Journal of Animal and Veterinary Advances 8 (11): 2125-2132, 2009
ISSN: 1680-5593

Estimation of Economic Values for Production and Functional Traits in Chinese Holstein

Jun Chen, Yachun Wang, Yi Zhang, Dongxiao Sun and Yuan Zhang
Key Laboratory of Ministry of Agriculture, Department of Animal Genetics and Breeding,
College of Animal Science and Technology, China Agricultural University, Beijing 100193, China

Abstract: Bio-economic profit models were used on Chinese Holstein production system to evaluate economic values for production traits Milk Yield (MY), Fat Percentage (FP), Protein Percentage (PP)) growth traits Mature Live Weight (LW) and functional traits Age at First Calving (AFC), Calving Interval (CI), Production Lifetime (PL) and Somatic Cell Count (SCC) traits. Economic and production parameters were derived from large scale dairy farms located in Beijing in 2008 to characterize Chinese Holstein production system, which were described according to their growth stage and levels of feed and management environment. Revenue and cost were calculated according to different age group in dairy production. With a fixed number of cows per herd as a basis of evaluation, two milk payment systems were considered. Under payment system based on milk volume, estimated economic values were RMB 1.99 (MY, kg),-4.72 (PP, %), -8.00 (FP,%), 0 (SCC), -4.96 (AFC, days), 1.71 (CI, days), -2.73 (LW, kg) and 1.58 (PL, days), respectively. Under payment system based on milk composition and quality (fat percentage, Protein Percentage, SCC), changes in the economic values were only observed for PP (64.21), FP (41.24), SCC (-393.88), respectively. Sensitivity of economic values was studied, factors considered included the price of milk, price of beef, price of feed and other production variables. Economic values of MY, PP and FP increased significantly with higher price of milk and the beef price had no effect on the economic values of milk production traits. With higher feed price, the economic value for the grow traits and functional traits increased, but that for milk production traits decreased. In summary, evaluated economical value for different traits showed that production and functional traits would have a positive effect, while growth traits would have a negative effect on profitability of Chinese Holstein production system and price of milk and feed were identified as the main factors influencing profit. The bio-economic profit model constructed for Chinese Holstein breeding system could provide general ideas for breeding goals setting in Chinese dairy breeding system in the future.

Key words: Economic value, bio-economic profit model, production trait, functional traits, Chinese Holstein

INTRODUCTION

The establishment of breeding goals is the basis of animal breeding and premise of animal genetic improvement. Breeding objectives are very important for genetic improvement of all livestock species (Hazel, 1943). In order to maximize profits, selection must be directed towards appropriate breeding objectives (Wolfova *et al*., 2007), to produce the desired products under future economic, natural and social circumstances (Groen *et al*., 1997). Deriving economic values of breeding objective traits is the first step in the development of breeding objectives (Kahi and Nitter, 2004; Ponzoni and Newman, 1989; Rewe *et al*., 2006). Hazel (1943) defined the economic value of a given trait as the improvement in profitability resulting from a unit genetic improvement with all other traits being constant, including all the biological traits, which impact the profits. Calculating economic values of these objective traits were based on a bio-economic model that takes into account the revenues and costs of the production system, which is affected by economic, management, nutrition and other market factors. A bio-economic model is used to describe the relationship between the revenues and costs related to the traits in the current production system, where marginal economic values of milk production traits, growth traits and functional traits were calculated.

In selection of breeding objectives of the Holstein cows, more and more countries currently considered the production traits and functional traits and breeding goals of many countries and many breeds also include health traits (Miglior *et al*., 2005; Nielsen *et al*., 2005; VanRaden, 2004). Breeding objectives were mainly included production traits for Chinese Holstein Cattle were evaluated by Zhang and Fewson (1992). The profit function should be updated, when new information

Corresponding Author: Yuan Zhang, Key Laboratory of Ministry of Agriculture, Department of Animal Genetics and Breeding, College of Animal Science and Technology, China Agricultural University, Beijing 100193, China

becomes available (Meuwissen and Goddard, 1997). It is the time to have a reassessment of the breeding objectives and to include more necessary traits for Chinese Holstein Cattle.

In this study, economic values were estimated using a bio-economic model, with biological and economic parameters reflecting the updated changes for Chinese Holstein cattle production system. The aim is to estimate economic values for milk production traits Milk Yield (MY), Fat Percentage (FP), Protein Percentage (PP), growth traits (mature Live Weight, LW) and functional traits Age at First Calving (AFC), Calving Interval (CI) and Production Lifetime (PL) of Chinese Holstein Cattle populations under different payment systems.

