

Economic assessment of wet barley cultivar replacing dry barley and green fodder mix for sheep in Riyadh region, Saudi Arabia

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Abstract: This research performs an economic assessment of replacing green fodder and dry barley by wet barley cultivar to feed sheep for both producers and buyers of wet barley cultivar in Riyadh. Economic comparative analysis compares the increase in the value of the animal's weight and the value of daily nutrition. The study shows that when sheep breeders buy wet barley cultivar to replace dry barley and green fodder, total daily feeding costs increase at a rate between 25.4% and 191.9%. The replacement process is economically rewarding only for Najdi, Naimi and Baladi sheeps. Sheep feed costs are exacerbated when the state reduces energy and water support, and sheep breeders increase the sale price of sheep, or put pressure on natural pastures through increased overgrazing, and therefore impact the efficiency and sustainability of natural pastures. The study recommends: (1) no expansion in the replacement of dry barley and green fodder with barley cultivar to feed the Alhari, Barbary, and Rafidi sheeps, (2) following the feeding pattern of adding 0.8 kg dry barley cultivar to 4.16 kg wet barley cultivar to increase the weight of the animal an average of 230 grams per day, especially for the producers of barley cultivar.

Keywords: barley cultivar, sheep, feeding costs, growth rate, Riyadh region.

INTRODUCTION

Saudi Arabia imported 9.06 million tons of dry barley worth 7.58 billion riyals in 2015 (General Administration of Statistics, 2016ab). To reduce the consumption of dry barley, some sheep breeding and fattening projects moved to the partial substitution of dry barley by wet barley cultivar, which has a protein content of 10% (Ministry of Agriculture and Land Reclamation, 2016). It is known that the barley breeding process begins with screening barley, washing barley with water and then washing with Clorox, then soaking the barley in water for three hours. The barley is then placed in trays with dimensions 30×100 cm, at a rate of 2 kg in each tray. At the end of the production cycle, ranging from 7 to 10 days, each tray hold between 12 and 13 kg of barley culture medium. When a tray of barley cultivar is dried, its weight decreases to 1.82 kg, while the protein content increases to 16.5%. Therefore, it is clear that each kilogram of barley free of impurities gives 6.25 kg of wet barley culture medium, which is equivalent to 0.91 kg dry barley culture medium (Duwais et al., 2017).

At the end of 2016, KSA government announced the reduction of directed energy and water support, gradually raising prices to keep pace with global export prices during the period 2017–2020. Increased energy and water prices increase wet barley cultivar production costs, so replacing dry barley and green fodder with wet barley cultivar may lead to a rise in the

daily feeding costs of farm animals. As a result, the breeders of farm animals either increase the selling prices of animals to maintain their profit margin, or put pressure on natural pastures through increased overgrazing, thus impacting the efficiency and sustainability of natural pastures in the Kingdom of Saudi Arabia. It is therefore becomes important to try to answer the following two questions:

1. Is the process of using barley cultivar to replace dry barley and green fodder economically viable?
2. What is the best pattern to feed the sheep when using barley cultivar to replace dry barley and green fodder?

RESEARCH OBJECTIVES

This research aimed at conducting an economic assessment of using barley cultivar to replace dry barley and green fodder mix to feed sheep by both cultivar producers and buyers in Riyadh region. The specific study objectives include the following:

1. Studying the current status of the pattern and cost of daily nutritional feed for sheep.
2. Estimating production cost and farm price for wet barley cultivar.
3. Measuring the impact of using barley cultivar to replace dry barley and green fodder on the cost of daily nutrition for sheep.
4. Comparing the value of increased animal weight to the value of the daily nutritional feeding when substituting barley cultivar for dry barley plus green fodder mix.

