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Economics of Dairy Cow Feed Management Strategiesand Policy Analysis

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Abstract:
Oman traditional dairy sector recorded cow population of 382k cows required about 872k tons of Dry Mater feed per year. The raw milk production of traditional sector is low due to un-availability of formal marketing channels facilities and limited sources of local feedstuffs. The poor animal nutrition in study area caused by multiple factors associated with lack of adequate quantity and quality of feed available. The pastureland in Dhofar Region are severely degraded due to over-grazing and lack of appropriate grazing and feed management. This situation not only cause financial losses but have social, environmental and animal welfare consequences.The stochastic budgeting models examined three dairy cow feed strategiesand found existing livestock farming system and feeding cows with Rhodes Grass hay and concentrate with low yield of 10 Liter, 8 liters and 6 Liters milk production per day obtain the lowest net return with high probability of negative Net Returns (NRs) of 28.86%, 44.29% and 54.11% respectively. The risk premium price of RO 0.223 per liter is required to be paid to convince farmers to switch from low milk production of 6 Liters/day to a higher milk production of 10 Liters/day and reduce negative NRs risk within current feed management strategy. The Government support program are needed to facilitate formal market channels and risk premium of RO 0.297 per liter is calculated as amount of money to be paid to farmer to compensate facing risk of un availability of market access promotion facilities and compensate farmers to switch from 6 liters to 12 liters milk production level per day and feed cow with risk efficient feed strategy with Maize silage, Rhodes grass and concentrate. The economics, risk efficient feed management are examined and result shows feeding cow with Alfalfa forage is good strategy for high milk production cows and reduce feeding cost at low milk production level.Feeding Maize Silage and Rhodes Grass hay and concentrate is risk efficient and mitigate and manage risk at downside level if forage quality and reasonable price are maintained to livestock farmers. The formal marketing access support and improve feed management strategieswill enhance farmers' income, rural development and achieve environmental and economic sustainability.

Key words:*feeding system risk efficient;stochastic budget model;Certainty Equivalent; risk premium price;economic and environmental sustainability.*

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I. Introduction :

Sultanate of Oman is located at (15-27°) north latitude with six months summer season and six months warm winter season and low rain fall. The animal population as per year 2018 censes account for 3.479 Million and cow population is estimated of 382k which represent 11% of the total animal population. Most of the cow population are in Dhofar Region i.e. 57.8% and required 871,651 tons per year consist 28.2% of the total dry mater nutrient requirement i.e. 3.09 Million tons as per MAF statistical report (2018).

The local cow breed in Jabal area depend on grassing mounting pasturelandto feed their animal. The natural grassing area only cover three to four months of the feed requirement and contributed 50-60% of the total feed resources available in the country, Second Country Report on the State of Farm (2014). The irrigated green fodder crop provides only 20% of the total feed resources and face risk due to fodder crop re-allocated to desert to maintain underground water at costal area, Ishag K. H.M. (2015) .The commercial concentrate feed along with other supplement feed such as dates, dried sardine fish are used to feed animal as per Uta Dickhoefer (2009). The pastureland in Dhofar Region are severely degraded due to over-grazing and lack of appropriate grazing practices and feed strategy management.

Dhofari cow breed lactation curve is formed from 173 dairy herds data record at Salalah livestock Research Station during 2010 and 2014. The study shows peak yield of 9.72 kg/day, peak time 60 days 305 days milk yield of (1580) kg, Salim Bahashwan (2018). The livestock farmers at Jabal area feed their animal with Rhodes Grass forage crops, commercial concentrate, dates and dried sardines fish and only surplus and excess bulls are sold to the local market. However, this type of production system generates low profit and animal owner could not offer sufficient animal feed to his animal from his own pocket. Many farmers in this area engaged in other economic activity not related to farming to cope with forage yield and feed price fluctuation risk.

Few livestock farmers near cities practices semi-intensive production systems and sell their raw milk through hawker to informal marketing channels to cover concentrate and forage feed cost and other cost of production expenses. The informal marketing channels in the study area face a lot of problems such as insufficient roads and utilities, cold storage facilities, milking and handling raw milk equipment, and cannot extend the milk market to remote long-distance area.

The resent feasibility study of milk collection and dairy processing project in Dhofar Region performed by HYA and Hail Agriculture (2015), studied the cost of milk production and collection and recommend government subsidy of RO 0.160 for cow milk and RO 0.200 for camel milk to compensate farmers to sale their milk to milk collection center. The study recommended establishing regular formal marketing channels at Dhofar Region.

1.2 Feeding problem statement:

Dhofar Region developed very fast during last four decades and schools, utilities, roads and health services provided to region and Jabal area. The livestock population also increase due to animal health care and water points availability in the area. The vegetation area of Jabal is no longer able to provide enough grassing area to animal and overgrazing practices create a sever environmental problems. The animal owner at present used to purchase Rhodes Grass hay and commercial concentrate to feed their animal for more than ten months out of the year. As a result, animal owner spent a substantial amount of their income on paying animal feed to maintain their animal health and herd numbers. They only give minimum Rhodes Grass and concentrate feed to cope with animal feed price risk and informal market risk situation expenses.

Presently the only source of income from the herds is fattening bulls and selling meat. Selling breakeven quantity of fresh milk is difficult due to animal feed cost increase and unavailability of formal marketing channels. To cope with this situation herd owners, use to milk their cows in alternative days to keep daily milk production at minimum level.