MATERIALS AND METHODS

Description of herd management: Chinese Holstein production system was characterized by economic and production circumstances in 2008. Information was collected from Beijing Sanyuan Dairy Farming Center, China Dairy Association and Beijing Dairy Cattle Breeding Center, relating to dairy breeding, economic, nutrition and management. Average Performance data was calculated based on the current production and marketing circumstances (Table 1). Herd composition was shown in Fig. 1.

According to growth stage, dairy cattle can be grouped into calves, heifers and Lactating cows.

Calves: Male calves are sold with fixed prices after birth. Bulls are fed in bull station and not considered in this system. All female calves are fed milk three times a day (2 kg each feeding) till weaning. Dry matter of roughage fed to calved are assumed to be equivalent to 0.05% of calf weight after 10 days. Calves will be weaning at 2 months of age. The total supplement of concentrate was 90 kg during the calving stage.

Heifer: Concentrate of fixed quantity (2 kg day^{-1}) are fed. The dry matter of roughage are assumed to be equivalent to 2% of heifer weight from weaning to mating at 16 months.

Cows: During gestation period, cows are fed at a fixed concentrate (3 kg day^{-1}). The dry matter of roughage fed are assumed to be equivalent to 3% of cow weight and cows are fed concentrate with a fixed quantity (8 kg day^{-1}). During lactation period, according to nutrition standards (NRC, 2001), energy of roughage is calculated by subtracting the energy of concentrate feed

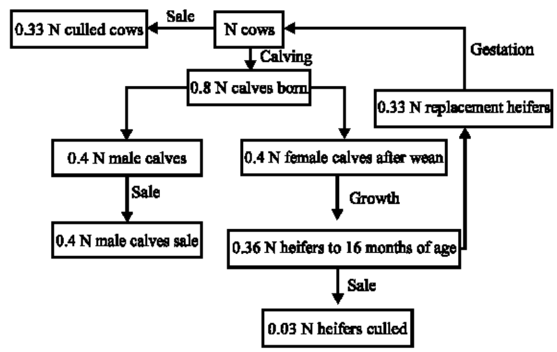

Fig. 1: Demography of typical Chinese holstein cattle herd composition based on a fixed number of N breeding cows

from the total energy needs. Roughage includes silage and hay, dry matter content of silage to hay is 1:1. Milking cow stays in the herd on average for 3 lactations. Two milk payment standards were used in current study, under milk volume and under milk composition, respectively. All biological, nutritional and economical parameters were shown in Table 1.

Biological traits affecting revenues and costs: It is assumed that the 8 biological traits have influence on revenues and costs and they were assigned to 3 groups and Table 2 shows the definition and relationship of 8 traits in three animal groups.

Milk production traits: Milk Yield per cow per year (MY), Fat Percentage per cow per year (FP) and Protein Percentage per cow per year (PP).

Growth traits: Mature weight of cow (LW)

Functional traits: Age at First Calving (AFC), Productive Lifetime (PLT), Calving Interval (CI), Somatic Cell Count (SCC).

Bio-economic profit models: Bio-economic profit models have been used to combine revenues and costs to estimate economic values. The models can be used to predict profitability of the Chinese Holstein cattle. In the literature, there are two methods to derive economic values, which referring to method of field data and data simulation. For data simulation approach, bio-economic models have been used (Kahi and Nitter, 2004; Vargas *et al.*, 2002; Wolfova *et al.*, 2007). This type of model is combined revenue and cost variable of a dairy population (Albera *et al.*, 2004). This approach is difficult

Table 1: Biological, economical and nutritional parameters for Chinese holstein cattle

