calculated. Effects of different system limitation for economic efficiency were considered. In maximizing profit tendency, trait long life of flock is less changeable than other traits. In tendency minimizing cost and to be changeable of all costs per cattle efficiency of economic qualities is independent kind of limitation in dimensions and system. So, if in calculation of economic efficiency tendency choice to be minimizing cost and cost to allow for changeable per cattle economic efficiency product, probable maximizing changeable in dimensions team in future will be come without changing.

Key words: Dairy cattle, economic efficiency, herd life, Iran, production traits

INTRODUCTION

A breeding program is an organization in which information on performance of potential breeding animals is used to estimate breeding values and superior animals are selected to breed the next generation. The optimal method for dealing with complex breeding objectives including several traits is selection index (Hazel, 1943). In selection index, the breeding objective (total merit, aggregate genotype) are defined by a linear function of economically important trait. In order to establish total merit indexes using Hazel, the relative economic weights of the traits were considered in the aggregate genotype (breeding objective) have to be known. Hazel (1943) defined the economic value of a trait as the improvement in profitability resulting from a unit genetic improvement in a given trait when all other traits being constants. In theory, the decision about included traits in the aggregate genotype should only be driven by their economic importance under future conditions of production (Fewson, 1993). The first steps of breeding development program are the definition of production system and the establishment of the selection goal. The goal for individual animals should be to maximize the economic benefits of the production enterprise. Economic values are necessary to determine the relative importance constituting the breeding objective traits. To obtain maximum economic gain from selection, an expression of the goal for individual animals is needed. Most researchers formulated a profit equation (Harris, 1970; Amer, 1994; Van Arendonk and Brascamp, 1990). A profit function is a procedure or rule that describes the change in net economic returns as function of a series of physical, biological and economic parameters (Gibson *et al*., 1992). The use of the profit function in animal breeding is principally to define economic weights of traits, contributing to economic genetic improvement. Maximizing economic gain can be achieved by maximizing of profit (Harris, 1970) or minimizing cost in system (Hazel, 1943). Standard measures of economic efficiency are profit and proportion of all cost to income that shown with P and Q, respectively(Harris, 1970). Dairy cattle traits,

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economic efficiency calculations need to define a production system outward a flock that have limitations as (Groen and Ruyter, 1990):

- Fix number of animal
- Fix input
- Fix product

This limitation maybe affect to economic efficiency of trait (Groen and Ruyter, 1990; Van Arendonk and Brascamp, 1990). Kind of system limitations maybe change with economic condition and production. Procedure or rules of economic efficiency calculation are independent of system limitation change. Different researchers (Brascamp *et al*., 1985; Gibson, 1989; Groen and Ruyter, 1990; Smith *et al*., 1986) showed that in maximizing profit, these rules should have 3 conditions (Geroen and Ruyter, 1990):

- Unique crop of system product
- Establishment complete par between offer and demand
- Changeable of all cost is caution quantity of crop production

Each country emphasis on different traits depends on future situation. All countries emphasis protein yield over fat yield and nearly all select against milk volume or for concentration. Most countries now select for longevity, health and conformation traits (Parna *et al*., 2003). Breeding objective have been considering on milk fat and milk volume in Iran. As mentioned economic values are necessary to determine the relative importance of the traits constituting the breeding objective as milk volume, milk components and herd are important factors in Iranian dairy cattle farm condition, this research were studied necessary parities for calculation economic efficiency of production traits and flock herd life of tendency in kinds selection and limitation of system and with use of gather statistics in economic efficiency also, necessary condition for economic efficiency calculation of one trait in case that it doesn't to settle under effect and kind of changeable system limitation.