MATERIALS AND METHODS

The study used a comparative economic analysis of the value of the increase in animal live weight (increase in return) and the cost of daily nutritional feed for sheep in case that barley cultivar, locally produced in the farm or bought from outside sources, is used to replace dry barley and green fodder mix on the basis of the following equations:

1. Value of increase in animal weight = daily increase in amount of animal weight \times unit selling price (kg) of live animals.
2. Daily nutritional cost per animal = amount of fodder consumed by the animal per day \times unit purchase price per kg of feed.
3. Proportion of value of return to daily feeding costs = value of increase in animal weight \div daily nutritional cost per animal.

The substitution process of using barley cultivar to replace dry barley and green fodder is economically viable for both producers and buyers of barley cultivar if the ratio of the increase in the return to daily costs is greater than one. If the ratio is less than one, the replacement process becomes uneconomical (Attia, 1994).

The study used primary data obtained through two types of questionnaires: one for breeding and fattening sheep projects, and one for wet barley production projects in Riyadh region. The data was collected through personal interviews of project managers at both sheep

breeding and fattening projects and wet barley cultivar producers in 2016. Twenty sheep breeding and fattening projects were found funded by the Agricultural Development Fund during the period 1996–2015 (Agricultural Development Fund, 2016). While there were only two wet cultured barley production projects in Riyadh region with their production devoted to feeding the animals owned by the two projects. A random sample of 10 projects was selected to represent 50% of the total sheep breeding and fattening projects funded by the Agricultural Development Fund during the period 1996–2015.

RESULTS AND DISCUSSION

1. Current practice of cost and feeding pattern for sheep in Riyadh region:

By studying the current situation of feeding sheep, it is clear from Table (1) that a lamb with a weight of 30 kg consumes 6% of its weight of dry filler matter, or about 1.8 kg per day, to survive with a an insignificant increase in its weight. Based on the average purchase price of a unit of dry green fodder, the daily feeding costs amount to 2.11 riyals. By adding 0.50 kg of barley grains to 1.3 kg of dry filler matter for the same lamb, the weight increases at a rate of 150 grams per day. Based on the average purchase prices of green fodder and dry barley grain, the daily feeding costs amounts to 1.89 riyals. By adding 1 kg of barley grains to 0.80 kg of dry filler matter for the same lamb, the lamb's weight increases at a rate of 230 grams per day, and the daily feeding costs reach 1.68 riyals.

Table 1: Nutrition, growth rates, and the costs of daily nutrition for sheep in Riyadh region (2016).

Feed mix	Feed rate	Growth rate	Unit price (riyals/kg)	Daily feed costs (riyals)	Total daily nutrition costs (riyals)
Dry green fodder	1.8 kg	Sustain life	1.17	2.11	2.11
Dry green fodder	1.3 kg	Increase in weight at a rate of 150 grams per day	1.17	1.52	1.89
Barley grains	0.5 kg		0.74	0.37	
Dry green fodder	0.8 kg	Increase in weight at a rate of 230 grams per day	1.17	0.94	1.68
Barley grains	1.0 kg		0.74	0.74	

Source: Questionnaires collected in 2016.

2. Estimated production costs and farm price for barley cultivar in Riyadh region

Cultured barley total production cost includes both fixed and variable costs. Fixed costs include capital assets, depreciation, and wages of permanent employees. Variable costs include the cost of the barley used in the germination, the value of water, sterilization materials, electricity, fuel, and oil. It is clear from Table (2) that the fixed costs amount to 85.25 thousand riyals, representing 41.26% of total costs, while total variable costs reach 121.39 thousand riyals, representing 58.74% of the total cost of 206.64 thousand riyals. Based

on average barley cultivar production of 681.41 tons, the average total cost of production is 303.26 riyals/ton, equivalent to an average of 0.30 riyals/kg.

Owing to the lack of markets for the sale of barley cultivar, the average farm price for barley cultivar has been calculated using the following equation:

Farm price for barley cultivar (Ghanim and Al-Qahtani, 2016) = (Production costs + 35% of production costs - secondary value of output) ÷ Average project productivity.