Parameters	Unit	Abbr.	Value[1]
Biological parameter			
Milk yield per cow per year	Kg	MY	8000
Protein percentage	%	PP	3
Fat percentage	%	FP	3.4
Calf birth weight	Kg	BW	40
Weight at weaning	Kg	WAW	82
Pre-weaning daily gain	Kg	DG	0.7
Post-weaning daily gain	Kg	PDG	0.8
Mature live weight	Kg	LW	650
Calving percentage	%	CR	80
Survival rate to 24 h after birth	%	S24	98
Pre-weaning survival rate	%	SR	95
Post-weaning survival rate	%	PSR	95
Calving interval	Days	CI	410
Period from birth to weaning	Days	WA	60
Period from weaning to 16 months	Days	DWN	420
Period from 16 months to first calving	Days	DAFC	300
Productive lifetime	Days	PLT	1100
Age at first calving	Days	AFC	780
Economic parameter[2]			
Milk price per kg	RMB	MP	2.6
Milk price per kg with fat percentage increase one percentage	RMB	FP	0.05
Milk price per kg with Protein percentage increase one percentage	RMB	PP	0.07
Number of milk quality classes according to SCC			3
Milk price per kg with SCC increase one class	RMB	SP	0.05
Upper limits of somatic cell count for quality classe 1	cells mL^{-1}		450000
Upper limits of somatic cell count for quality classe 2	cells mL^{-1}		600000
Price per kg LW	RMB	LWP	8
Calf price	RMB	Pc	300
Costs[3]			
Concentrate cost per kg DM	RMB	PCONC	2
Silage cost per kg DM	RMB	PSIL	0.18
Hay cost per kg DM	RMB	PPAS	0.9
Heifer health cost per head per day	RMB	CHHEA	0.08
Cow health cost per head per year	RMB	CHCOW	200
Heifer reproduction cost per head per day	RMB	CHREP	0.13
Cow reproduction cost per head per year	RMB	CRROW	50
Labor cost per head per day	RMB	CLAB	1.2
Cow labor cost per head per year	RMB	CLCOW	1241
Marketing cost per kg milk	RMB	CMMILK	0.03
Marketing cost per kg live weight	RMB	CMLW	0
Marketing cost per head of male calf	RMB	CMMC	0
Calf housing and other fixed cost per head per year	RMB	CCHFC	150
Heifer housing and other fixed cost per head per year	RMB	CHHFC	50
Cow housing and other fixed cost per head per year	RMB	CBCOW	187.5
Hydro costs per head per year	RMB	FCPP	400
Nutrition parameters			
Amount of DM consumed from concentrates per calf per day	Kg	DCC	2
Amount of DM consumed from concentrates per heifer per day	Kg	DCCA	3
Amount of DM consumed from concentrates per cow per day	Kg	DCCOs	8
DM content in concentrates	%	DCIC	0.9
DM content in silage	%	DCIS	0.24
DM content in hay	%	DCIP	0.88
Energy content in concentrates	MJ	ECIC	8
Energy content in silage	MJ	ECIs	4.3
Energy content in hay	MJ	ECIP	4.7

[1]1 US$ = 7.0 RMB in 2008. [2]Milk price is milk with given average fat and protein percentages price. [3]DM: Dry Matter. Reproduction costs include semen and insemination labor costs. The marketing costs per kg milk include costs incurred in recording milk, transportation milk and calves

when, information of a production system under analysis being insufficient (Groen *et al*., 1997). As the case in China, since detail parameters is not fully available related to dairy genetic, nutritional, managerial and other economic aspects, a similar approach to model profit function as in the literature was adapted (Fernandez-Perea and Alenda Jimenez, 2004; Kahi and Nitter, 2004). Production system practiced in Beijing Sanyuan Dairy Farms was assumed to be optimal under Chinese circumstance, then profit was modeled as the difference

Table 2: Biological traits that influence revenues and costs

Effect on profit	Class of cattle	Traits[1]
Revenues	Male calves	CI
	Culled heifers	PLT, CI
	Milk cows	MY, FP, PP SCC
	Culled cows	LW PLT
Costs[2]	Male calves	CI
	Female calves	LW AFC,CI
	Heifers	AFC, CI
	Cows	MY, FP, PP, LW
	Culled heifers	PLT,CI
	Culled cows	LW, PLT

[1]MY: Milk Yield, FY: Fat Yield, AFC: Age at First Calving, CI: Calving Interval, LW: Mature Live Weight, PLT: Productive Lifetime. [2]Costs included feeding, health, reproduction, labor, marketing

between revenues and costs for above mentioned 8 traits assuming fixed herd size. Animals were grouped (calves, heifers and cows) and the revenues and costs were calculated for each group. Table 2 shows the biological traits affecting revenues and costs in production system. In general, the total bio-economic profit function can be expressed as:

$$P = \sum_{i=1}^{3} P_i = \sum_{i=1}^{3} (R_i - C_i) \quad (1)$$

Where:

P = The profit per cow per year (RMB)
R = The revenues per cow per year (RMB)
C = The costs per cow per year (RMB)

Total profitability was expressed per cow per year based on the difference between Revenues (R) and Costs (C) for the three classes of livestock: i = 1, 2 and 3 representing calves, heifers and cows, respectively.

