American Journal of Applied Sciences 7 (4): 466-472, 2010
ISSN 1546-9239
© 2010Science Publications

Dairy Heifer Rearing in Hot Arid Zone: An Economic Assessment

M.A. Razzaque, S.A. Mohammed and T. Al-Mutawa
Department of Aridland Agriculture and Greenery,
Kuwait Institute for Scientific Research, P.O. Box 24885, Safat 13109, Kuwait

Abstract: Problem statement: Economic losses due to high mortality in young calves born in hot arid zone including Kuwait and a high cost of rearing are the main constraints to this region. Therefore, dairy producers have to depend on importation of pregnant heifers for herd replacement. Research data on cost of heifer rearing from their weaning to first lactation were lacking. The objectives of the present investigation were to compare the costs/benefits of raising heifers born in Kuwait without and with intervention measures and project the future financial benefits. **Approach:** Present study methods involved using cost-benefit model where without and with intervention scenarios were compared using a total of 58 herd parameters. These variables included in the spreadsheets in the model could be varied during each year of projection period. Production turnoff of 3 herds each of 245 cows in three scenarios namely baseline, improved and future were evaluated. Input costs of imported heifers (baseline), locally raised heifers with interventions (improved) and projected 10 year (future) and the income generated from these scenarios were analyzed. **Results:** Total income generated from baseline, improved and the future projection were KD 268,715/-, 281,246/-and 342,251/- respectively (1 KD Kuwaiti Dinar = US $3.45); total operating costs of these scenarios were KD 249,372/-, 242,276/-and 205,929/-respectively. Financial analyses showed that benefits were double when interventions were applied KD 19,343/-Vs KD 38,970/-in baseline and improved operation respectively. **Conclusion:** Fifty percent of the total heifers needed for herd replacement could be sourced locally showing an increased net income as an outcome of intervention measures. Locally born adapted heifers could be used for dairying in this hot arid zone with a phase-wise increase in their herd size reducing dependence on imported dairy cattle.

Key words: Dairy heifers, economic assessment, interventions, financial analysis

INTRODUCTION

Many countries of hot arid zone including Kuwait do not possess a dairy cattle breed of their own, therefore, depend on imported Holstein Friesian cattle. Imported pregnant heifers are exposed to an extreme hot arid feedlot environment. After their calving and subsequent breeding, they can last for 2-3 lactations. In Kuwait, the calves born from unadapted imported dams suffer from a very high mortality rate. Mean crude mortality rate was 43.6% in 1997 (Razzaque *et al*., 2009a). Observing the high young calf losses in Kuwait, studies were initiated in 1998 to investigate the causes of calf mortality. The management constraints and the pathogens causing the high death rates were identified. Intervention measures were undertaken in the commercial dairy farms from year 1999 through 2006 resulting in a phase-wise reduction of crude mortality rate of pre-weaned calves from mean high of 43.6% to a low of 4% (Razzaque *et al*., 2009b). Subsequent work in Kuwait involved raising of heifers from their 91d age through their breeding and lactation stages.

Published information on cost/benefit analysis of replacement heifer rearing in Kuwait and under similar hot arid zones is scanty. In addition, dairy producers in this region are hesitant to undertake the venture of heifer raising as the economic data and the cost/benefit analyses are limited. Studies conducted in Kuwait (Razzaque *et al*., 2009c) showed encouraging results with a significant reduction of calf losses and improvement in growth rate of pre-weaned Holstein-Friesian calves born from imported cows when they were housed in hutches. Improved management practices and heat detection of heifers at their first mating were found to have reduced heifer rearing cost by 40% (Heersche *et al*., 1994; Tenhagen *et al*., 2004).