The Government has requested to initiate Milk Collection Centers to generate regular income to cover increasing animal feed cost. The construction of Milk Collection Centers Project is started, and Government announced to fixed cow raw milk price at RO 0.250 per Liters with a government subsidy of RO 0.100 per Liter to protect Net Returns downside risk. The Government also subsidized large irrigated forage crop project at Najed Agricultural Development Project to grow Rhodes Grass which was the main forage crop used by farmers in study area and grown at more than 878 ha. The project recently initiates to grow Alfalfa crop and reduce Rhodes Grass crop area due to irrigation water shortage. Introduction of Alfalfa crop will improve integrated crop management and ensure project sustainability, but economics and feed risk efficiency of each feeding ration need to be considered by policy makers.

The economics of three feed management strategiesare examined in this study in term of economics sustainability and risk efficiency. The introduction of feed ration with Alfalfa crop and concentrate is tested and compared with Maize silage, hay and concentrate and current feeding practices. The study also investigates the economic benefit of establishing Milk Collection Centers and introduction of a formal organized marketing channels and it is effect on increasing local milk production and improving livestock farmers income sustainability.

1.3 Literature review

Investment in dairy cow farming needs a long-term investment decision with uncertain milk yield production and sale price and feeding cost. The dairy cow farming practices sustainability should ensure system ability to maintain productivity in spite of major constrains and disturbance. The Net Return and financial viability can be taken as a measurement to choose between risk alternatives, Lien G. et.al (2007). The cow feed management strategiesand marketing policy alternative is used in this study to understand dynamic nature of dairy cow farming and get the probability of positive Net Return for each feed management strategy and Government market support policy.

The dynamic simulation analysis provided a range of outcomes that can reduce the risk of revenue and inputs cost uncertainty and give more reliable results for decision maker, farmers and policy advisers. The stochastic efficiency with respect to function technique can rank alternative cow feeding management, marketing access policy over a range of risk aversion level. This technique developed by Hardaker et al. (2004a) and called stochastic efficiency with respect to a function (SERF). Gregory K. et al. (2012) used SERF to evaluate genetically modified maize in South Africa. SERF is based on the notion that ranking risky alternatives in terms of utility which is the same as ranking alternatives with certainty equivalents (CE). The certainty equivalent is defined as the sure sum with the same utility as the expected utility of the risky prospect, Hardaker et al., (2004b). Irene Tzouramani et.al (2008), (2011) used stochastic efficiency with respect to a function (SERF) to explore economic viability of conventional and organic sheep farming in Greece and found both conventional and organic sheep farming are viable.

In this study, (SERF) technique is applied to assess a set of alternative dairy cow feed management policies. SERF also used to rank and compare economic impacts of changes in the farm bill of decision maker preferences at different level of risk aversion, Richardson J. W. et al. (2008). The evaluation of two methods of feeding for the fattening of Dhofari calves is performed, Salim Bahashwan et al. (2017). Dhofari cattle growth curve is predicted by using different non-linear model, Salim Bahashwan et al. (2015). Resent study on lactation curve modeling for Dhofari cows breedshown a peak yield of 9.72 kg/day and average day yield of 5 kg/day, Salim Bahashwan (2018). The study form two scenarios and six stochastic simulation models to estimate net return distribution.The marketing data are collected from direct farmers interview. The main objective of this paper is to investigate sustainability of cow feed management strategiesand recognize the most risk efficiency one over a range of risk aversion level.

II. Methodology

2.1 Dairy Cow Business Net Return :

The calculation of dairy business profitability depends on estimation income generated from milk and other products sales and estimation cost of feed and other expenses. The net return of this business is calculated with uncertain outcome and cost given the stochastic yields, price and variable cost.Thenet return probability range with relative preference and utilities of decision makers are considered to calculate economic evaluation of different feeding strategies. The proposal of market access promotion on milk production and income sustainability is tested.

The study constructed six stochastic budgeting models to incorporate risk of uncertain variable in the model and reduce all possible risky alternatives to small number of alternatives. The Net Return for each model is calculated by identifying key parameters and variables and subtracting the variable and fixed cost from the revenue.

Simulation model is used to investigate dairy cow feeding alternatives strategies, and formal marketing channels supports policy introduced by Government and Dhofar Region. The risk management failure could be measured in financial terms of getting a negative Net Return (Hansen and Jones, 1996).

2.2 Monte Carlo SimulationModel :

The study sued Monte Carlo simulation model to evaluate the variability or stochastic of input variables in the model. The simulation model used to study the effects of key variables on the Net Return of a given feed management proposal. The process involvesidentification and assessment of the key variables. The probability density function (PDF) performed for each key variable to fit a best describes range of uncertainty around the expected value of NRs.

The model including variables is calculated using randomlygenerated input values taken from the underlying probabilistic distribution function. The model combines revenue and cost inputs to generate an estimated outcome value for (NR) and process is repeated (ten thousand times). Monte Carlo simulation model is used to evaluate goat farming strategies risk efficiency and sustainability in Oman, Ishag Kheiry (2016). The study used @Risk 8.0 from (Palisade Corporation, Ithaca, New York) and Simetar Programs to calculate the stochastic nature of key variables in the simulation model. The first scenario represents present livestock farmers situation with informal marketing channels and current feeding cost (Rhodes Grass and concentrate) and low milk production level. The local Dhofari cow breed average milk yield is 6.9 Liter, Second Country Report on the State of Farm (2014). The main parameters and feeding cost used in six models are presented in Table (1).The second scenarios models represent Government market promotion support and Alfalfa forage crop feed ratio. Six models parameters presented in Table (2).

