

Economics of Dairy Cow Feed Risk Management Strategies and Policy Analysis

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Research

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Abstract

Background : 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.

Result : The stochastic budgeting models examined three dairy cow feed strategies and 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.

Conclusion : 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 risk management strategies will enhance farmers' income, rural development and achieve environmental and economic sustainability.

1. Background

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

The traditional local cow breed in Jabal area depend on grassing mounting pastureland to 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, The State of Animal Genetic Resources in Oman (2014). The green fodder crop provides only 20% of the total feed resources .The commercial concentrate feed along with other supplement feed such as dates, dried sardine fish are used to feed animal as per Eva Schlecht et al. (2009). The pastureland in Dhofar Region are severely degraded due to over-grazing and lack of appropriate grazing and feed 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 a very 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 government jobs and 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 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 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 NRs 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 initiate to grow Alfalfa crop and reduce Rhodes Grass crop area due to irrigation water shortage. The introduction of Alfalfa crop will improve integrated crop management and insure economic sustainability to the project, but economic and risk efficiency of each feeding ration need to be considered.

The economics of three feed management strategies are 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 insure 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 risk management strategies and 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 risk 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 breed shown 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 risk management strategies and recognize the most risk efficiency one over a range of risk aversion level.

2. Methodology

2.1 Net Return

The evaluation of dairy cow farming profitability depends on estimation income generated from raw milk and other products sales and cost values 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. The probability range of net return 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.

Six stochastic simulation models were used 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.

2.2 Monte Carlo Simulation

Monte Carlo simulation model is designed to evaluate the variability or stochastic of input variables in the model. It can be used to study the effects of key variables on the Net Return of a given proposal. The process involves identification and assessment of the key variables. For each key variable, we fit a probability density function that best describes the range of uncertainty around the expected value.

The model including variables is calculated using randomly generated input values taken from the underlying probabilistic distribution function. The computer model combines these 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 systems risk efficiency and sustainability in Oman, Kheiry (2016). The study used @Risk 8.0 from (Palisade Corporation, Ithaca, New York) and Simetar Program 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, The State of Animal Genetic Resources in Oman (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 strategies and 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 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 Data collection

Data collected 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 risk management strategies and inputs parameters effecting business income and net return. The other operational cost such as AI, vaccination and medicine cost, labour cost, depreciation, finance cost and utility cost were obtained and recorded for each model.

Market information such as raw milk price and other income revenue, milk production level, payment method and other marketing cost for each model were collected from market. The study used Monte Carlo Simulation analysis to identified stochastic variables to be incorporated in the model such as yields, input cost, and output prices. The study also identified the probability distributions of the risky uncertain input variables and normal distribution is used to estimate Cumulative Distribution Function (CDF) of the output (NR) for each model.

The study also performed Stochastic Efficiency with Respect to a Function (SERF) analysis to evaluate different dairy cow feed strategies and generates Certainty Equivalent (CEs) to rank alternatives according to risk-efficient within different risk aversion level. The Certainty Equivalent (CEs) value used to calculate risk premium need to be paid to livestock farmers for policy evaluation.

2.4 Model Structure

The stochastic budgeting model structure in this study aim to understand the two main points. 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 is used to provide a high level of understanding of each cow feeding risk management strategies. The scenario models 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 simulation model is presented below :

$$\tilde{N}R = (\tilde{Y}_a * \tilde{P}_a + Y_b * \tilde{P}_b + \dots) - FC - V\tilde{C}$$

Where :

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

\tilde{Y}_a Stochastic yield for raw milk yield.

\tilde{P}_a Stochastic raw milk price.

Y_b number of bulls sold as meat.

\tilde{P}_b Stochastic price for meat.

FC Fixed operation cost (Labour, medicine, housing, depreciation, interest,

$V\tilde{C}$ Stochastic operation variable cost (forage crop alfalfa, maize silage and Rhodes grass hay, concentrate,

2.5 Stochastic Efficiency with Respect to a Function (SERF)

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).

