Research Article

Developing Feeding Management Assessment Protocol at Small Scale Dairy Herds in Egypt

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Abstract | Assessment of feeding practices possibly sheds light on feeding problems that are faced by smallholder dairy farmers. The main objective of the study was to develop an assessment protocol to evaluate feeding practices at small dairy farms. The study was based on 56 smallholder farms that raised crossbred cows and local buffaloes in mid-lactation, with an average of 4.4 parties and an average herd size of 1.28 and 1.19 head/farm for Nile Valley and Newly Reclaimed districts, respectively. A structured questionnaire survey was designed, and field interviews were conducted to collect data and to characterize the current situation. Representative feed staff and milk samples were collected and analyzed. Feeding practices efficiency indicators were calculated to be compared with standards. Results revealed that most farmers in the studied two districts used the concentrate to feed animals, which was formulated at home and mixed with roughage at feeding times. The Newly reclaimed district used mixed roughages ($P < 0.001$) compared with Nile Valley district that provided mainly wheat straw. Green forage patterns differed ($P = 0.001$) in the two districts, where water grass (*Echinochloa crus-galli)* was the major fodder in both districts, followed by corn fodder and clover. The feed intake of concentrate and green fodder for fed buffaloes and cows was higher ($P < 0.05$) in Nile Valley district. A significant difference ($P < 0.05$) observed in daily milk and fat-corrected milk (FCM) yields between both districts. Cattle in all areas under this study showed a lower Fat : protein ratio than the optimal ratio. Milk urea nitrogen (MUN) was significantly different ($P < 0.05$) between the two districts, was ($P < 0.05$) higher than standard level in both districts. The MUN levels in cattle and buffalo milk were higher in the Nile Valley district than the Newly Reclaimed (23.66 and 22.76 mg/dl, respectively). The cost of producing one kg of milk was higher ($P < 0.05$) on the Newly Reclaimed district. Collected data through survey and lab analysis for milk (Fat: protein ratio and MUN) and feeds samples could help to set new and practical standards that fit small-scale farms at the districts level as well as adapt commercialized diagnostic tools for feeding practices in rural areas.

Keywords | Rural Regions, Dairy Farms, Feeding Practices, Milk Analysis, Milk urea nitrogen, Smallholders

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INTRODUCTION

There are more than 570 million farms worldwide; that occupy about 75% of the world's agricultural land, most of them are small (less than 2 ha) and operated by family members that form around 12% of the total world labor power (Lowder et al., 2016). A smallholder dairy farm is defined as a production unit managed by the owner with family labor and is considered the main source of milk suppliers in Egyptian market. It accounts for more than

80% of milk production in Egypt (Soliman and Mashhour, 2011). Small-scale dairy farming system is considered a significant source of livelihood. The family farming system is the most common model in Egypt, accounting for around 90 percent of farms. Most family farms are small-scale, with only two to three dairy cows and less than one hectare of land (Aboulnaga et al., 2017).

Livestock in worldwide consumed about six billion tons of dry matter feed, including roughages (73%) in different forms (such as grass and crop residues by-product), oilseed meals cake (5%), other by-products and wastes (8%), and only 14% consisted of grains and other feeds directly eaten to humans as reported by Mottet et al. (2017). Feed resources of livestock are classified as natural pastures, crop residues, improved pastures, ~~and~~ forage, agro-industrial by products, other by-products such as food and vegetable refusal. Feeding system of green fodder/grass based on two types; grazing and zero grazing (cut and carry system), which refer to cutting green fodder and feeding housed cows as mentioned by Martínez-García et al. (2013). In Egypt, the feeding system depends on berseem (Egyptian clover) in winter and darawa (70 days of green corn forage), sorghum, rice straw, and crop~~s~~ by-products in summer, supplemented with a limited amount of ingredients (corn, wheat bran, cotton seed cake, etc.) or concentrated feed mixture (Radwan et al., 2016).