Table (1) : Dairy cow low feeding cost strategiesand milk production with informal market promotion :

Variable	**Formal Market Access Promotion**			**Informal Market Access Situation**		
	LF20 (1)	**LF15 (2)**	**LF12 (3)**	**LF10 (4)**	**LF8 (5)**	**LF6 (6)**
Milk Production Litr	20	15	12	10	8	6
Alfalfa/kg	-	-	-	-	-	-
Rhodes Hay/kg	5	5	5	8	6	7.5
Maize Silage/kg	5	3	3	-	-	-
Concentrate/kg	5.67	5.60	5.94	3.03	3.32	4.87
Feeding Cost RO	1.489	1.364	1.406	1.160	1.000	1.341

Table (2) : Dairy cow high feeding cost strategies and milk production with formal marketing promotion :

Variable	**Maize Silage and Rhodes Grass Forage**			**Alfalfa and Rhodes Grass Forage**		
	LF20 (1)	**LF15 (2)**	**LF12 (3)**	**HF20 (4)**	**HF15 (5)**	**HF12 (6)**
Milk Production Litr	20	15	12	20	15	12
Alfalfa/kg	-	-	-	3	1	1
Rhodes Hay/kg	5	5	5	6	6	6
Maize Silage/kg	5	3	3	-	-	-
Concentrate/kg	5.67	5.60	5.94	3.58	4.78	4.95
Feeding Cost RO	1.489	1.364	1.406	1.501	1.340	1.360

2.3 Research Data Collection

The study collected data to perform dairy cow stochastic budget analysis for alternatives feeding risk management strategies. The operational data for each group performance parameters such as milk yield, feeding cost and other expenses for each model were collected from Dhofar Cattle Feed enterprise dairy farm data record and livestock farmers survey. Following Salim Bahashwan et al. (2017), (2018) and Shaver (2013), the data was supplemented with information from the literature and expert knowledge at MAF. Economic budget data and forage nutrient content data are collected and used to form alternative feed strategy models.

The modeling process began by defining dairy cow feed management strategies and inputs parameters effecting business income and net return. The other operational cost such as AI, vaccination and medicine cost, labour cost, deprecation, finance cost and utility cost were obtained and recorded for each model.

Market data such as raw milk price and other income revenue, payment method and other marketing cost for each model were collected from market and livestock farmers. The study used simulation model analysis to identified stochastic variables to be incorporated in the model such as input cost, yields, and output prices. The probability distributions of each uncertain input variables identified and normal distribution is used to estimate Cumulative Distribution Function (CDF) of group output (NR) for each group performance model.

The Stochastic Efficiency with Respect to a Function (SERF) analysis performed to evaluate different dairy cow feed strategiesand calculate Certainty Equivalent (CEs) and rank alternatives feed management strategies according to risk-efficient at different risk aversion level. The risk premium factor calculated through Certainty Equivalent (CEs) value to estimate amount of money need to be paid to livestock farmers for policy application and implementation.

2.4Stochastic Budget Model Structure

Stochastic budgeting model structure in this study aim to evaluate two main policies and represented in two scenarios. The first scenario models represent dairy cow feeding strategy in term of feed cost risks management strategy and it is effect on margin risk. The qualitative risk analysis in this study is used to understandcow feeding risk management strategies for each group. The first scenario models also represent the effect of introduction and organizing formal marketing channels to the area through building Milk Collection Centers and government raw milk price support which announced recently by Regional Government.

The models in the first scenario are named by forage quality and milk yield obtained for each group (LF20 = Low forage quality 20 Liters/day). The dairy cow milk yield 20 liters, 15 liters and 12 liters per day are considered to represent yield can be obtain with new formal market channels facilities, whereas dairy cow yield of 10 liters, 8 liters and 6 liters per day represent present milk production level within informal market channels.

The second scenario models represent the effect of introduction of new Alfalfa forage crop which introduced recently to the area as high forage quality crop in comparison with Maize Silage and Rhodes Grass forage crop which has been used as a main source of energy and protein in the area since long time. The study investigate economic sustainability for Government policies announced recently to support livestock farmers income and improve dairy business bottom line and mitigate margin risk. The models in the second scenario are named by forge quality and milk yield obtained for each group (HF20 = high forage quality 20 Liters/day), (HF15 = High forage quality 15 Liters/day). The high forage quality models represent Alfalfa crop, Rhodes Grass hay and concentrate. Whereas, low forage quality models represent Maize Silage, Rhodes Grass hay and concentrate.

The study simulation model equation and parameters :

$$N\tilde{R} = (\tilde{Y}a*\tilde{P}a + Yb*\tilde{P}b + \ldots) - FC - V\tilde{C}$$

Where :

$N\tilde{R}$ Probability distribution for dairy cow net return.

$\tilde{Y}a$Stochastic yield for raw milk yield.

˜PaStochastic raw milk price.
Ybnumber of bulls sold as meat.
˜Pb Stochastic price for meat.
FC Fixed operation cost (Labour, medicine, housing, depreciation, interest, ..…)
V˜C Stochastic operation variable cost (forage crop alfalfa , maize silage and Rhodes grass hay, concentrate,..).

2.5 Stochastic Efficiency with Respect to Function (SERF)

A stochastic dominance analysis performed by using new ranking method to compare the Net Return for two scenarios and six models for each scenario. Stochastic efficiency with respect to a function (SERF) is used to rank the risk-efficient feed management strategies alternatives simultaneously at different risk aversion preferences. The study also calculated risk premium by subtracting Certainty Equivalent (CE) for less preferred dairy cow feeding alternative from dominant alternative. The main hypothesis of SERF is that the decision-maker would be risk averse enough to accept a sure lower expected net return value versus a high unsure expected NR. Given a utility function u(.), a random wealth variable X, and an initial level of wealth w0, the certainty equivalent equation used in the models is :

$$CE = u^{-1}\{E[u(X + w0)]\} - w0,$$

The risk premium measure the minimum amount of money needs to be paid to decision maker to justify a switch from feed management strategy to other less risky alternative. The model simulated the costs and returns for keeping and maintaining dairy cow under different feed strategy. The Net Return is calculated and probability distributions generated by the simulation model. The model used to rank the best alternative policy across a full range of ARACs.The study finally performed CE analysis to estimate premium price should be given to livestock farmers to keep their dairy cow business at a less risky operation at specific risk aversion level and manage resources sustainable manner.