A stochastic efficiency model performed 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 risky alternatives simultaneously with different risk aversion preferences. Risk Premium is also calculated by subtracting CE Certainty equivalent for less preferred dairy cow feeding alternative from dominant alternative. Given a utility function $u(0)$, a random wealth variable X , and an initial level of wealth w_0 , the certainty equivalent equation used in the models is :

$$CE = u^{-1}\{E[u(X + w_0)]\} - w_0,$$

The risk premium measure the minimum amount of money needs to be paid to decision maker to justify a switch from present 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 RACs. 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 farming system and utilize farm resources in a sustainable manner.

3. Result And Discussion

3.1 Cost of Production 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 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 Maize Silage and hay to increase milk production level. Formal market access facilities and Milk Collection Center facilities 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 for second scenario analysis shows that feeding cow with Alfalfa forage crop and Rhodes Grass hay and concentrate will reduce feeding cost and improve the current farmers net return from RO (0.729) to RO (1.626) at medium and low milk production level.

The probability of negative NR for feeding Alfalfa are high compared to Maize silage, Rhodes Grass hay and concentrate due to high Alfalfa price. The 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 Net return and Cumulated Distribution Function Analysis

To test dairy cow feed risk management strategies sustainability the Cumulated Distribution Function CDF graphs performed 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, and Stochastic Efficiency with respect to a Function (SERF) is used to have a better ranking analysis. The analysis indicates that market access models i.e. Model LF20 (1), Model LF15 (2) and Model LF12 (3) are risk efficient as its distribution lines located on the right and preferred to those on the left lines models which represent traditional cow feed management and low milk production level, as shown by Figure (1).

3.3 SERF Analysis and Certainly Equivalent

The SERF method used to calculate Certainly Equivalent CE values over a range of absolute risk aversion coefficients (ARACs). The 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. 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 Liters per day obtain lower CE figures RO 0.732.

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

Risk	Risk Neutral		Slight Risk		Normal Risk	
Rank	Model	CE	Model	CE	Model	CE
ARAC		0.000		0.0015		0.00350
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 management efficient 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 (2). The risk premium price of RO 0.297 per liter is the amount of money to be paid to farmer to compensate risk facing un availability of market access promotion 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 are currently selling 4 Liters/day for RO 30 per month through hawkers.

3.4 Certainty Equivalent Value and Assessment of Present Dairy Cow Milk Production

The present low milk production level and feed risk management strategy represented by Model LF10 (4), Model LF8 (5) and Model LF6 (6). The analysis shows 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.

The high quality forage is important for high milking cows as it is increase energy consumption and feed dry mater intake DMI. As a result, adequate supply and availability of Alfalfa forage at economic price is the main constrain for dairy business at study area.

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. The cow feed risk management scenario shows feeding cow with Alfalfa forage is good strategy for high milk production level and reduce feeding cost for 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 if forage crop maintained at reasonable price to livestock farmers as shows in figure (3) Below.

Increasing milk production through changing feed management strategy and improving feed quality without addressing formal market access promotion, will not be a good decision, especially if we know the average herd size is 39 cows per farmer and marketing breakeven production will be difficult for local farmers to cope.

3.5 StopLight Analysis and Economic Viability of Dairy Cow feed strategies

The StopLight Chart analysis (Simetar Program) used to performed and test economic viability of dairy production system and feed risk management tools. StopLight analysis can be used as good tool for ranking cow feed risk management strategies and market access promotion policy. The analysis indicated probability of getting favorable Net Return. Assuming each operation practices has risk-averse preferences, the optimal scenario is the one which has the highest probability of target cow milk 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) can get 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%.

Conclusion

Oman traditional dairy sector recorded cow population of 359 k cows required about 605 k 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 management 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 can be used to supplement the Rhodes Grass forage diet. The animal feed diet currently used to feed animal are poor due to lack of forage crop and quality control regulation of the irrigated forage farm production.