Corresponding Author: M.A. Razzaque, Department of Aridland Agriculture and Greenery,
Kuwait Institute for Scientific Research, P.O. Box 24885, Safat 13109, Kuwait
Tel: +965 24989828 Fax: (965) 2498-9809

Economic analysis of heifer rearing was carried out in the Virginia Tech. Cooperative by Bailey (1999) and Ohio State University. Bailey and Currin (1999) reported economic feasibility of heifer rearing from the ages of 3-23 months. Total costs of raising heifers were on feeds, laborers and utility ranged from US $1000/-to $2000/-per heifer, representing $1.50-3.00 h^{-1} day^{-1} and a gross costs ranged from $50-60/month/head. In the USA, assessments of heifer rearing expenses were estimated by many investigators earlier (Head, 1992; Baily, 1992; Mourtis *et al*., 1997; Harash *et al*., 1998). Most of the previous analyses of the heifer growth issues had used average or estimated marginal costs to assess savings. While the costs to raise a heifer vary widely across the farms and management schemes. These costs could be partitioned into those costs that were likely to vary with faster growth rates (e.g., breeding and vaccines), costs that will change a function of growth rate (feed) and the duration of the heifer growing period (Harash *et al*., 1998). They found that feed was the most important cost factor which changed with the growth rate of heifers. As the heifers grew faster, the relative percent of feed consumption used for maintenance declined, which indicated that an accelerated growth was effective in feed cost savings.

In Kuwait, studies on feasibility of heifer rearing from weaning to breeding and calving ages are not available. Our recent economic assessment data on calf rearing from birth to the weaning at 90 days in Kuwait (Razzaque *et al*., 2009c) on biological performance of locally born heifers (Razzaque *et al*., 2009d) formed a strong basis for undertaking the present study. The objectives of this investigation were to compare the costs/benefits of replacement heifer raising in Kuwait without and with intervention measures and make projections on future financial benefits of the enterprises.

MATERIALS AND METHODS

The approach of the study involved the use of benefit-cost framework where the 'with' and 'without' interventions and projected future scenario in the whole dairy farm were compared.

Scenarios for the financial analysis: Using three herds each of 245 dairy cows, the model was used to compare three scenarios. The variables of herd performance in baseline, improved and projected future scenarios (10 year) are given in Table 1.

Table 1: Herd performance parameters

	Baseline	Improved	Future
Calving (%)			
Imported cows	95	95	95
Imported cows (years)			
3	50	50	85
4+	50	50	85
Local heifers	95	95	95
Local cows (years)			
3	50	50	85
4+	50	50	85
Mortalities (%)			
Female calves			
1 week	24	3	3
1 week to 3 months	15	1	1
3-6 months	7	2	2
Females 7-18 months	2	2	2
Local heifers 19-30 months	2	2	2
Local cows 3-4 years	3	3	3
Local cows 4-10 years	3	3	3
Imported Heifers	2	2	2
Imported cows (year)			
3	3	3	3
3-10	3	3	3
Male calves			
1 week	24	3	3
1 week to 3 months	15	1	1
3 months to 6 months	4	2	2
Males 7-18 months	1	2	2
Herd bulls	4	3	3
Culling rates (%)			
Breeders imported (year)			
3-4	50	50	25
4-5	50	50	25
5-6	100	100	25
6-7	100	100	100
7-8	100	100	100
8-9	100	100	100
9-10	100	100	100
10-11	100	100	100
Breeders local (year)			
3-4	50	50	25
4-5	50	50	25
5-6	100	100	20
6-7	100	100	50
7-8	100	100	100
8-9	100	100	100
9-10	100	100	100
10-11	100	100	100
Herd bulls	25	25	25
Replacement cows-imported (%)	100	0	0
Percentage if sales (of balance remaining)			
Female calves			
1 week	100	0	0
3 months	0	0	0
6 months	0	5	10
12 months	0	10	5
Male calves			
1 week	0	0	0
3 months	20	0	0
6 months	50	0	0
Mating			
Artificial imnsemination (local heifers only)	0	0	0
Bull joining rate (%)	5	5	5
Milk production-liters/lactation			
Imported cows (lactation)			
1st	5083	5083	6800
2nd	5383	5383	7000
3rd	5217	5217	7000
4th	5167	5167	7000
Local cows (lactation)			
1st	4083	4083	6800
2nd	4167	5383	7000
3rd	4167	5217	7000
4th	4167	5167	7000

Baseline: This was the traditional dairy cattle operation in the absence of any of the intervention measures for improvement was largely based on baseline data (Razzaque *et al*., 2009a; 2009b) and the experience with the industry-base survey. Only a small proportion of replacement animals were locally bred and for simplicity, it was assumed that all replacement dairy herds were imported in the baseline scenario.