Revenues came from sold male calves, culled heifers and cows and milk, the Revenues (R) per cow per year were calculated as follows:

$$R = NmcCy \times p_c + NfcCy_{cull} \times W_{heifer} \times p_{lw} + \frac{LW}{PLTy} \times p_{LW} + MY * p_{milk} \quad (2)$$

Where:

$NmcCy$ = The number of male calves
p_c = The calf price (RMB)
$NfcCy_{cull}$ = The number of female calves per cow and year for culling
$W_{heifers}$ = Heifers weights (kg)
p_{lw} = The price per kg LW (RMB)
LW/PLTy = Number of cows per year for culling,
MY = Milk yield per cow per year (kg)
p_{milk} = The price per kg milk (RMB)

The Costs (C) are derived from the following Eq. 3:

$$\begin{aligned} C = (&C_{Feed-calves} + C_{Feed-16month} + C_{Feed-16months-afc} \\ &+ 365 \times C_{Feed-cows} + C_{Health-calves} + C_{Health-heifers} \\ &+ C_{Health-cows} + C_{Labor-calves} + C_{Labor-heifers} + C_{Labor-cows} \\ &+ C_{Reproduction-heifers} + C_{Reproduction-cows} + C_{Market-milk} \\ &+ C_{Market-weight}) + C_{Fix} + C_{Hydro} \end{aligned} \quad (3)$$

Where:

$C_{Feed\ -\ calves}$ = Costs for feeding calves (RMB)
$C_{Feed\ -\ 16\ months}$ = Costs for feeding from calves to 16 month (RMB)
$C_{Feed\ -\ 16\ months\ -\ afc}$ = Costs for feeding heifer from 16 month to first calving (RMB)
$C_{Feed\ -\ cows}$ = Costs for feeding cows (RMB)
$C_{Health\ -\ calves}$ = Calves health cost per head (RMB)
$C_{Health\ -\ heifers}$ = Heifers health cost per head (RMB)
$C_{Health\ -\ cows}$ = Heifer health cost per head (RMB)
$C_{Labor\ -\ calves}$ = Calves labor cost per head (RMB)
$C_{Labor\ -\ heifers}$ = Heifers labor cost per head (RMB)
$C_{Labor\ -\ cows}$ = Cows labor cost per head (RMB)
$C_{Reproduction\ -\ heifers}$ = Heifers reproduction health cost per head (RMB)
$C_{Reproduction\ -\ cows}$ = Cows reproduction cost per head (RMB)
$C_{Market\ -\ milk}$ = Marketing cost per kg milk
$C_{Market\ -\ weight}$ = Marketing cost per kg weight (RMB)
C_{Fix} = The fixed cost (RMB), fixed costs included housing, machines, farm and equipments
C_{Hydro} = The hydro and other miscellaneous costs

Costs were calculated separately for feeding, health, labor, reproduction marketing and fixed costs for 3 groups of animals. Feeding costs were calculated on the basis of daily net energy requirements of maintenance, growth, lactation and pregnancy for different animal categories and the price of feed. Reproduction costs were costs of the AI, semen, services per conception. Health costs included veterinary costs on the basis of head/year.

Estimation of economic values: The economic values were estimated assuming fixed herd-size under the Chinese Holstein production system, many evaluation methods of economic values were shown by Brascamp *et al.* (1985), Fernandez-Perea and Alenda Jimenez (2004), Kahi and Nitter (2004) and Rewe *et al.* (2006). Economic value of a trait is as follows:

$$EV = \frac{\Delta R - \Delta C}{\Delta T} \quad (4)$$

Where:

EV = The economic value of the trait per unit change
ΔR = The marginal change in revenues
ΔC = The marginal change in costs after 1% increase in the trait of interest
ΔT = The marginal change in a trait after 1% increase

Additional analysis was performed on the changes in production variables and prices, such as alternative milk price, beef price, feed price and production variables. Changes of (±) 10% with respect to the original values were considered, one aspect was changed at a time, while keeping all other parameters constant. Economic values were calculated under two milk pricing systems.