Farm price for barley cultivar = (206.64 + 72.32 - 0) ÷ 681.41

From the previous equation, it is clear that the average farm price for barley cultivar is 409.4 riyals/ton, an average of 0.41 riyals/kg. In light of the farm price for barley cultivar, the total value of production is 279.0 thousand riyals.

Table 2: Average fixed and variable costs for the production of barley cultivar in Riyadh region (2016).

Statement	Value (riyals)	Relative importance(%)
Fixed costs:		
Depreciation of capital assets:		
Unit breeding barley (incubation)	10000	4.84
Ground water tanks and concrete	1350	0.65
Warehouses, hangars and shades	3600	1.74
Housing management and staff buildings	800	0.39
Cars	8500	4.11
Total capital assets depreciation	24250	11.74
Labor wages	61000	29.52
Total fixed costs	85250	41.26
Variable costs:		
Barley	91250	44.16
Water used in production	18250	8.83
Sterilization materials (soap, Clorox, and chlorine)	7665	3.71
Electricity	1825	0.88
Fuel and oil	2400	1.16
Total variable costs	121390	58.74
Total overall costs	206640	100
The annual production in tons	681.41	--
Average variable costs per unit produced	178.15	58.74
Average fixed costs per unit produced	125.11	41.26
Average total costs per unit produced	303.26	100

Source: Questionnaires collected in 2016.

3. Cost impact of using barley cultivar to replace dry barley only

As the protein content of barley grain is 10% and that of its dry barley cultivar counterpart amounts to 16.5%, based on the rates of feeding sheep in table (1), the possible amount of wet barley to replaces dry barley is estimated as follows:

Amount of dry barley cultivar containing 100 grams protein = $(100 \div 165) = 0.61$ kg

Amount of wet barley = $(6.25 \times 0.61) \div 0.91 = 4.16$ kg

If only barley is replaced by self-cultured barley at a rate of 2.08 kg of wet barley cultivar plus 1.3 kg of dry green fodder, the daily feeding costs amounts to 2.14 riyals, an increase of 13.2% from the estimated current practice cost (Table 3).

When adding 4.16 kg of wet barley cultivar to 0.80 kg of dry green fodder, the daily feeding cost amounts to 2.19 riyals representing an increase of 30.4%.

Table 3: Growth rate and daily nutrition costs for sheep if producers replace dry barley with barley cultivar.

Feed mix	Feed rate	Growth rate	Unit price (riyal/kg)	Daily nutrition costs (riyals)	Total daily nutrition costs (riyals)	Rate of increase in daily feeding costs (%)
dry green fodder	1.8 kg	Sustain life	1.17	2.11	2.11	--
dry green fodder	1.3 kg	Gain weight at a rate of 150 grams per day	1.17	1.52	2.14	13.2
barley culture medium	2.08 kg		0.30	0.62		
dry green fodder	0.8 kg	Gain weight at a rate of 230 grams per day	1.17	0.94	2.19	30.4
barley culture medium	4.16 kg		0.30	1.25		

Source: Collected and calculated from data contained in Tables (1 and 2).

In case of sheep breeders buying barley cultivar at the farm price of 0.41 riyals/kg and use it to replace dry barley, it is clear from the data in Table (4) that adding 2.08 kg of barley cultivar to 1.3 kg of dry green fodder brings daily feeding costs to 2.37 riyals, an increase of 25.4% from the estimated case of non-replacement. In the case of adding 4.16 kg of barley cultivar to 0.80 kg of dry green fodder, the daily feeding costs amount to 2.65 riyals, an increase of 57.7% from the estimated case of non-replacement.

Table 4: Growth rate and daily nutrition costs for sheep if buyers replace dry barley with barley cultivar.