Improved: This was an improved farm enterprise where the results and recommendations of the experimental work done in Kuwait farms and intervention measures were applied to the commercial dairy farms (Razzaque *et al*., 2009c). Because the practice of culling imported cows after an average of 2.3 lactations in Kuwait, the number of heifers that could be raised was insufficient to replace all of the imported cows because of a quick turnover of the cows by culling, but a significant inroads could be made. There was some capital expenditure involved with calf raising hutches (Razzaque *et al*., 2009d), additional accommodation for the increase in animal numbers and some equipment necessary to implement the recommended intervention measures were used based on the findings of the applied research in the dairy farms.

Future projections (10 year): A hypothetical model was used based on experience with improved dairy enterprises elsewhere in the region, which could take the industry further along the improved efficiency path in order to take full advantage of the improvements which were demonstrated in Kuwait through the applied studies (Razzaque *et al*., 2009a; 2009b; 2009c). Locally bred animals were carried through a number of lactations in the milking herd and their productivity was to be significantly improved through better breeding practices by Artificial Insemination (AI) using imported USA origin frozen semen of Holstein Friesian breed, improved nutrition, feeding and overall management of the enterprise (Razzaque *et al*., 2009b). It included some cooling of the animal shed environment during the summer season to assist in feed intake, reproduction and modest rises in milk production were also built in the model and spreadsheets.

Additional capital expenditure would be required as a result, including some evaporative coolers and feed mixing equipment.

Whole farm financial analysis: The whole farm financial results presented in this study were partial budgets containing the most important of the operating expenses, but did not include fixed costs. Such information was not fully available at that time, but this was not important when comparing three scenarios of interest only. In this situation, the fixed and other costs were common to all situations and did not change from one model/scenario to the next.

Economic model and variables of assessment: The model was developed in 1998 using spread sheets and reported earlier (Razzaque *et al*., 2009a; 2009c). The model involved a dairy herd structure analysis which took the herd numbers, production and fertility variables and projecting the possible changes in herd structure over a ten year period. A total of 58 herd performance variables were included in the spreadsheets and model, all of which could be varied for each year of the projection period (Table 2). The parameters included mortalities, calving and culling rates for a range of animal classes and ages; the age of selling for locally born progeny; provision for an increasing incidence of AI; and milk yields differentiated by age and whether the cow was imported or locally bred.

The model automatically produced a herd size with a specified number of milking cows each year, as it was important to compare farms of the same size or milk output. This aspect was important as some farms had a restriction in the farm space available for raising the progeny and could not do so without a reduction in the number of milking cows. Other farmers might decide that they did not want to increase their production of over-quota milk and may reduce cow numbers as production per cow increases, which would enable some of the progeny to be raised in a limited space situation. The model was capable of incorporating such management strategies.

Herd numbers and structures: Baseline dairy herd size in Kuwait varied considerably. However, average herd size of 245 milkers (Table 2) was common, therefore, an operation of 245 herd size was used for the financial analysis. The locally born heifers were to be introduced showing the herd management input and output of animals. An average total herd sizes were thus in the baseline, improved and projected future scenarios were 265, 464 and 460 dairy cattle (milkers and other herds), respectively (Table 2). In those cases, the locally born heifers are to be retained as replacement herd for breeding.

Costs and financial data: From the dairy herd data, it is a simple task to generate much of the required financial data over a ten year period, using unit costs per animal for feeds and veterinary medicines, as well

as income using milk production, turnoff data and unit sale prices. Other costs data such as labor, water, power, repairs and maintenance and administration costs were included.