MATERIALS AND METHODS

Information of dairy cattle farm of Zanjan province were used that consist of cost (nutrition, human force, fuel, repair, hygiene, remedy, artificial insemination) and income statistics (milk, calf, heifer, culling cow, manure) in years of 2003. Used registered information were included average of milk product in one year from one herd, fat and protein percentage and flock herd life. Economic efficiency, in tendency of maximizing profit and interest of minimizing cost calculated in distinct manner until these differences affects defined cattle breeding goal. One of the calculations economic efficiency rules is analyzing system rules. In this rules one deterministic model formed economic efficiency (ø) proportional with system product (Miller and Pearson, 1979). That can be shown as:

$$ø = f(y_1, y_2, \ldots, y_m) \quad (1)$$

Where, y_i, average of traits (i = 1, 2,..., m) and m number of effective trait to economic efficiency. Economic efficiency, in tendency of maximizing profit and interest of minimizing cost showed with P = N (R-A) and Q = (NA+H)/NR, respectively.

Economic efficiency of trait i, (y_i) calculated derived 2 tendency be caution average of trait i (Harris, 1970).

$$\nu i = \partial ø/\partial yi \quad (2)$$

For calculation of traits economic efficiency by deterministic model, yearly income and cost of dairy flock calculated by the model (3 and 4) also we should consider that rating one kg milk in Iran is based on, price of one kg milk according stand percent of fat (3.2%), protein (3%) and additional fat and protein to stand percent of protein and fat. Income definition is depend on milk product and other source like calf, manure ant etc sales so we consider fraction outward of fix quantitative yearly cattle fix cost.

$$RN = N[M(B + q\times S + g\times I)] \quad (3)$$

$$CN = N[M(b + t\times S + j\times I) + D + a/L]+H \quad (4)$$

Where:

RN = Yearly income of flock
N = Number of dairy cattle in flock
M = Average of produced milk in one period
B = Price of one kg milk with stand percent of fat
q = Price of one unique of fatness percent addition to stand fat
S = Average percent of additional fat to stand fat percent
g = Price of one unique of protein percent addition to stand protein
I = Average percent of additional protein to stand protein percent
CN = Yearly cost of flock
b = Average cost of product of one kg milk with stand percent fat (without cost of keeping and pregnancy)

t = Average cost arising of addition one percent fat to stand fat
j = Average cost arising of addition one percent protein to stand protein
D = Average yearly fix cost of one dairy cattle (maintenance and pregnancy cost)
a = Average replacement pure cost of one dairy cattle
L = Average herd life flock (year)
H = Average yearly fix cost of flock (human force, repairs and oil cost)

Average pure cost of cattle replacement calculated as average income of one culled cattle (Knock out) minus average cost of one replacement heifers. Herd life based on year that showed with L calculated according below (Van Arendonk and Brascamp, 1990):

$$L = N/n \quad (5)$$

Where:
n = Average number replacement heifer in year

Use of this Eq. 5, change the balance of female calf to replacement heifer in model.

So, yearly income (R) and cost (A) equation of one dairy cattle according Eq. 3 and 4 will be as:

$$R = M(B + q\times S + g\times I) \quad (6)$$

$$A = M(b + t\times S + j\times I) + D + a/L \quad (7)$$

Instead of (B + qS + gI) and (b + tS + jI) we used r and w, respectively then:

$$R = M\times r \quad (8)$$

$$A = M\times w + D + a/L \quad (9)$$

So, Eq. 3 and 4 outward easily as below:

$$RN = N\times R \quad (10)$$

$$CN = N\times A+H \quad (11)$$

If to carry all costs outward changeable and according dairy cattle number, CN can be written:

$$CN = N\,(A + H/N)$$

If expression H/N shows with h, then:

$$CN = N\,(A + h)$$

If C used instead of (A+h) so:

$$CN = N\times C \quad (12)$$

RESULTS AND DISCUSSION

Economical parameters of traits in different situation calculated with use of equations (Table 1-4) and cost, price also average of products were shown in Table 5. In this experimental considered M = 8410 kg, S = 0.22%, I = 0%, L = 3.6 years, B = 1548.5 Rials, q = 20 Rials, g = 20 Rials, b = 423.71 Rials, t = 9.99 Rials, j = 5.08 Rials, D = 1918660 Rials, a = 4485000 Rials, H/N = h = 894607 Rials, R = 13392925 Rials, A = 6912746 Rials, C = 7807353 Rials, r = 1592.50 Rials, w = 445.69 Rials.