RESULTS

Base line situation: Under the fixed Herd-size, Chinese Holstein bio-economic profit models for Chinese Holstein production system was constructed and economic value of the objective traits under the base situation was calculated. The results were shown in Table 3. The total profit is RMB 6818.03 per cow per year. Milk and beef revenues accounted for 92.14 and 7.86% of total revenues. The variable costs and fixed costs accounted for 97.5 and 2.5% of the total costs, respectively. Costs of feeding milking cows represent 57.09% of the total costs (most of the variable costs), which was the most important cost. Heifer costs account for 36.39% of the total costs. The costs of the marketing accounted only for 1.52% of the total costs. Hydro and other miscellaneous costs, accounted for 2.46% of the total costs. The profit of calf, heifer and cow is RMB -455.23, RMB -3938.62 and RMB 11611.88, respectively, without considering the hydro and miscellaneous cost.

In the Chinese Holstein production system, economic values for traits are defined per unit increase in genetic merit. Under price of milk volume, the economic values of MY, PP and FP were RMB 1.99, -4.72 and -8.00 per kg, respectively. The economic benefits of CI, PLT traits were positive (RMB 1.71 and 1.58, respectively) indicating selection should aimed at the increasing direction, however, increasing CI will only benefiting reducing the loses of selling male calves and culled heifer to some extent. Economic value of AFC and LW were negative (RMB -4.96 and -2.73, respectively), suggested that decreasing AFC and LW would bring better profit to the system. Under pricing system of milk composition, shown in Table 4, economic value of MY was not changed, however, that of PP, FP were changed to RMB 64.21 and 41.24 per kg, respectively. Economic values of the functional traits were not changed from different price system of milk, except that for SCC. Economic value of SCC was RMB -393.88. When SCC grade increase, overall profit will reduce to a large extent.

Changes in price variables and payment systems: As shown in Table 4, the sensitivity of the system were studied That changing variables of one trait, while the other traits staying constant, The economic value was impacted by changes of the price of milk, beef, feed and production traits. Overall profit and economic value of MY and CI traits significantly rise with increasing milk prices. On the other hand, reduction of the price of milk will reduce the overall profit as well as economic value of MY and CI. Increase in beef price will raise the overall profits slightly, but decrease the economic value of CI, LW, PLT. Increase the price of feed will reduce profit and reduce the economic value of MY, FP and PP. Price of milk and feed were identified as the main factors influencing profit.

Table 3: Initial revenues and costs per cow/year and economic values per unit increase in genetic merit for traits

		Marginal changes after one unit in genetic merit							
Parameters	Initial	MY	PP	FP	SCC	AFC	CI	LW	PLT
Milk	20800.00	208.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Male calves	104.69	0.00	0.00	0.00	0.00	0.00	-1.04	0.00	0.00
Culled heifer	-56.41	0.00	0.00	0.00	0.00	0.00	-10.43	0.00	10.99
Culled cows	1725.45	0.00	0.00	0.00	0.00	0.00	0.00	17.25	-17.08
Costs									
Cow[1]	8995.08	46.33	37.76	63.98	0.00	0.00	0.00	24.96	0.00
Heifer [2]	5733.13	0.00	0.00	0.00	0.00	38.65	-18.48	10.06	-23.52
Marketing[3]	240.00	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other costs[4]	400.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(a)Variable	15355.71	48.73	37.76	63.98	0.00	38.65	-18.48	35.02	-23.52
(b)Fixed	387.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total(a+b)	15755.71	48.73	37.76	63.98	0.00	38.65	-18.48	35.02	-23.52
Profit(1-2)	6818.03	159.27	-37.76	-63.98	0.00	-38.65	7.02	-17.77	17.42
EV[5]	-	1.99	-4.72	-8.00	0.00	-4.96	1.71	-2.73	1.58

[1]Cow costs include cow feed, health, labor and reproduction costs, [2]Heifer costs includes heifer feed, health, labor and reproduction costs, [3]Marketing costs include marketing milk, male calves, culled cows and heifers, [4]Other costs include hydro and other miscellaneous costs and [5]Economic values assuming that payment of milk were based on milk volume

Table 4: Sensitivity of economic value to changes in prices of milk, beef, feed and production variable in price systems