Table 2: Dairy herd numbers and structures

	Baseline	Improved	Future
Farm size-number of milkers	245	245	245
Breeders B/f (imported) (year)			
3-4	91	44	0
4-5	44	21	0
5-6	0	0	0
6-7	0	0	0
7-8	0	0	0
8-9	0	0	0
9-10	0	0	0
Breeders B/f (locally bred) (year)			
3-4	0	47	71
4-5	0	23	51
5-6	0	0	40
6-7	0	0	19
7-8	0	0	0
8-9	0	0	0
9-10	0	0	0
Replacement heifers (local)	0	97	96
Breeders mated	136	232	277
Replacement cows (imported)	186	90	0
Less culls	179	179	89
Less deaths	8	8	7
Breeders C/f	136	136	181
Female calves	123	123	123
Less deaths	29	7	7
Less sales at 1 week	93	0	0
Less sales at 3 months	0	0	0
Less sales at 6 months	0	6	12
Females 6 months C/f	0	110	104
Females 6 months B/f	0	110	104
Less deaths	0	2	2
Less sales at 12 months	0	11	5
Available for breeding	0	97	97
Replacements	0	97	96
Non-Replacements Sold	0	0	1
Balance C/f 18 months	0	0	0
Heifers 18 months B/f	0	0	0
Less deaths	0	0	0
Available for breeding	0	0	0
Less replacements at 24 months	0	0	0
Balance sold	0	0	0
Male calves	123	123	123
Less deaths	46	7	7
Less sales at 1 week	0	0	0
Less sales at 3 months	16	0	0
Less sales at 6 months	30	0	0
Balance 6 months C/f	30	115	115
Males B/f 6 months	30	115	115
Less deaths	0	1	1
Balance sold at 12 months	30	114	114
Bulls B/f	5	8	10
Plus replacements	2	4	4
Bulls required	7	12	14
Less deaths	0	0	0
Less culls	2	3	3
Bulls C/f	5	8	10
Average number of animals	265	464	460

RESULTS

Financial and economic analyses: The main emphasis of the present study was financial analysis related to private commercial dairy producers, their costs and benefits in rearing replacement heifers in Kuwait. However, involvement of public resource input on dairy cattle production such as infrastructures (roads, water, electricity and marketing) extension services and subsidies needed to be considered. Therefore, the dairy subsector as a whole needed to be economically as well as financially viable. The results of this presented analyses of three scenarios included were herd structures, production level, commodity prices, input costs and projections of cost/benefit in an extended 10 year period. The dairy herds of all classes starting from weaned calves to milking cows of both imported and locally obtained herds are shown for three scenarios in Table 2. Number of animals differed with differences in scenarios.

Herd production and input costs: The production turn off of the dairy herd I, three scenarios are shown in Table 3 and the commodity prices i.e., milk and turnoff the herds are given in the Table 4. The data of Table 2 and 3 formed the basis for financial analysis. The prices input of the enterprise comprising of imported pregnant dairy heifers, feed cost, veterinary and labor expenses are given in Table 5. The input cost of pregnant heifers was very high (KD 620/heifer, KD 1 = US$3.45) followed by feed cost for all classes of dairy herds. The labor cost of the total herd also formed a substantial amount.

Table 3: Herd production

	Baseline	Improved	Future
Turnoff: Numbers			
Breeder culls (imported)	179	86	0
Breeder culls (local)	0	93	89
Female calves (1 week)	93	0	0
Females (months)			
3	0	0	0
6	0	6	12
12	0	11	5
Local heifers (24 months)	0	0	0
Male calves (1 week)	0	0	0
Males (months)			
3	16	0	0
6	30	0	0
12	30	114	114
Culled herd bulls	2	3	3
Total turnoff	350	312	222
Manure @ 3 m^3 $head^{-1}$ $year^{-1}$	795	139	1380
Total milk production (L)	1247561	1156787	1674386
Quota @ 70% (L)	873292	809751	1172071
Non-quota @ 20% (L)	249512	231357	334877
Direct sales @ 10% (L)	124756	115679	167439

Table 4: Prices of different commodities

Commodity prices	Baseline	Improved
Fresh milk		
Quota KD L^{-1}	0.170	0.170
Non Quota KD L^{-1}	0.140	0.140
Direct Sales KD L^{-1}	0.150	0.150
Turnoff livestock		
Breeder culls (imported)	250.000	250.000
Breeder culls (local)	250.000	250.000
Female calves (1 week)	50.000	50.000
Females (3 months)	100.000	100.000
Females (6 months)	200.000	200.000
Females (12 months)	300.000	300.000
Local heifers 24 months	350.000	350.000
Male calves 1 week	50.000	50.000
Males 3 months	100.000	100.000
Males 6 months	200.000	200.000
Males 12 months	300.000	300.000
Culled herd bulls	350.000	350.000
Manure KD m^{-3}	3.000	3.000

KD: Kuwaiti Dinar 1 KD = US $3.45 (exchange rate changeable)