III. Result and Discussion

3.1 Cow Feed Management and Net Return Simulation Analysis

The net return stochastic budgeting simulation analysis for the first scenario models shows that feeding cow with maize silage, hay and concentrate and achieve 20 Liters milk production per day model LF20 (1) obtained the highest net return per cow, followed by model LF15 (2) and model LF12 (3). The existing livestock farming system and feeding cows with Rhodes Grass hay and concentrate with yield of 10 Liter, 8 liters and 6 Liters milk production per day got the lowest net return with high probability of negative NR i.e. 28.86% for model LF10 (4), 44.29% for model LF8 (5) and 54.11% for model LF6 (6).

The analysis shows that the formal market access promotion program announced and supported by Government will encourage livestock farmers to feed cows with new maize silage feed and hay to increase milk production level. Formal market access facilities such as Milk Collection Center and milk price subsidy will improve farmers net returns and reduce probability of negative NR to 15.0% for cow milk yield of 12 liters/day as presented in table (3).

Table (3) : First Scenario Models Revenue, Cost of Production and Net Return Statistics Result - Rial Omani :

Variable	**Formal Market Access Promotion**			**Informal Market Access Situation**		
	LF20 (1)	**LF15 (2)**	**LF12 (3)**	**LF10 (4)**	**LF8 (5)**	**LF6 (6)**
Milk Production Litr	20	15	12	10	8	6
Revenue RO	5.217	3.967	3.217	2.717	2.217	1.717
Feeding Cost RO	1.489	1.364	1.406	1.160	1.000	1.341
Total cost RO	1.999	1.874	1.916	1.670	1.510	1.851
Net Return Mean RO	3.412	2.361	1.626	0.729	0.204	-0.162
Probability of Negative NR	11.82%	9.82%	15.00%	28.86%	44.29%	54.11%
St Dev	2.609	1.866	1.733	1.228	1.308	1.383
CV	76.45	79.03	106.59	168.38	639.63	-855.39
Skewness	0.0109	-0.0069	0.00518	0.0161	0.0145	0.0363
Kurtosis	2.950	2.965	3.0135	2.988	2.976	3.0617
Min	-3.78	-3.27	-2.69	-3.42	-4.29	-4.58
Max	10.91	7.81	6.80	4.37	5.27	3.80

Stochastic budget models analysis for second scenario shows that feeding cow with Alfalfa forage crop and Rhodes Grass hay and concentrate will reduce feeding cost and improve current farmers NRs from RO

0.729 to RO 1.626 at medium and low milk production level and manage risk at upside level as showed in figure (1).

The probability of negative NR for feeding cow Alfalfa are relatively high compared to Maize silage, Rhodes Grass hay and concentrate at all production levels due to high Alfalfa price. The expected negative NRs of Alfalfa feed is higher by 9.71% than Maize silage feed at 12 litrs/day milk production level, and by 3.99% at 20 Lite/day.The variance parameters such as minimum, maximum, Standard deviation (St Dev) and confidence of variation (CV) figures for Alfalfa forage crop feeding models are greater than Maize silage feeding models as shown in table (4).

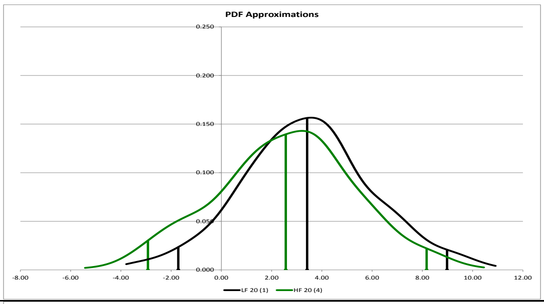
Table (4): Second Scenario Models Revenue, Cost of Production and Net Return Statistics Result - Rial Omani :

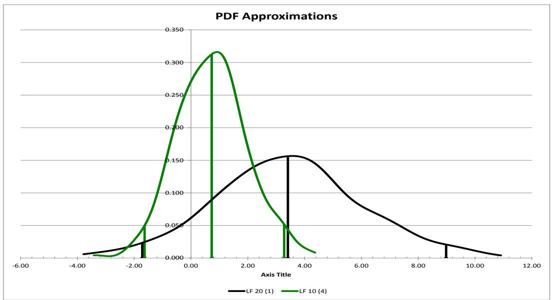
Variable	Maize Silage and Rhodes Grass Forage			Alfalfa and Rhodes Grass Forage		
	LF20 (1)	**LF15 (2)**	**LF12 (3)**	**HF20 (4)**	**HF15 (5)**	**HF12 (6)**
Milk Production Liter	20	15	12	20	15	12
Revenue RO	5.217	3.967	3.217	5.217	3.967	3.217
Feeding Cost RO	1.489	1.364	1.406	1.501	1.340	1.360
Total cost RO	1.999	1.874	1.916	2.011	1.850	1.870
Net Return Mean RO	3.412	2.361	1.626	2.563	1.978	1.169
Probability of Negative NR	11.82%	9.82%	15.00%	15.81%	15.93%	24.71%
St Dev	2.609	1.866	1.733	2.768	1.923	1.692
CV	76.45	79.03	106.59	107.99	97.23	144.75
Skewness	0.0109	-0.0069	0.00518	0.0091	-0.0067	0.0258
Kurtosis	2.950	2.965	3.0135	2.959	3.0376	2.963
Min	-3.78	-3.27	-2.69	-5.42	-3.35	-4.29
Max	10.91	7.81	6.80	10.45	8.25	7.69