		Marginal changes after one unit change in genetic merit							
Alternative	Profit	MY	PP	FP	SCC	AFC	CI	LW	PLT
Economic value[1]	6818.03	1.99	64.21	41.24	-393.88	-4.96	1.71	-2.73	1.58
Changes in prices									
P_{milk}									
+10%	8866.18	1.13	1.00	1.00	1.00	1.00	1.04	1.00	1.00
-10%	4769.88	0.87	1.00	1.00	1.00	1.00	0.96	1.00	1.00
P_{beef}									
+10%	6984.94	1.00	1.00	1.00	1.00	1.00	0.85	0.90	0.97
-10%	6651.13	1.00	1.00	1.00	1.00	1.00	1.15	1.10	1.04
P_{feed}									
+10%	5560.18	0.97	0.99	0.98	1.00	1.10	1.19	1.20	1.13
-10%	8075.88	1.03	1.01	1.02	1.00	0.90	0.81	0.80	0.88
Traits									
CI									
+10%	6882.47	1.00	1.00	1.00	1.00	1.00	0.91	1.00	1.00
-10%	6739.27	1.00	1.00	1.00	1.00	1.00	1.11	1.00	1.00
PLT									
+10%	6977.99	1.00	1.00	1.00	1.00	0.91	1.00	1.04	0.91
-10%	6622.53	1.00	1.00	1.00	1.00	1.11	1.00	0.96	1.11
CR									
+5%	6782.59	1.00	1.00	1.00	1.00	1.00	1.05	1.00	1.00
+10%	6747.14	1.00	1.00	1.00	1.00	1.00	1.10	1.00	1.00

[1]Economic values assuming that payment of milk was based on milk composition. Pm: Price of milk per kg; P_{beef}, beef price per kg; P_{feed}: Feed cost per kg include concentrate silage and pasture

Changes in CI, PLT and CR will influence profit, however, to a much smaller magnitude when compared to the situation of change price of milk, beef and feed. Increase or decrease CI and PLT will impact the profit correspondingly, as Table 3 showed positive economic value of CI and PLT. Surprisingly increase CR will reduce the overall profit, as in a fixed herd size and rate of replacement, reduction of CR will be reduce the rate of culling and the cost of feed and rearing calves and culled heifer all brought negative profit.

DISCUSSION

The aim of this study is to estimate economic values for production and functional traits for Chinese Holstein Cattle production system by adopting a bio-economic profit models under the base line situation. The biological parameters and relationships considered in the model, which derived from Chinese national dairy performance database and partially from Beijing Sanyuan Dairy Farming Center, however, the bio-economic model were general and flexible, which can be applied to a wide range of different production systems by changing the input variables and adapt to changes in the future market. From current study, one cow could have a net profit of 6818.03 RMB per year and milking cows is the group, which bringing the most significant profit in Chinese dairy farming system.

Production traits: Economic value of MY was positive (RMB 1.99 per kg, Table 3), agreed with results reported in the literatures (Kahi and Nitter, 2004; Wolfova *et al.*, 2007). Economic value of MY increased significantly compare to the results (Zhang and Fewson, 1992), Because, the genetic quality of dairy cows to increase in these years. However, economic value of MY in some studies were negative (Gibson, 1989; Groen, 1989a, b; Vargas *et al.*, 2002), where, in these studies, milk price was paid by fat and protein content and then economic value of milk volume (without composition) were negative. But in current research, milk price is set at given average fat and protein percentage. Milk is the most important source of dairy cattle, which determine the economic profits of Holstein cattle. Economic profits of FP and PP were negative under pricing system of milk volume (Kahi and Nitter, 2004), because, FP and PP are traits influencing costs and the nutritional needs of lactating cows and feed consumption. Under pricing system of milk composition, increases of FP and PP will enhance economic efficiency, therefore, have a positive effect for profit and with a large magnitude comparing to that under pricing system of milk volume (Bekman *et al.*, 1993; Groen, 1989b; Wolfova *et al.*, 2007). The current payment system used in China has higher price for protein compared to fat, so economic value of PP is bigger than FP. Also, reflects the pursuit of quality milk by Consumers, The important of milk fat and milk protein in the breeding objectives need to be considered than before (Zhang and Fewson, 1992).

Growth traits: The economic values of LW were derived from the sale of calves, culled heifer and culled cows. Because, the cost of feeding was more than revenue of sales under current beef price setting, so that the profit was negative. This is consistent with the results in the study (Zhang and Fewson, 1992; Bekman *et al.*, 1993;

Visscher *et al*., 1994; Wolfova *et al*., 2007). Marketing cost of calves, culled heifer and culled cows were set to zero according to Chinese situation and it is relatively a small proportion in the entire production system. Since, middle of 2008, there was an increasing trend for the beef price in China and it had an influence on price of dairy male claves and culled animals, as Table 4 should, if the beef price increase, the absolute value of economic value of LW would decrease and overall profit would increase, benefiting the dairy producer.