Tendency of maximizing profit: The economic efficiency equation of milk yield, fat and protein percent and herd life of flock in case of fix cost of flock and all cost changeable according the number of cattle with use of Eq. 12 were shown in Table 1 and 2.

In interest of maximizing profit and limited number of cattle the economic efficiency of milk product is 1146.8 Rials. Fix cost of cattle (D), fix cost of flock (H) and average of Milk product (M) did not affect the economic efficiency of trait. In this trend each factor that decrease of cost or increase income of one kg milk product increased economic efficiency of trait and fix or changeable cost didn't affect the economic efficiency of trait. Theses results are in agreement with other researchers (Harris, 1970; Van Arendonk and Brascamp, 1990).

In tendency of maximizing profit, input limitation, fix cost of flock and changeable of all cost the economic efficiency of milk product is 729 and 828, respectively. This trend depends on income and cost of milk that related with income relative to yearly cost of one cattle. In condition fix cost of expression (R/A) and changeable of all costs per cattle (R/C) b ecause C is bigger than A (Eq. 12) so in changeable of all costs economic efficiency of this trait is bigger than other condition.

In this system are conditions that make profit because relation of income to cost is bigger than one, so economic efficiency of trait in number cattle limitation is small.

In system that relation of cost to income equal one (profit is zero), the economic efficiency of milk product in two limitation number of cattle and input is equal. These results are in agreement with other research (Brascamp *et al*., 1985).

The economic efficiency of milk product in limitation of milk production in tendency maximizing profit, with fix or changeable cost is 376.3 and 482.7 Rials, respectively. In this system only yearly fix cost of one cattle and average product are related then with increasing average product, number of cattle decrease until surface total product be fix. Economic efficiency of fat and protein percent in tendency of maximizing profit in all situations related to average of milk product.

Table 1: Equations of economic efficiency for production traits and herd life of flock (per year) in tendency of maximizing profit, fix cost and kind of limitation in dimensions system

Trait limitation	Milk production	Fat percentage	Protein percentage	Herd life of flock
Number of cattle	r-w	M (q-t)	M (g-j)	a/L^2
Input	r-w-(R-A)w/A	M [q-t(R/A)]	M [g-j(R/A)]	$(R/A)a/L^2$
Milk production	(D+a/L)/M	M (q-t)	M (g-j)	a/L^2

Table 2: Equations of economic efficiency for production traits and herd life of flock (per year) in tendency of maximizing profit, changeable of all cost according to number of cattle and kind of limitation in dimensions system

Trait limitation	Milk production	Fat percentage	Protein percentage	Herd life of flock
Number of cattle	r-w	M (q-t)	M (g-j)	a/L^2
Input	r-w-(R-C)w/C	M [q-t(R/C)]	M [g-j(R/C)]	$(R/C)\ a/L^2$
Milk production	(D+h+a/L)/M	M (q-t)	M (g-j)	a/L^2

Table 3: Equations of economic efficiency for milk product, fat and protein percent and herd life of flock (per year) in tendency of minimizing cost, fix cost of flock and kind of limitation in dimensions system

Trait limitation	Milk production	Fat percentage	Protein percentage	Herd life of flock
Number of cattle	-(D+h+a/L)/R	M (t-q×Q)/r	M (j-g×Q)/r	$-a/(r\times L^2)$
Input	-(D+a/L) Q/A	-M (q-M×t×r/A) Q/r	-M (g-M×j×r/A) Q/r	$-R\times Q\times a/A\times r\times L^2$
Milk production	-(D+a/L)/R	M (t-q×Q)/r	M (j-g×Q)/r	$-a/(r\times L^2)$

Table 4: Equations of economic efficiency for milk product, fat and protein percent and herd life of flock (per year) in tendency of minimizing cost, changeable of all cost according to number of cattle and kind of limitation in dimensions system