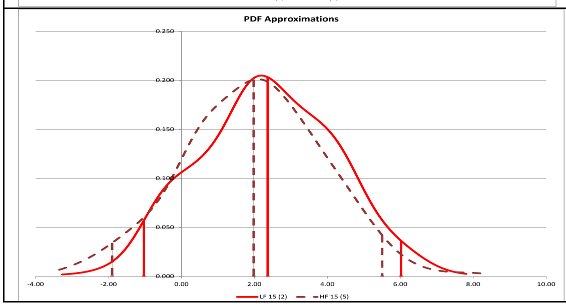
3.2 Probability Density Function and Risk Assessment of Dairy Cow Milk Production Systems

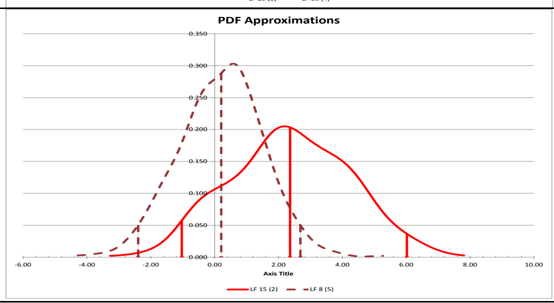
The current low milk production level and feed management strategy represented in the study by Model LF10(4), Model LF8(5)and Model LF6(6). The analysis showed a negative mean NR value for Model LF6(6) and low positive NR for the other two models. The cow feed cost is the most important elements of production cost and represent about 72% of the total cost of production. Recently, the study area faces a significant risk of price fluctuation and price increase for forage crop and milk production at large commercial enterprise are affected.

Maize Silage Feed and Alfalfa Forage Feed Strategy	Formal and Unformal Market Access Promotion









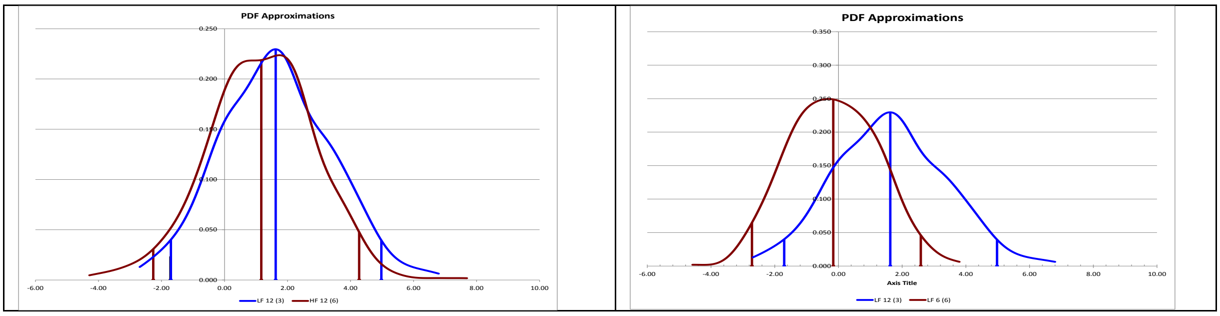


Figure (1) : Comparison of 6 PDF for NRs of Cow Feed Management and Marketing Access Promotion.

The study examined introduction of Alfalfa crop in the feed ration to maximize forage quality used in the rations, high fiber contend in Alfalfa will increase intake to the maximum limit to realize potential milk production. Probability density function analysis performed to understand business risk at downside and upside level. The feed management scenario shows feeding cow with Alfalfa forage is good strategy for high milk production level and reduce feeding cost for low milk production level of 15 and 12 Liters per day. Feeding maize silage and Rhodes Grass hay and concentrate mitigate and manage risk at downside level, whereas Alfalfa, grass hay and concentrate managed risk at upside production level and support high yield milk production systems as shows in figure (1).

The Government market promotion program increase NRs mean yield production for high yield level, but at the same time increase NRs mean variance at high milk production level i.e. 20 Lit/day, and manage risk at downside level for milk yield below 12 Lits/day as shown in figure (1). The study confirmed availability of market support programs and adequate supply of forage crops at economic price are the main constrains for dairy business improvement and development at study area.Increasing milk production through changing feed management strategy alone without addressing formal market access promotion program, will not be a good decision, especially if we know that average herd size is 39 cows per farmer and marketing breakeven production will be difficult for local farmers to achieve.

3.3Dairy Net Return and Cumulated Distribution Function Analysis

The study test cow feed management strategiessustainability through forming Cumulated Distribution Function CDF graphs to illustrate the range and probabilities of net return value for different alternatives cow feed management. Due to CDF lines cross in the graph we could not ranked feed managements according to their sustainability by using first degree stochastic dominance. As a result, Stochastic Efficiency with Respect to a Function (SERF) is used to obtain a better ranking analysis. The analysis reviles that market access models i.e. Model LF20 (1), Model LF15 (2) and Model LF12 (3) are risk efficient as its distribution lineslocated on the right and preferred to those on left lines models which represent current feed management and low milk production level, as shown by Figure (2).