Understanding the type of feed resource and its nutritional quality is important for improving productivity and then enhances food security. Milk production and composition are a function of nutrition, health status, management, environment, and genetic potential of the animal. Among these factors, nutrition plays the most important role, as it represents the major expense in most dairy enterprises. Dietary nutrients favor the metabolic pathways that empower the animal to express its genetic potential. The nutrients (minerals, vitamins, carbohydrates, proteins, and fat) are equally important as imbalances or deficiencies of one or more of these nutrients alter the productivity and health status. Fat and protein ratio is an effective indicator to diagnose acidosis and ketosis. Several researchers studied the biological relationship between tissue mobilization and changes in milk component ratios and reported that the milk fat/protein ratio could predict many illnesses in dairy cattle, including negative energy balance, ketosis, displaced abomasums, lameness, and mastitis (Atalay, 2019; Heuer et al., 1999; Mulligan et al., 2006; Negussie, 2013). The milk urea nitrogen (MUN) is considered as a tool for monitoring dietary efficiency in terms of protein energy ration (Hof et al., 1997). A High level of MUN reflects an unbalanced energy and protein in the animal's diet, which is regularly followed by low fertility, high feeding cost, and low production efficiency (Roy et al., 2003). The efficiency of nutrient conversion to milk components substantially influences the profitability of a dairy herd. Costs associated with feed are continually rising and, on average, it accounts for greater than 50% of all operating costs of dairy production systems (Moran, 2005).

The major problem in improving dairy cattle production is animal feed, particularly at small-scale farms, where the small size land availability is an obstacle to cultivate forages. Whereas the livestock production system is based on cut and carry for cultivated forages. Furthermore, the concentrates are expensive, as they are mostly imported or produced outside the farm, and most farmers cannot afford them. In addition, the efficiency with which the available feed is utilized is constrained by the failure to use recommended feeding management practices that can improve milk production.

It is important to characterize better strategies through definite assessment protocol, especially with regard~~s~~ to feeding practices that formulate 60% to 80% of variable costs, which could help to identify the main weak points that might enhance the competitiveness of small dairy farms. It is essential to estimate needs and assess of the quantity and quality of available feedstuff resources in relation to the livestock requirements of small-scale farms and their important role in increasing milk production and composition.

There is relatively little published information on most aspects of dairy production at the smallholder level in Egypt. Therefore, the main objectives of this study were to assess ration balancing: the gap between actual consumption and an animal's energy, and protein requirements evaluate the effect of ration balancing status on milk yield and composition. Test the potential of utilizing milk as a diagnostic tool for assessing farm level feeding system. Also, this study tried to set an assessment protocol to evaluate the feeding practices that fitting smallholder dairy farms to set realistic scenarios to improve feeding practices, productivity, and subsequent profitability.

MATERIALS AND METHODS

An overall description for the whole assessment protocol Figure 1.

Description of the study area

The present study was done in two different governorates. The first district located in Giza Governorate (El-Atf village is located 50 km south of Cairo at a latitude 31°17'04"N and a longitude 29°11'39"E) and represents the old small scale production system in the Nile Valley). The second ~~village~~ district located in El-Beheira Governorate

(El-Emam Malik village is located 120 km north of Cairo at a latitude 30°16'38.22"N and a longitude 20°35'30"E) and represents the newly reclaimed land dairy production system that represents the traditional system in the Nile Valley. Figure (2) shows the locations of the two studied areas through Google Earth.

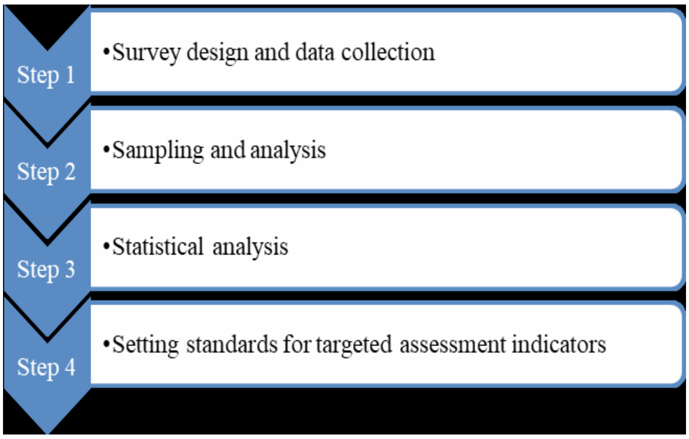

Figure 1: Framework of proposed methodology protocol for feeding practices assessment and expected results

Figure 2: Map of Lower Egypt showing the study locations of Nile Valley and Newly Reclaimed districts