Livestock farmers net return stochastic budget simulation analysis are performed to test feeding risk efficient strategies and 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 54–29% within current market facility and feed management strategy. Few farmers near cities 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 feed their cow with Maize silage, Rhodes grass and concentrate.

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 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. Feeding Maize silage and Rhodes Grass hay and concentrate is risk efficient and mitigate and manage risk at downside level if high quality of forage crop are maintain with reasonable price to livestock farmers. 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.

Abbreviations

(NRs) : Net Returns

(St Dev) : Standard Deviation

(CV) : Confidence of Variation

(RO) : Rial Omani

(DMI) : Dry Mater Intake

(SERF) : Stochastic efficiency with respect to a function

(ARAC) : Absolute Risk Aversion Coefficient

(CE) : Certainty Equivalent

Declarations

Ethics approval and consent to participates

Not applicable

Consent for publication

Not applicable

Availability of data and material

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The author declared that the research was conducted in the absence of any commercial or financial and non-financials relationships that could be construed as a potential conflict of interest.

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Not applicable.

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Figures

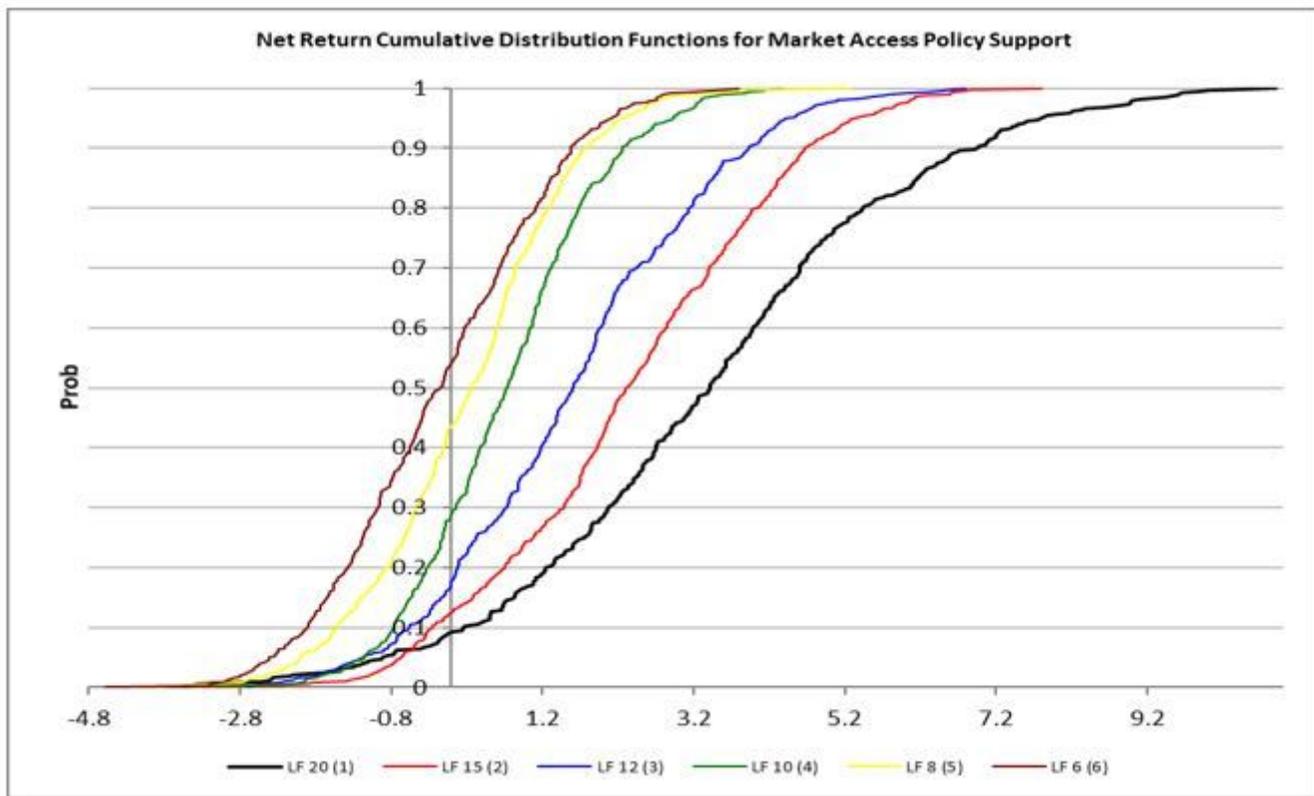


Figure 1

Comparison of 6 CDF of NRs of Dairy Cow Production Models and Marketing Access Promotion.



Figure 2

Stochastic Efficiency with Respect to Function for Alternative Feed Cost and Market availability Models.