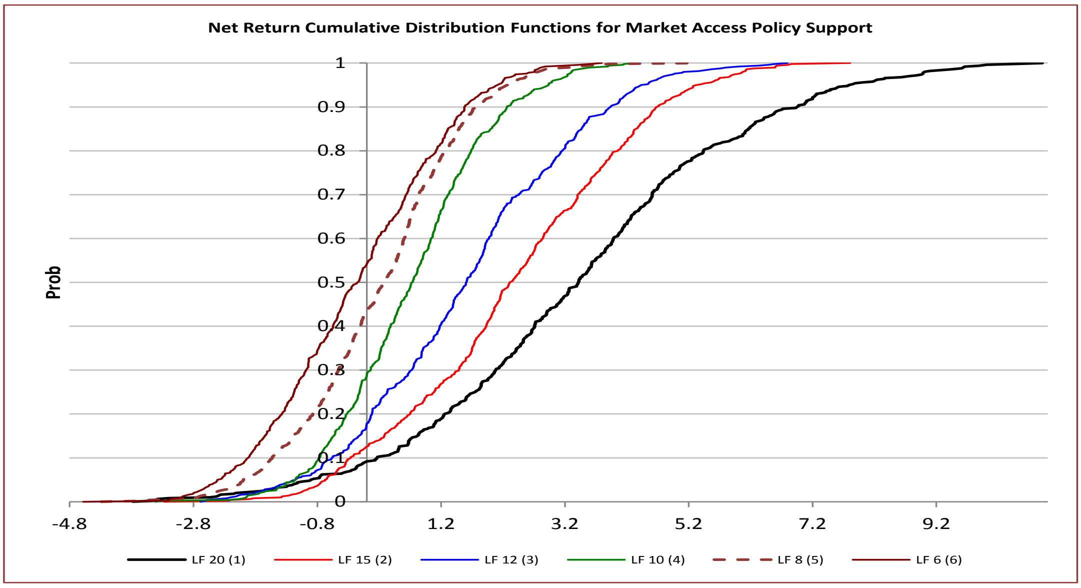


Figure (2) : Comparison of 6 CDF for NRs of Dairy Cow Production Level and Marketing Access Promotion.

3.4 Certainly Equivalent and SERF Analysis

The study used SERF method to calculate Certainly Equivalent CE values for each alternative feed management over a range of Absolute Risk Aversion Coefficients (ARACs). The absolute risk aversion coefficient (ARAC) represents a decision maker's degree of risk aversion. Decision makers are risk averse if ARAC > 0, risk neutral if ARAC = 0, and risk preferring if ARAC < 0. The ARAC values used in this analysis ranged from (0.000) represent risk neutral to (0.0035) represent normal risk averse. Many studies normalized range of (ARAC) with wealth. The average NRs in study was R. O. 2.180 and accordingly (ARAC) ranged between 0.000 to 0.00350. The market access models, Model LF20 (1) obtained high CE values of RO 3.413 followed by Model LF15 (2) of RO 2.362, whereas low milk yield with 10 and 8 Liters per day obtain lower CE figures RO 0.732 and R.O. 0.206 respectively at risk neutral level.

Table (5): Ranking Dairy Cows Feeding Strategies and Formal Market Access Promotion by CE of Net Profit :

Risk	Risk Neutral		Slight Risk		Normal Risk	
ARAC	0.000		0.0015		0.00350	
Rank	Model	CE	Model	CE	Model	CE
1	LF20 (1)	3.413	LF20 (1)	3.408	LF20 (1)	3.401
2	LF15 (2)	2.362	LF15 (2)	2.359	LF15 (2)	2.355
3	LF12 (3)	1.620	LF12 (3)	1.618	LF12 (3)	1.615
4	LF10 (4)	0.732	LF10 (4)	0.731	LF11 (4)	0.730
5	LF8 (5)	0.206	LF8 (5)	0.205	LF8 (5)	0.203
6	LF6 (6)	-0.159	LF6 (6)	-0.160	LF6 (6)	-0.162

The analysis shows giving formal market access promotion and feeding cow with maize silage, Rhodes Grass hay and concentrate are the most risk efficient management at all (ARAC) level and need to be followed to achieve economic sustainability as shown in Table (5). The maize silage feeding techniques is practices only at commercial dairy farms.

Farmers group feeding cow with Rhodes hay and concentrate without market access promotion support obtain lower CE figures. The analysis reveals that Model LF6 (6) are less risk efficient alternative and got a negative CE values at all (ARAC) level as shown by Figure (3).The risk premium price of RO 0.297 per liter is the amount of money to be paid to farmer to compensate risk facing unavailability of market access facilities and compensate farmers to switch from 6 liters/day to 12 liters/day production level and feed their cow with maize silage, Rhodes grass and concentrate.

The risk premium price of RO 0.223 per liter need to be paid to convince farmers to switch from low milk production (6 Liters/day) to a higher milk production (10 Liters/day) within current market facility and feed management strategy. Few farmers in study area are currently selling 4 Liters/day for RO 30 per month through hawkers.