Table 5: Prices of Input in Two-Scenarios

Input prices	Baseline	Improved
Imported pregnant cows KD/head	620.00	620.00
Herd bulls KD/head	470.00	470.00
Feed costs-milking cows KD/lactation	372.00	372.00
Dry cows KD/month	26.00	26.00
Female calves to 1 week	1.05	1.12
Female calves 1 week to 3 months	15.00	16.00
Females 3-6 months	35.00	39.00
Females 6-12 months	114.00	138.00
Heifers 12-15 months	76.50	94.50
Heifers 15-24 months	280.00	343.00
Male calves to 1 week	1.05	1.12
Male calves 1 week-3 months	15.00	16.00
Males 3-6 months	35.00	39.00
Males 6-12 months	114.00	138.00
Herd bulls KD $year^{-1}$	350.00	350.00
Additional veterinary expenses	0.00	0.00
Birth to weaning	0.00	19.00
Weaning to breeding	0.00	15.50
Breeding/pregnancy	0.00	10.50
Dairy and milking	0.00	6.50
Labor	14973.00	16863.00

Financial analysis: Table 6 presents the capital and operating expenses and income generation from the enterprise in three scenarios. The capital cost was not included in the baseline scenario, whereas, in both improved and future scenarios additional equipment and facilities were included incurring KD 12,778 in both. However, a substantial improvement was planned in providing cooling in the future scenario with a cost of KD 30,309/-, thus total capital cost including above equipment and facilities increased to KD 53,087/-for the future projected scenario (Table 6). The total income in three operations baseline, improved operation and future (10 years) were KD 268,715/-, 281,246 and 342,251, respectively. The total partial operating costs for these farms were KD 249,372/-, 242,276/-and 205,929/-, respectively.

Table 6: Financial analysis (amount in KD)

	Baseline	Improved	Future
Additional capital expenditure			
Koral koolers	0	0	30309.03
Feed mixer	0	0	10000.00
Animal accommodation (yards and sheds)	0	3600	3600.00
Calf Hutches and cooling	0	6713	6713.00
Milk mixer	0	180	180.00
Scales	0	1800	1800.00
Refrigeration	0	485	485.00
Total capital expenditure	0	12778	53087.00
Income			0.00
Milk sales			
Quota	148460	137658	199252.00
Direct sales	34932	32390	46883.00
Non quota	18713	17352	25116.00
Heifer subsidy @ 100 KD	0	9660	9682.00
Turnoff sales			
Breeder culls (imported)	44669	21534	0.00
Breeder culls (local)	0	23140	22153.00
Female calves 1 week	4655	0	0.00
Females 3 months	0	0	0.00
Females 6 months	0	1153	2306.00
Females 12 months	0	3220	1529.00
Local heifers 24 months	0	0	0.00
Male calves 1 week	0	0	0.00
Males 3 months	1583	0	0.00
Males 6 months	6078	0	0.00
Males 12 months	9058	34155	34155.00
Culled herd bulls	569	986	1175.00
Manure sales	2386	4173	4139.00
Total income	268715	281246	342251.00
Partial operating costs			
Purchase imported cows	115618	55726	0.00
Purchase herd bulls	900	11	15.00
Labor	14973	16863	18549.00
Feed costs			
Milking cows	89689	89693	89773.00
Dry cows	12334	6167	6179.00
Female calves to 1 week	98	133	133.00
Female calves 1 week-3 months	0	1892	1892.00
Females 3-6 months	0	4430	4317.00
Females 6-12 months	0	14963	14208.00
Heifers 12-15 months	0	9128	9150.00
Heifers 15-24 months	0	0	0.00
Male calves to 1 week	98	133	133.00
Male calves 1 week-3 months	1173	1892	1892.00
Males 3-6 months	2127	4496	4496.00
Males 6-12 months	3453	15791	15791.00
Herd bulls	2374	4065	4846.00
Additional feed-future model only			
Repairs and maintenance	2087	2087	2087.00
Veterinary supplies	1217	1217	1217.00
Additional veterinary expenses (improved)	0	7802	7808.00
Water	1361	1361	1361.00
Power	583	583	583.00
Bedding sand/straw	687	687	687.00
Administration costs	600	600	600.00
Total partial operating costs	249372	242276	205929.00
Partial operating surplus	19343	38970	136322.00

The operating surpluses were KD 19,343/-, 38,970/-and 136,322/-, respectively. The results of analyses clearly indicated financial benefits were double when interventions were applied i.e., KD 19,343 Vs KD 38,970 in baseline and improved operation.