Functional traits: SCC grades show, the negative economic value in present study under pricing system of milk composition. Similar value was reported by Boettcher *et al*. (1998) and Wolfova *et al*. (2007). In China not all pricing systems considering SCC yet, however, the undesirable relationship between SCS and milk production would also suggest dairy farm to decrease SCS through genetic improvement and dedicate management. PLT represents a cow's entire life benefits. Increase in PLT will reduce average heifer replacement rate. The economic value of PLT was positive, it is because that the reduction in revenues could be compensated by a more significant reduction in heifer rearing (Boettcher *et al*., 1998; Kahi and Nitter, 2004; Wolfova *et al*., 2007). The economic value of AFC was negative and it is obviously due to increase in AFC will increase costs of the feeding time and feed consumption. The economic value of CI was positive. Increase in CI will certainly lead to reduction in revenues of selling male calves and culled heifers, however at the same time, the reduction in revenues were compensated by a more significant decrease of feeding cost. CI was derived by changing its genetic merit allowing no simultaneous change in genetic merit of MY (Kahi and Nitter, 2004), so changes of milk production was not considered. Therefore, further modification of model will be necessary in order to include all the interrelations among traits. At present, many countries include health traits in their breeding objectives (Miglior *et al*., 2005; Shook, 2006). Due to the lack of biological and economic parameters, the health traits were not included in the current study.

In Chinese Holstein production system, the milk pricing system is the most important factor that influences the economic value of milk volume, fat and protein percentages. As a result of market competition, different regions and enterprises have developed different standards for milk collection. It is obvious that uniform standards for collecting milk should be established to encourage sustainable genetic improvement, production of milk with more consistent quality and better food security. In China political decisions also could play important role on establishing sustainable breeding and production system and milk pricing system, considering market conditions and consumer requirements. So, a number of factors should be integrated to develop a desired breeding objectives.

Currently, in China genetic improvement of dairy cattle mainly depends on importing semen of elite bulls, Due to the large dairy population (13.88 million heads in 2008) existed in China and rearing under various conditions. The interaction might exist between the genes and the environment suggested us the importance of Chinese national evaluation system. Breeding goals include not only production traits, other trait (functional traits) also similar important for Chinese Holstein, such as resistance for heat stress, low quality roughage become very important in China. These traits play a role of indirect economic effects. However, these trait is difficult to testing throughout the country and only testing in some large state farming.

CONCLUSION

Economic values for milk production, growth and functional traits were derived under fixed herd-size using bio-economic model for the Chinese Holstein production system, which include relationships among genetic, nutrition, reproduction and health traits. Milk production traits Milk Yield (MY), Fat Percentage (FP), Protein Percentage (PP) have the most economically importance on overall profit. Functional traits Age at First Calving (AFC) Calving Interval (CI) and Production Lifetime (PL) appear to be less economically important. Growth traits (LW) have negative economic value. Price of milk and feed were identified as the main factors influencing profit. In summary, genetic improvement of milk production, functional and growth traits should be considered in a balanced breeding objective system, also more interaction effects in the Production and management environment should be taken into account in the bio-economic profit model to develop a desired breeding system for Chinese Holstein.

ACKNOWLEDGEMENTS

We are very grateful for the financial support from the State Major Basic Research Development Program (2006CB102107), National 948 project (2006-G48), National High-tech R and D Program (2007AA10Z157) and National Key Technology R and D Program (2006BAD04A01) and for permission to use information data from Beijing sanyuan dairy farming center, China Dairy Association and Beijing Dairy Cattle Breeding Center and for provision of facilities.

REFERENCES

Albera, A., P. Carnier and A.F. Groen, 2004. Definition of a breeding goal for the piemontese breed: Economic and biological values and their sensitivity to production circumstances. Livest. Prod. Sci., 89 (1): 66-77. DOI: 10.1016/j.livprodsci.2003.12.004.

Bekman, H., V. Arendonk and J.A.M., 1993. Derivation of economic values for veal, beef and milk production traits using profit equations. Livest. Prod. Sci., 34: 35-56. DOI: 10.1016/0301-6226(93)90034-F.