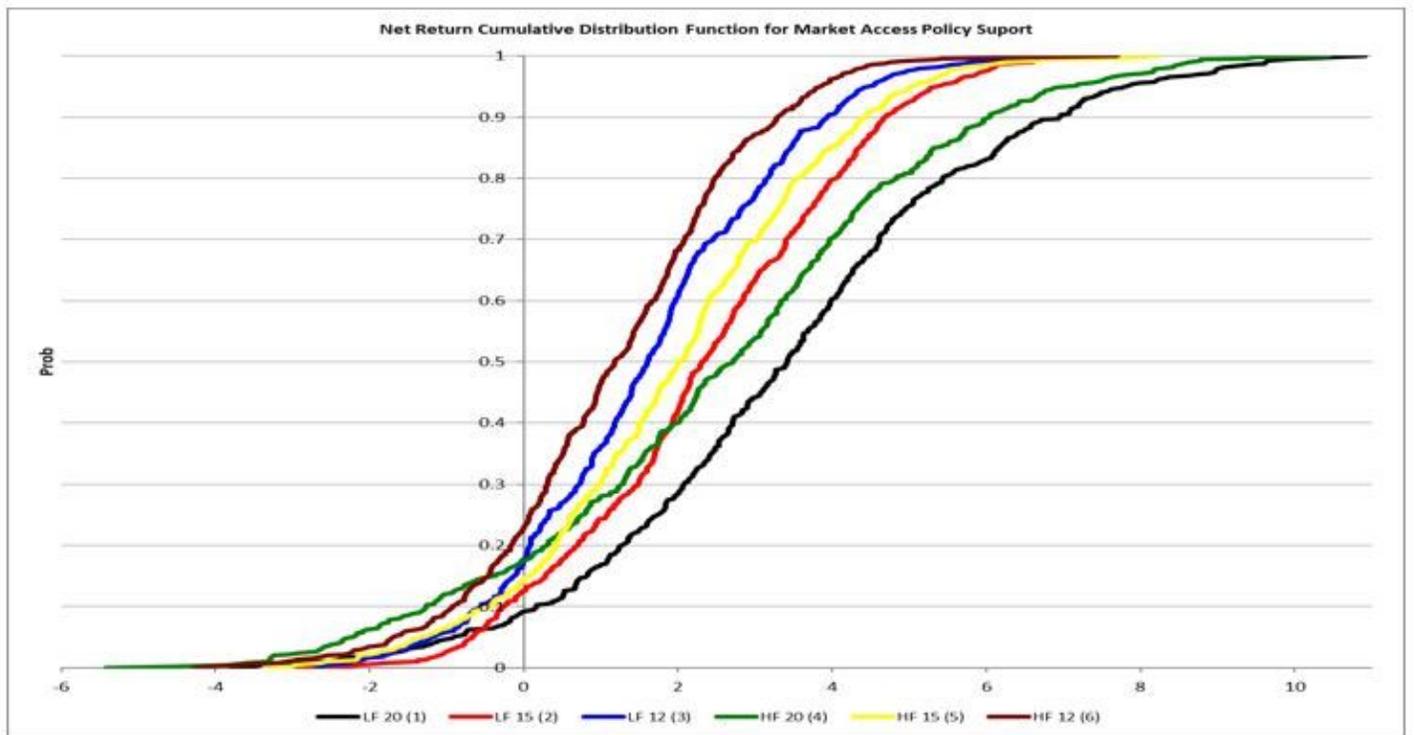


Figure 3

Comparison of 6 CDF of NRs of Dairy Cow forage feed Models and Marketing Access Promotion.