DISCUSSION

Government supports: It was expected that the Government of Kuwait would provide continued good extension services and other direct support on input to the commercial dairy producers. However, it was revealed that the Government support to the subsector was not continuous but interrupted on input such as subsidies on feeds and health services. Therefore, the farmers were providing additional capacity in their water supplies, equipment and buildings from their own resources and/or with loan funds. Under these circumstances, a financial analysis was found to be more appropriate in this study.

Raising of heifers for replacement purposes (the "improved" model) without any changes in the milking herd structure would not result in sufficient numbers to completely replace imports. The "future" model indicates that with additional changes in the herd structure and improving performance of the milking herd, including retaining the cows in the herd for longer periods, total replacement from locally bred heifers would be possible. In that future scenarios (10 years) the operating surplus of KD 136,322 was projected (Table 6).

Calf survival: The improvement in calf survival resulted in a large increase in the number of males and females raised and sold for meat at 6-12 months (Table 6). The impact of this was shown in the previous biological and economic impact studies (Razzaque *et al*., 2009a; 2009d). Achieving a high calf survival rate was the main emphasis of Norwegian dairy producers for reducing economic losses. The Norwegian dairy achieved mean calf mortality rate of 4.6% (Gulliksen *et al*., 2009). These results were consistent with a mean pre-weaned calf mortality rate of 4.2% in Kuwait's farm where the intervention measures were implemented (Razzaque *et al*., 2009b; 2009d).

When increased calf survival was coupled with the raising of replacement heifers, the impact was demonstrated by a comparison with the baseline and improved scenarios (Table 6). Even if all the heifers were raised, the number would be insufficient to completely replace imported cows; only around 50% replacement would be possible. This was because of the traditional practice of only milking cows for an average of 2.3 lactations, selling them into the meat trade, thus resulting in a faster turnover of the milking herds than usual dairy farming operations. That seemed a wasteful practice, but prices for meat in Kuwait are such that it was profitable.

Improvement potential: There was an increase in the net income (Table 5) in the cooperating farms resulting from adoption of applied research intervention measures (Razzaque *et al*., 2009d). However, the full potential benefits of such innovation can not be realized unless similar improvements in productivity are also promoted in the rest of the herds of the entire dairy industry in Kuwait and similar climatic zone. This could be achieved through the extension work and demonstration of the improved dairy herd management technology.

Cost rearing replacement heifers: Our present studies showed that the input cost of rearing heifers born and adapted in the Kuwait was quite high. Recent studies showed locally reared and bred cows could thrive well for over 4 lactations with their 2 times more milk yield compared to imported cows (Razzaque *et al*., 2009e). Total input cost of rearing heifers from their 3-24 months age till first lactation was KD 514/heifer (US$1,749 in 2005) and the feed cost represented 84.6% of the total input cost. Moore *et al*. (2009) found that 63% of the input cost was represented by feed cost for heifer rearing of the same age group in the USA. Daily feed cost of heifer raising was about 2 times higher in Kuwait than that found in USA due to higher cost of imported feed in Kuwait.

Milk yield potential: In order to provide some indications of the likely impact, the "future" model has been presented (Table 6), which included improvements in breeding performance, nutrition, feeding practices and some cooling of the environment for the cows so that milk yields and breeding are not so adversely affected during the hot summer and humid periods in summer to autumn seasons. The impact on the operating surplus, even from a very conservative improvement in milk yields to 7,000 L per lactation/cow. It was observed that in rearing of dairy heifers for replacement purposes in the improved scenario without any changes in the milking herd structure would not result in producing sufficient numbers to completely replace the importation. The projected future (extended 10 years) will require additional capital costs, changes in herd structure, improved performance of milking herds. Thus an operating surplus was projected to be KD 136,322/- (Table 6).

CONCLUSION

The results of the economic assessments showed that reducing calf mortality and raising heifers to enter the milking herd were both profitable activities, thus a small investment on facilities and additional inputs are worth undertaking. The benefits of similar improvements on a whole herd basis are expected to be

much larger and further studies need to be undertaken to develop the technology and demonstrate the impact of intervention to the dairy industry in wider scale.