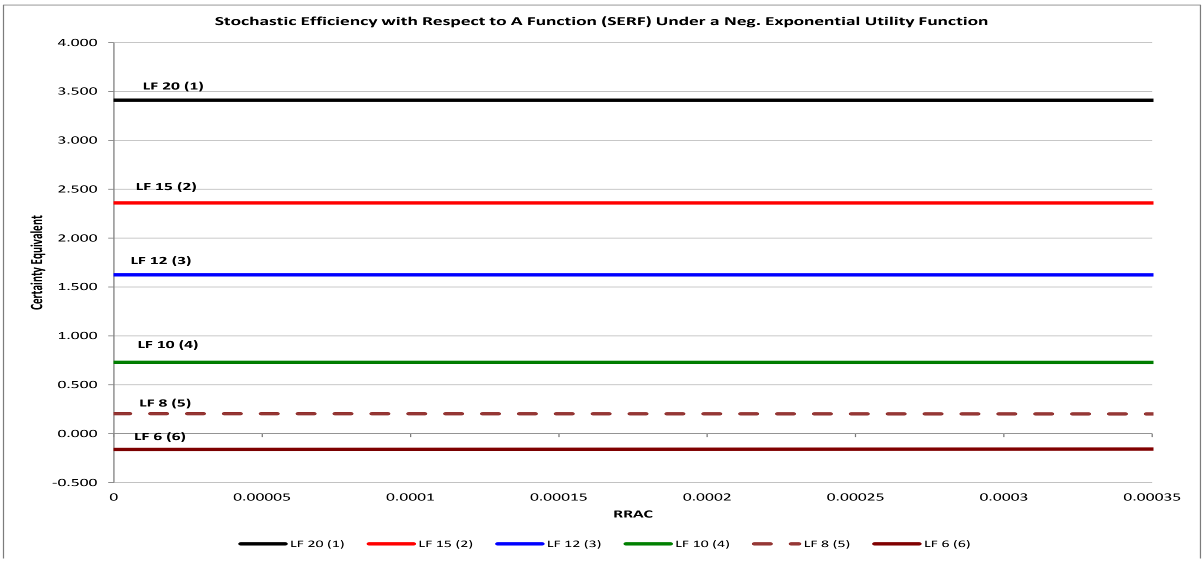


Figure (3) : Stochastic Efficiency with Respect to Function for Alternative Feed Cost and Market Availability Models.

3.5 Target Economic Viability of Dairy Cow feed strategies

The Stoplight function in (Simetar Program 2013) used to test probability of achieving target NRs value and economic viability of dairy production system and feed management strategies. Stoplight analysis used in this study as good tool for ranking feed management strategiesand market access promotion policy. The analysis indicated probability of getting target Net Return per day for two target values i.e. (less than RO 1.5 and greater than RO 3.5). Assuming each feeding practices has risk-averse preferences, the optimal scenario is the one which has the highest probability of getting target net return. The probability of achieving RO 3.500 Net Return per cow/day is presented in green colour, whereas, probability of getting Net Return of RO 1,500 and lower is denoted in red colour. Livestock farmers achieving NR between RO 1.500 and 3.500 is denoted in yellow, as shown in Figure (4).

Formal marketing access promotion scenario i.e. Model LF20 (1), Model LF15 (2) and Model LF12 (3) got NR of RO 3.500 or more with a probability of 48%, 29% and 14% respectively. The present cow milk production level without market access promotion support got low NR below RO 1.500 with a probability of 75%, 85% and 88%.

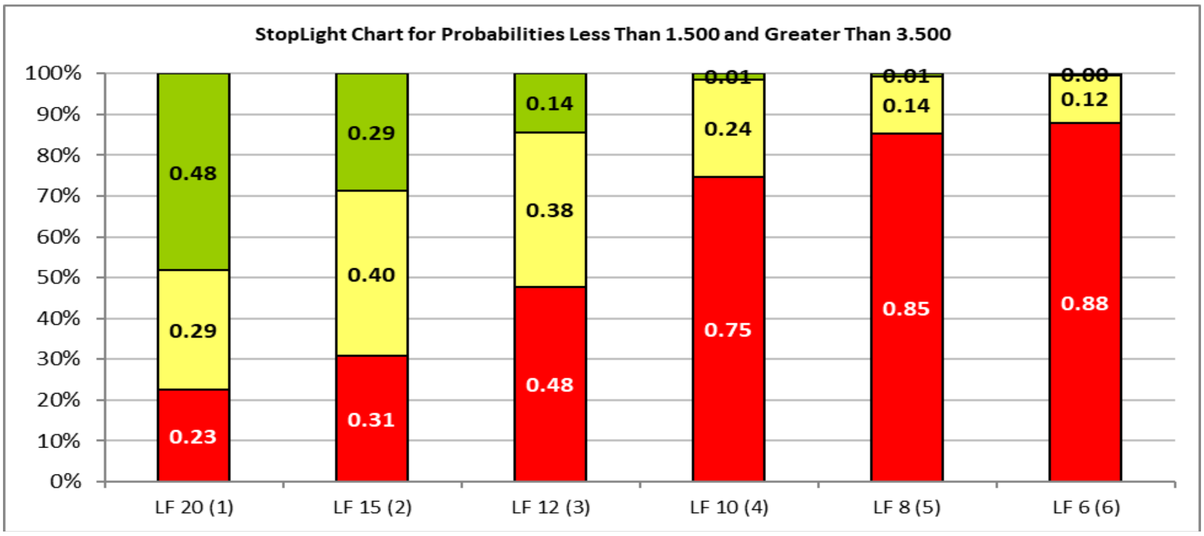


Figure (4) : Stoplight Analysis of 6 NRs of Milk ProductionSystem and Marketing Access Promotion Scenarios.

IV. Research Conclusion

Oman traditional cow breed sector required about 605k tons of dry mater feed per year. The raw milk production of traditional sector is low due to un-availability of formal marketing channels facilities and limited sources of local feedstuffs. The poor animal nutrition in study area caused by multiple factors associated with lack of adequate quantity and quality of feed. Moreover, Government issued regulations asking farmers to restrict animals grazing to their farms area, hence the major dairy production system with high animal population density and small area available for grazing during Kharif season created constrain for dairy sector improvement. The excessive use of pastureland in Dhofar Region cause a severely degraded due to over-grazing and lack of appropriate grazing management.

The problem of lack of feed and knowledge of appropriate feeding techniques has therefore been aggravated by environmental change where animals depend on feed resources from outside the farm. The quality of commercial concentrate feedstuffs is adequate and used to supplement Rhodes Grass forage diet. The animal feed diet currently used to feed animal are poor due to lack of forage crop and quality control issue of the irrigated forage production.