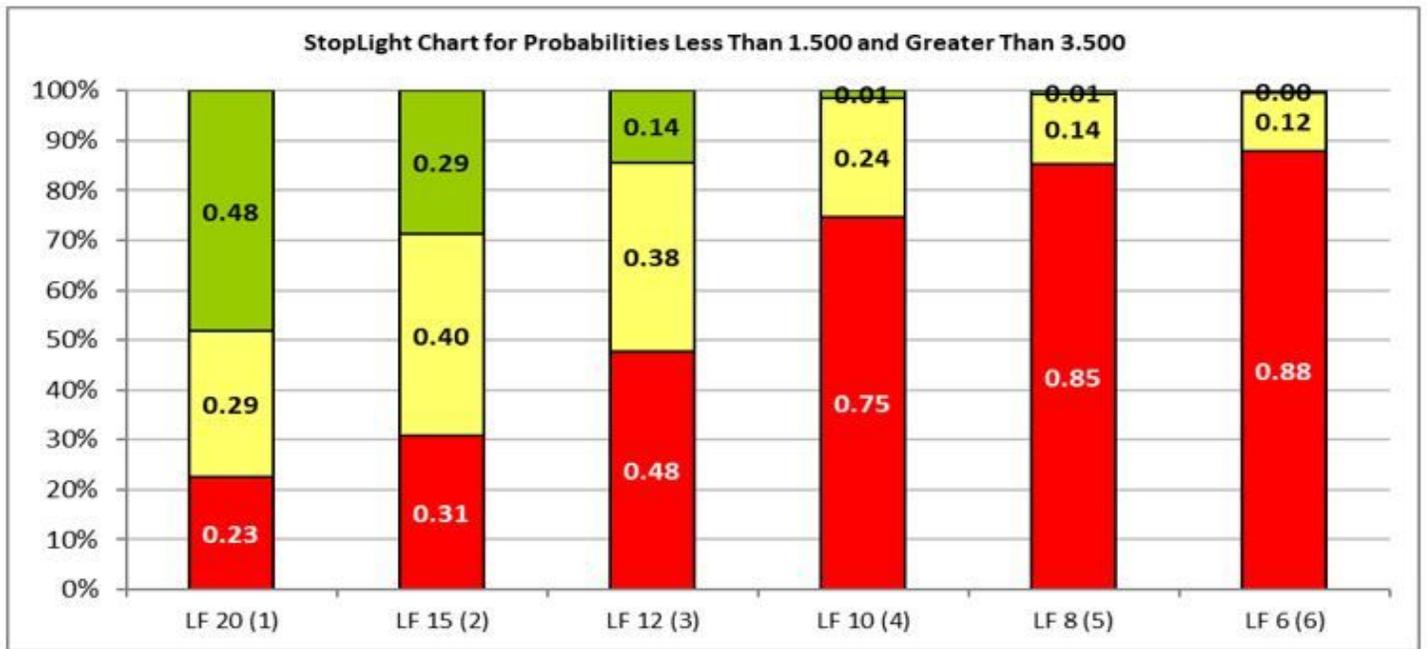


Figure 4

StopLight Chart analysis 6 NRs of Dairy milk Production and Marketing Access Promotion.