Feed mix	Feed rate	Growth rate	Unit price (riyals/kg)	Daily nutrition costs (riyals)	Total daily nutrition costs (riyals)	Rate of increase in daily feeding costs (%)
dry green fodder	1.8 kg	Sustain life	1.17	2.11	2.11	--
dry green fodder barley culture medium	1.3 kg 2.08 kg	Gain weight at a rate of 150 grams per day	1.17 0.41	1.52	2.37	25.4
dry green fodder barley culture medium	0.8 kg 4.16 kg	Gain weight at a rate of 230 grams per day	1.17 0.41	0.94 1.71	2.65	57.7

Source: Collected and calculated from data contained in Tables (1 and 2).

4. Cost impact of using barley cultivar to replace both dry barley and green fodder:

If barley cultivar producers replace all of the dry barley and green fodder when feeding sheep, it is clear from the data in Table (5) that a lamb weighing 30 kg needs 1.8 kg per day of dry barley cultivar to survive with an insignificant increase in its weight. Based on the average unit cost of production of dry barley cultivar, the daily feeding cost amounts to 4.54 riyals, an increase of 115.2% from the current practice cost. In the case of adding 2.08 kg of wet barley cultivar to 1.3 kg of dry barley cultivar for the same lamb, its weight increases at a rate of 150 grams per day. Based on the average unit cost of production of wet and dry barley cultivar, the daily feeding costs amount to 3.90 riyals, an increase by 106.3% from the estimated case of non-replacement. In the case of adding 4.16 kg of wet barley cultivar to 0.80 kg of dry barley cultivar for the same lamb, the weight increases at a rate of 230 grams per day. The daily feeding costs amount to 3.27 riyals, an increase of 94.6% from the estimated case of non-replacement.

Table 5: Growth rate and daily nutrition costs for sheep if producers replace both dry barley and green fodder with barley cultivar.

Feed mix	Feed rate	Growth rate	Unit price (riyals/kg)	Daily nutrition costs (riyals)	Total daily nutrition costs (riyals)	Rate of increase in daily feeding costs (%)
dry barley culture medium	1.8 kg	Sustain life	2.52	4.54	4.54	115.2
dry barley culture medium	1.3 kg	Gain weight at a rate of 150 grams per day	2.52	3.28	3.90	106.3
barley culture medium	2.08 kg		0.3	0.62		
dry barley culture medium	0.8 kg	Gain weight at a rate of 230 grams per day	2.52	2.02	3.27	94.6
barley culture medium	4.16 kg		0.3	1.25		

Source: Collected and calculated from data contained in Tables (1 and 2).

If sheep breeders buy barley cultivar to replace both dry barley and green fodder, it is clear from the data in Table (6) that a lamb with a weight of 30 kg needs 1.8 kg per day of dry barley cultivar to survive. Based on of the average purchase price of a unit of dry barley cultivar, the daily feeding costs amount to 6.16 riyals, an increase of 191.9% from the estimated case of non-replacement. In the case of adding 2.08 kg of wet barley cultivar to 1.3 kg of dry barley cultivar for the same lamb, the daily feeding costs amount to 5.30 riyals, an increase of 180.4% from the estimated case of non-replacement. In the case of adding 4.16 kg of wet barley cultivar to 0.80 kg of dry barley cultivar for the same lamb, the daily feeding costs amount to 4.45 riyals, an increase of 164.9% from the estimated case of non-replacement.

Table 6: Growth rate and daily nutrition costs for sheep if buyers replace both dry and green fodder barley with barley cultivar.

Feed mix	Feed rate	Growth rate	Unit price (riyals/kg)	Daily nutrition costs (riyals)	Total daily nutrition costs (riyals)	Rate of increase in daily feeding costs(%)
dry barley culture medium	1.8 kg	Sustain life	3.42	6.16	191.9	191.9
dry barley culture medium	1.3 kg	Gain weight at a rate of 150 grams per day	3.42	4.45	5.30	180.4
barley culture medium	2.08 kg		0.41	0.85		
dry barley culture medium	0.8 kg	Gain weight at a rate of 230 grams per day	3.42	2.74	4.45	164.9
barley culture medium	4.16 kg		0.41	1.71		

Source: Collected and calculated from data contained in Tables (1 and 2).