Livestock farmers net return stochastic budget simulation analysis are performed to test feeding risk efficient strategiesand to calculate CE and the risk premium price. The risk premium price of RO 0.223 per liter is required to be paid to convince farmers to switch from low milk production of 6 Liters/day to a higher milk production of 10 Liters/day and reduce probability of negative NR from 54% to 29% within current market facility and feed management strategy.Few farmers near cities are currently selling 4 Liters/day for RO 30 per month through hawkers.

The Government support program are needed to facilitate formal market channels and risk premium of RO 0.297 per liter is calculated as amount of money to be paid to farmer to face risk of un availability of market access promotion facilities and compensate farmers to switch from 6 liters milk production level to 12 liters production level per day and introduce Maize silage feed to their current cowsfeeding program. The market support program increase NR mean,but also increase variance and risk at high yield level. The Government marketing support program reduce variance and mitigate risk at downside level for milk yield group below 15 Lites per day, as shown in Figure (1). Quota program could be used to manipulate variance risk above this level.

The impact of three feeding strategies on net return in term of risk efficiency and economic sustainability are tested. The current feeding practices with Rhodes grass and concentrate, compared with maize silage, grass hay and concentrate as second strategy and Alfalfa, grass hay and concentrate as third feed strategy. The economics and risk efficiency of introduction of Alfalfa crop in the feed ration are examined and result shows feeding cow with Alfalfa forage is good strategy for high milk production level and reduce feeding cost at lower milk production level of 15 and 12 Liters per day and managed risk at upside level. Feeding maize silage and Rhodes Grass hay and concentrate is risk efficient and mitigate and manage risk at downside level. Implementing formal marketing access support program and fixing feed risk efficient strategy will maintain positive net return and achieve social, environmental and animal welfare improvement.

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Competing interests

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References

[1]. Bahashwan S, Alrawas A S, Alfadli S and Johnson E S, 2015.Dhofari cattle growth curve prediction by different non-linear model functions. Livestock Research for Rural Development. Volume 27, Article #236. http://www.lrrd.org/lrrd27/12/baha27236.html

[2]. Bahashwan, Salim,2017.Evaluation of two methods of fattening Dhofari calves. International Journal of Scientific Research in Agricultural Sciences. DO - 10.12983/ijsras-2017-p0019-0022

[3]. Gerhard Veldink,2015. Techno-Economic Feasibility Study on Milk collection and Processing Project in Dhofar Region. Hail Agriculture, HYA, UAE.

[4]. Hansen J.W., Jones J.W. ,1996. A systems framework for characterizing farm sustainability, Agr. Syst. 51, 185–201.

[5]. Hardaker J. B., Richardson J. W., Lien G, Schumann K D., 2004a. Stochastic efficiency analysis with risk aversion bounds : a simplified approach. Australian Journal of Agricultural and Resource Economics 48:253-270.

[6]. Hardaker, J. B., R. B. M. Huirne, J. R. Anderson, and G. Lien. ,2004. Coping with Risk in Agriculture. Centre for Agricultural Bioscience International (CABI), Wallingford, UK.

[7]. Irene Tzouramani; PavlosKaranikolas; George Alexopoulos; Alexandra Sintori and Angelos E. Liontakis, 2008.Modelling Economic Alternatives for Tobacco Producers : The Case of Sheep Farming , No 6695, 107th Seminar, January 30-February 1, 2008, Sevilla, Spain, European Association of Agricultural Economists.

[8]. Irene Tzouramani, Alexandra Sintori, AngelosLiontakis, PavlosKaranikolas, George Alexopoulos, 2011. An assessment of the economic performance of organic dairy sheep farming in Greece. J. Livestock Science 141 (2011) 136–142.

[9]. Ishag Kheiry, 2016. Economic Performance of Goat Breeds Farming Sustainability and Policy Analysis, VL - Volume 9, IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS. DO - 10.9790/2380-0909022735.

[10]. Ishag, K.H.M. Fodder crop re-allocation sustainability and risk efficiency. Agric Econ 3, 15 (2015). https://doi.org/10.1186/s40100-015-0033-6

[11]. Lien G., Hardaker J. B. and Flaten O. ,2007. Risk and economic sustainability of crop farming systems. J. Agricultural Systems, volume 94, issue 2:541-552. DOI: 10.1016/j.agsy.2007.01.006.

[12]. MAF Ministry of Agriculture and Fisheries Report, 2014. Second Country Report on the State of Farm.http://www.fao.org/3/i4787e/i4787e120b.pdf

[13]. Regier, G.K., Dalton, T.J., & Williams, J.R. ,2013. Impact of genetically modified maize on smallholder risk in South Africa. AgBioForum, 15(3), 328-336. http://www.agbioforum.org.

[14]. Richardson, James, Outlaw, J. , 2008. Ranking risky alternatives: innovations in subjective utility analysis. DO - 10.2495/RISK080231

[15]. Salim Bahashwan, 2018. Lactation Curve Modeling for Dhofari Cows Breed. Asian Journal of Animal and Veterinary Advances, Volume 13, Issue 3 : 226-231. DOI: 10.3923/ajava.2018.226.231.

[16]. Shaver R. D., 2013. Feeding Strategies When Forage Supplies Are Short. University of Wisconsin. www.fyi.extension.wisc.edu/forag/short. Accessed April 2013.

[17]. Uta Dickhoefer, 2009. Social and economic aspects of crop and livestock husbandry, and development of sustainable management options for Al Jabal al Akhdar oases agriculture in Oman, Ph.D. Dissertation, College of Agriculture and Marine Science, Sultan Qaboos University, Muscat, Oman.

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