Boettcher, P.J., J.C.M. Dekkers and B.W. Kolstad, 1998. Development of an udder health index for sire selection based on somatic cell score, udder conformation and milking speed. J. Dairy Sci., 81 (4): 1157-1168. PMID: 9594405.

Brascamp, E.W., C. Smith and D.R. Guy, 1985. Derivation of economic weights from profit equation. Anim. Prod., 40: 175-180.

Fernandez-Perea, M.T. and R. Alenda Jimenez, 2004. Economic weights for a selection index in Avilena purebred beef cattle. Livest. Prod. Sci., 89 (2-3): 223-233. DOI: 10.1016/j.livprodsci.2004.01.004.

Gibson, J.P., 1989. Economic weights and index selection of milk production traits when multiple production quotas apply. Anim. Prod., 49: 171-181.

Groen, A.F., 1989a. Economic values in cattle breeding. 1 Influences of production circumstances in situations without output limitations. Livest. Prod. Sci., 22: 1-16. DOI: 10.1016/0301-6226(89)90121-8.

Groen, A.F., 1989b. Economic values in cattle breeding. Influences of production circumstances in situations with output limitations. Livest. Prod. Sci., 22: 17-30. DOI: 10.1016/0301-6226(89)90122-X.

Groen, A.F., T. Steine, J.J. Colleau, J. Pedersen, J. Pribyl and N. Reinsch, 1997. Economic values in dairy cattle breeding, with special reference to functional traits. Report of an EAAP-working group. Livest. Prod. Sci., 49 (1): 1-21. DOI: 10.1016/S0301-6226(97)00041-9.

Hazel, L.N., 1943. The genetic basis for constructing selection indexes. Genetics, 28: 476-490.

Kahi, A.K. and G. Nitter, 2004. Developing breeding schemes for pasture based dairy production systems in Kenya. Derivation of economic values using profit functions. Livest. Prod. Sci., 88: 161-177. DOI: 10.1016/j.livprodsci.2003.10.008.

Miglior, F., B.L. Muir and B.J.V. Doormaal, 2005. Slection indices in Holstein cattle of various countries. J. Dairy Sci., 88: 1255-1263. PMID: 15738259.

Meuwissen, T.H.E. and M.E. Goddard, 1997. Selection of farm animals for non linear traits and profit. Anim. Sci., 65: 1-8.

Nielsen, H.M., L.G. Christensen and A.F. Groen, 2005. Derivation of sustainable breeding goals for dairy cattle using selection index theory. J. Dairy Sci., 88 (5): 1882-1890. PMID: 15829683.

NRC (National Research Council), 2001. Nutrient Requirements of Dairy Cattle. 6th Edn. National Academy Press, Washington, DC. ISBN: 0309069971.

Ponzoni, R.W. and S. Newman, 1989. Development breeding objectives for Australian beef cattle production. Anim. Prod., 43: 545-551.

Rewe, T.O., D. Indetie, J.M. Ojango and A.K. Kahi, 2006. Economic values for production and functional traits and assessment of their influence on genetic improvement in the Boran cattle in Kenya. J. Anim. Breed Genet., 123 (1): 23-36. PMID: 16420262.

Shook, G.E., 2006. Major advances in determining appropriate selection goals. J. Dairy Sci., 89 (4):1349-1361. PMID: 16537966.

VanRaden, P.M., 2004. Invited review: Selection on net merit to improve lifetime profit. J. Dairy Sci., 87 (10): 3125-3131. PMID: 15377590.

Vargas, B., A.F. Groen, M. Herrero and J.A.M. Van Arendonk, 2002. Economic values for production and functional traits in Holstein cattle of Costa Rica. Livest. Prod. Sci., 75 (2): 101-116. DOI: 10.1016/S0301-6226(01)00305-0.

Visscher, P.M., P.J. Bowman and M.E. Goddard, 1994. Breeding objectives for pasture based dairy production systems. Livest. Prod. Sci., 40: 123-137. DOI: 10.1016/0301-6226(94)90042-6.

Wolfova, M., J. Wolf, J. Kvapilík and J. Kica, 2007. Selection for profit in cattle. Economic weights for purebred dairy cattle in the Czech Republic. J. Dairy Sci., 90: 2442-2455. PMID: 17430949.

Zhang, Y. and D. Fewson, 1992. A study on the methods for calculating marginal profits of the traits in the breeding objective for the dairy cattle in China. Chinese J. Anim. Sci., (4): 8-12.