5. Estimated proportion of the increase in revenue to the daily costs of feeding sheep

It can be seen from the data in Table (7), given the average selling price of live sheep and the rate of daily growth of 150 grams, the value of the daily increase ranged from 2.09 riyals for Rafidi to 6.09 riyals for Najdi. However, when increasing the weight of the animal at a rate of 230 grams per day, the value of the daily increase in animal weight ranged from 3.20 riyals for Rafidi to 9.34 riyals for Najdi. From Table (8) it is clear that the cost increase in the status quo surpassed the cost of feeding sheep when using barley cultivar in place of dry barley. Using barley cultivar to replace dry barley resulted in returns exceeding the costs of the daily feeding for Najdi, Naimi, Baladi and Alsoakny breeds for both producers and buyers of barley cultivar. It also exceeds the costs of the daily feeding for Alhari, Barbary and Rafidi when increasing the weight of the animal at a rate of 230 grams per day, but not at the rate of 150 grams.

Table 7: Value of the daily increase in the weight of different types of sheep in Riyadh region

Type	Average sale price of live sheep (SR / kg)	Value of the daily increase in the weight of the animal (riyals)		
		Sustain life	150 grams	230 grams
Najdi	40.6	--	6.09	9.24
Naimi	32.4	--	4.86	7.45
Alsoakny	24.6	--	3.69	5.66
Alhari	15.0	--	2.25	3.45
Barbary	14.1	--	2.12	3.24
Rafidi	13.9	--	2.09	3.20
Average	21.6	--	3.24	4.97

Source: Collected and calculated from data in table 1 and questionnaires collected in 2016.

Table 8: Proportional cost increase in animal weight attributable to daily feeding costs.

Type	Status quo		Barley cultivar replacing dry barley only			
			Producers use barley cultivar		Buyers use barley cultivar	
	150grams	230grams	150grams	230grams	150 grams	230grams
Najdi	3.22	5.56	2.85	4.26	2.57	3.52
Naimi	2.57	4.43	2.27	3.40	2.05	2.81
Alsoakny	1.95	3.37	1.72	2.58	1.56	2.14
Alhari	1.19	2.05	1.05	1.58	0.95	1.30
Barbary	1.12	1.93	0.99	1.48	0.89	1.22
Rafidi	1.11	1.90	0.98	1.46	0.88	1.21
Average	1.71	2.96	1.51	2.27	1.37	1.88

Source: Collected and calculated from data in Tables (1, 2, 3, 4, 5, 6, and 7).

When using barley cultivar to replace the dry barley plus green fodder feed mix, it is evident that the value of the increase in the return exceeds the daily feeding costs for Najdi, Naimi and Baladi for both producers and buyers of barley cultivar, except for buyers when increasing the weight of Naimi by 150 grams per day (Table 9). The value of the increase in return does not exceed the daily cost of feeding for Alsoakny, Alhari, Barbary and Rafidi when increasing the weight of the animal at a rate of 150 grams per day for either producers or buyers of barley cultivar. However, when increasing the weight of the animal at a rate of 230 grams per day, increase in return does not exceed daily feeding costs for Barbary or Rafidi for either producers or buyers to barley cultivar, or for Alhari for buyers of barley cultivar.

Table 9: Barley cultivar replaces both dry and green fodder

Type	Barley cultivar replacing both dry and green fodder			
	Producers use barley cultivar		Buyers use barley cultivar	
	150 grams	230 grams	150 grams	230 grams
Najdi	1.56	2.86	1.15	2.10
Naimi	1.25	2.28	0.92	1.67
Alsoakny	0.95	1.73	0.70	1.27
Alhari	0.58	1.06	0.42	0.78
Barbary	0.54	0.99	0.40	0.73
Rafidi	0.54	0.98	0.39	0.72
Average	0.83	1.52	0.61	1.12

Source: Collected and calculated from data in Tables (1, 2, 3, 4, 5, 6, and 7).