ACKNOWLEDGEMENT

Kuwait Foundation for the Advancement of Sciences (KFAS) provided partial financial grants. Authors thank dairy producers of Kuwait for providing farm facilities, dairy herds and partial financial assistance to the study. Specialized dairy economics help was provided by Mr. R.F. Woolcock of GRM International, Australia. Professional assistance of Ms. Mini Jacob, Ms. Sheeba Albert and Ms. Shalini Mathew in the laboratories and secretarial work of Ms. Shiji Thomas for the preparation of the paper are acknowledged.

REFERENCES

Bailey, T. and J. Currin, 1999. Heifer inventory and the economics of replacement rearing, Virginia cooperative extension. Virginia Tech and Virginia State University, USA, Virginia. Publication No. 404-287. http://pubs.ext.vt.edu/404/404-287/404-287.pdf

Bailey, T., 1999. Milk production evaluation in 1st lactation heifers. Virginia Regional College Veterinary Medicine.,Publication No. 404-285, Richmond, Virginia, USA. http://www.careerportals.com/cp/docs/pdf/first_lactation_heifers.pdf

Baily, T.L., 1992. Economic considerations of dairy heifers. Proceeding of the Society for Theriogenology, San Antonio, Texas, pp: 56-59.

Gulliksen, S.M., K.I. Lie, T. Loken and O. Osteras, 2009. Calf mortality in Norwegian dairy herds. J. Dairy Sci., 92: 2782-2795. http://jds.fass.org/cgi/content/abstract/92/6/2782

Harash, S., C. Wolf and E. Wittenberg, 1998. Dairy profitability and enterprise efficiency project report. Michigan State University Agricultural Economics, Staff Paper No. 2000.

Head, H.H., 1992. Heifer Performance Standards: Rearing Systems Growth Rates and Lactation. In: Large Herd Dairy Management, Van Horn, H.H. and C.I. Wilcox (Eds.). American Dairy Association II, Champaign, pp: 422-425.

Heersche, G., Nebel and R.L. Illinois, 1994. Measuring efficiency and accuracy of detecting of estrus. J. Dairy Sci., 77: 2754-2761. http://www.dairy-science.org/cgi/reprint/77/9/2754

Moore, R., J. Beiler and G. Schnitkey, 2009. The economics of heifer contracting. Ohio State University Factsheet, Animal Science, Publication No. AS-0060-00. http://ohioline.osu.edu/as-fact/0006.html

Mourtis, M.C.M., A.A. Dijkhuizen, R.B.M. Huirne and D.T. Galligan, 1997. Technical and economic models to support heifer management decisions: Basic concepts. J. Dairy Sci., 80: 1406-1415. http://jds.fass.org/cgi/reprint/80/7/1406.pdf

Razzaque, M.A., S. Abbas and M. Bedair, 2009a. Mortality of pre-weaned calves in Kuwait's dairy herds, its causes and impact of interventions. Internet J. Vet. Med., 5: 1-12.

Razzaque, M.A., S. Abbas, T. Al-Mutawa and M. Bedair, 2009b. Performance of pre-weaned calves in confined housing and open environment hutches in Kuwait. Pak. Vet. J., 29: 1-4. http://pvj.com.pk/pdf-files/29_1/1-4.pdf

Razzaque, M.A., M. Bedair, S. Abbas and T. Al-Mutawa, 2009c. Economic impact of calf mortality on dairy farms in Kuwait. Pak. Vet. J., 29: 97-101. http://www.doaj.org/doaj?func=abstract&id=429201

Razzaque, M.A., S.A. Mohammed, T. Al-Mutawa and M. Bedair, 2009d. Growth, reproduction and milk yield of Holstein Friesian heifers born and adapted in Kuwait. Pak. J. Nutr., 8: 1159-1163. http://www.pjbs.org/pjnonline/fin1312.pdf

Razzaque, M.A., S.A. Mohammed, T. Al-Mutawa and M. Bedair, 2009e. Improving performance of replacement heifers in hot arid environment under intensive management. Am. J. Anim. Vet. Sci., 4: 85-91. http://www.scipub.org/fulltext/AJAV/AJAV4485-91.pdf

Tenhagen, B.A., M. Drillich, R. Surholt and W. Heuwieser, 2004. Comparison of timed AI after synchronized ovulation to AI at Estrus: Reproductive and economic considerations. J. Dairy Sci., 87: 85-94. http://jds.fass.org/cgi/reprint/87/1/85