Trait limitation	Milk production	Fat percentage	Protein percentage	Herd life of flock
Number of cattle	(w/r)-(C/R)	M (t-q×Q)/r	M (j-g×Q)/r	$-a/(r\times L^2)$
Input	(w/r)-(C/R)	M (t-q×Q)/r	M (j-g×Q)/r	$-a/(r\times L^2)$
Milk production	(w/r)-(C/R)	M (t-q×Q)/r	M (j-g×Q)/r	$-a/(r\times L^2)$

Table 5: Economic efficiency of milk product, fat and protein percent and herd life of flock (per day) in two tendency, maximizing profit and minimizing cost, with fix cost of flock and changeable of all cost according to number of cattle and kind of limitation in dimensions system

		Tendency of maximizing profit		Tendency of minimizing cost	
Trait	Kind of limitation	Fix cost of flock	Changeable of all cost	Fix cost of flock	Changeable of all cost
Milk production	Number of cattle	1146.8	1146.8	-0.30	-0.30
	Input	729.0	828.0	-0.27	-0.30
	Milk production	376.3	482.7	-0.24	-0.30
Fat percentage	Number of cattle	84184.1	84184.1	-8.82	-8.82
	Input	5425.5	24077.1	-1.99	-8.82
	Milk production	84184.1	84184.1	-8.82	-8.82
Protein percentage	Number of cattle	125477.2	125477.2	-34.70	-34.70
	Input	85427.8	94912.3	-31.30	-34.70
	Milk production	125477.2	125477.2	-34.70	-34.70
Herd life of flock	Number of cattle	948.1	948.1	-0.60	-0.60
	Input	1836.9	1626.4	-0.67	-0.60
	Milk production	948.1	948.1	-0.60	-0.60

In tendency of maximizing profit with fix cost and changeable cost the economic efficiency of fat and protein percent with number cattle limitation also milk product limitation are 84184.1 and 125477.2, respectively and related fat and protein additional percent to stand percent. Yearly profit per cattle increased 84184.1 and 125477.2 Rials with increasing each unique of fat and protein percent, respectively. In input limitation, economic efficiency of milk fat and protein percent, in addition to income and cost of one unique fat and protein, related to income and yearly cost of one head cattle.

The economic efficiency of flock herd life yearly calculated with equations (Table 1-4) then divided to 365 so daily economic efficiency calculated. This economic efficiency in tendency of maximizing profit with number cattle and milk production limitation is the same (948.1 Rials) and fix or changeable cost did not affect the economic efficiency of this trait. In this system increasing average pure cost of replacement cattle (a) increase economic efficiency of this trait so increasing price of heifer increase this trait importance and versus. These results are in agreement with others (Van Arendonk and Brascamp, 1990). In limit situation quantity of input, economic efficiency of this trait in addition to pure cost replacement related to income and yearly cost of one head cattle.

Tendency of minimizing cost: The economic efficiency equation of milk yield, fat and protein percent and herd life of flock in case of fix cost of flock and changeable all cost based on the number of cattle were shown in Table 3 and 4.

Equations of economic efficiency in tendency of minimizing cost were shown in Table 3 and 4. In new research tendency of minimizing cost have a 2 advantage:

- In this system because economic efficiency means quantity of yearly cost to income so economic efficiency of traits haven't a money unit
- Because economic efficiency have not a money unit so economic efficiency of one trait in different situation is comparable

Large and negative value in this system means that this situation had an important affect on system product. In tendency of minimizing cost, changeable all costs of economic efficiency in different kind of limitation for each trait is equal and means in this situation different kind of limitations of system dimensions weren't affect of economic efficiency in other words in minimizing cost to income is based on per cattle so changeable all of cost cause change all of equation elements. Use of economic efficiency in selection index should be long period applicable and be little affect able by change of limitation and system dimension. With respect that tendency minimizing cost is based on per cattle and allows all changeable costs may be able to secure this necessary. Suggested economic efficiency of dairy cattle selection index in Iran for milk production, fat percent, protein percent and herd life is 0.3, 8.82, 34.7 and 0.6, respectively.

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