CONCLUSIONS AND RECOMMENDATIONS

The comparative economic analysis between the current daily feeding costs and estimated counterparts when using barley cultivar to replace dry barley and green fodder shows that the replacement process will lead to increased total daily sheep feeding costs for barley producers of 13.2% to 115.2%. In the case of sheep producers buying the barley cultivar, the total daily sheep feeding costs increase from 25.4% to 191.9%. Even when increasing daily nutritional costs resulting from using barley cultivar to replace dry barley, the increase in revenue exceeds the costs of the daily nutrition for Najdi, Naimi, Baladi and Alsoakny for producers and buyers of barley cultivar but not for Alhari, Barbary and Rafidi specifically when buying barley cultivar to increase the weight at a rate of 150 grams per day. In the case of using barley cultivar to replace dry barley plus green fodder feed mix, the replacement process is only economically rewarding for Najdi, Naimi and Baladi.

There is no doubt that the feeding costs for sheep will increase when the government reduces energy and water support during the upcoming period (2017–2020). Sheep breeders may opt at increasing the market prices of their products thus increasing the prices of red meat, or exert additional pressure on natural pastures which will result in increased overgrazing and the impact on the efficiency and sustainability of natural pastures in Saudi Arabia. In light of the results obtained, the study recommends the following: (1) do not expand the use of barley cultivar to replace dry barley and green fodder when purchasing barley cultivar to feed sheep with a low price, such as Hari, Barbary, and Rafidi; (2) follow the feeding pattern of adding 0.8 kg of dry barley culture medium to 4.16 kg of wet barley culture medium to increase the weight of the animal at a rate of 230 grams per day, especially for producers of barley cultivar.

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التقويم الإقتصادي لإحلال الشعير الرطب محل مخلوط الشعير الجاف والأعلاف الخضراء في تغذية الأغنام بمنطقة الرياض، المملكة العربية السعودية

المخلص: إستهدف البحث إجراء التقويم الإقتصادي لإحلال الشعير الرطب محل مخلوط الشعير الجاف والأعلاف الخضراء في تغذية الأغنام لكل من منتجي ومشتري الشعير الرطب بمنطقة الرياض. ولتحقيق هذا الهدف تم إستخدام التحليل الإقتصادي المقارن بين قيمة الزيادة في وزن الحيوان وقيمة التغذية اليومية. وأوضحت الدراسة أن قيام مربي الأغنام بشراء الشعير الرطب لإحلاله محل مخلوط الشعير الجاف والأعلاف الخضراء، قد أدى إلى زيادة جملة تكاليف التغذية اليومية بمعدل تراوح بين حد أدنى بلغ ٢٥,٤٪ وحد أعلى بلغ ١٩١,٩٪. كما تبين أن عملية الإحلال تكون مجزية إقتصادياً فقط لأصناف أغنام النجدي والنعمي البلدي. وقد تتفاهم تكاليف تغذية الأغنام عند قيام الدولة بتقليص الدعم الموجه للطاقة والمياه، ومن ثم يلجأ مربو الأغنام إلى زيادة أسعار بيع الأغنام في السوق، أو استنزاف المراعي الطبيعية وزيادة الرعي الجائر وبالتالي التأثير على كفاءة وإستدامة المراعي الطبيعية. توصي هذه الدراسة بالآتي: (١) عدم التوسع في إحلال الشعير الرطب محل مخلوط الشعير الجاف والأعلاف الخضراء عند شراء الشعير الرطب لتغذية أصناف أغنام الحري والبربري والرفيدي، (٢) إتباع نمط التغذية المتضمن إضافة ٠,٨ كجم شعير جاف إلى ٤,١٦ كجم شعير رطب لزيادة وزن الحيوان بمعدل ٢٣٠ جرام يومياً (خاصة لمنتجي الشعير الرطب).

كلمات دالة: الشعير الرطب، الأغنام، تكاليف التغذية، معدل النمو، منطقة الرياض.