Data collection process

Questionnaire survey: Field visits and personal interviews with semi-open questionnaires were used to collect information from randomly selected smallholder farmers in one-day interview during the summer season. The questionnaire was pre-tested for clarity and appropriateness of the questions. The data were collected by direct interviews and personal observation. Moreover, field observations on feed resource type, feeding practice, and mineral resources for animals were an important component of the study process. The farms were visited by the same member of the research team and, before starting the interview, farmers were informed about the objective of the study and that participation was voluntary with confidentiality guaranteed. A total of 55 cows (crossed local breed with Holstein breed, average party 4.36 years and in mid-lactation) and 47 Egyptian buffalos (average party 4.37 years and in mid-lactation) lactation belonging to 56 herds scattered in 2 districts (31 and 25 small-scale farms with average herd size 1.19 and 1.28 head / farm in Newly Reclaimed district, and in Nile Valley district, respectively) were enrolled in this research.

Sampling and analysis

Falcon tubes were identified based on given animal codes through the interview day. Represented morning and evening milk samples were collected from each animal (cow and buffalo) that milked by farmers. Samples were kept under freezing till collection. During the visits, milk samples were collected from each farm to assess milk composition (lactose, protein, fat, and total solids %) as well as MUN. The chemical composition of the milk samples was examined using Lactoscan MCC Combo 6030 at the Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt. The milk urea nitrogen (MUN) was conducted for milk samples using commercial kits, where the milk samples were vortex, pulled 2ml in Eppendorf and added HCL 0.1 N to precipitate casein (Nozad et al., 2011). Then, the Eppendorf samples were centrifuged at 14000 rpm for 30 min. After that, the supernatant was used to operate the protocol of determining urea by Bio-diagnostic® kits by colorimetric method using a spectrophotometric device (T80 UV/VIS Spectrometer, PG Instruments Ltd., UK) according to the standard protocols of the suppliers at the laboratory of Dairy Production, Dairy Science Department, National Research Centre, Giza, Egypt.

Feed samples collection and preparation: Representative samples were collected from farmers' concentrated mixture, fresh forages, and dry roughages and prepared for analysis at the laboratory of Dairy Production, Dairy Science Department, National Research Centre, Giza, Egypt. Proximate analysis of the collected feed samples (dry matters (DM), crude protein (CP), ether extract (EE), and ash) were analyzed according to Association of Official Analytical Chemists methods (AOAC, 2000). Non fiber carbohydrates (NFC) was calculated according to the following equation (NRC, 2001); NFC%= (100 – (%NDF + %CP +%EE + %Ash).

Fiber fractions of neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were analyzed by Ankom[200] Fiber Analyzer as described by Van Soest et al. (1991). Neutral detergent insoluble nitrogen (NDICP), and acid detergent insoluble nitrogen (ADICP), were analyzed according to Goering et al. (1972). The available crude protein is calculated by subtracting ADICP from the feed protein content. Animal requirements for total digestible nutrients (TDN) and CP are estimated using NRC (1988). Nutritive values (digestible crude protein, DCP, and TDN) of the concentrated feed mixture and forages were determined using equations (NRC, 2001): tdNFC = 0.98 (100 – [(NDF – NDICP) + CP +EE + Ash]) × PAF; tdCPf = CP × exp[-1.2 × (ADICP/CP)]; tdCPc = [1 – (0.4 × (ADICP/CP)] × CP]; tdFA = FA, Note: if EE<1, then FA=0; tdNDF = 0.75 × (NDFn – L) × [1 – (L/NDFn)0.667]; TDN1x (%) = tdNFC + tdCP + (tdFA × 2.25) + tdNDF -7; Where tdNFC, truly digestible NFC; tdCPf, truly digestible CP for forages; tdCPc, truly digestible CP for concentrates; tdFA, truly digestible FA; tdNDF, truly digestible NDF; TDN1x, total digestible nutrients; L, acid detergent lignin; PAF, processing adjustment factor; and NDFn= NDF – NDICP.

Statistical analyses

A T-test for independent samples was used to compare the difference in nutrients requirements, intake, and milk production between the farms in both ~~areas~~ districts (Nile Valley system and Newly Reclaimed) for cattle and buffalo. The statistical analysis and correlation coefficients were performed with SAS® On Demand for Academics. Statistical significance was set at a P value of <0.05. All data are presented in the text as the mean ± SEM.

RESULTS

Characterization of feeding practices of smallholder farms system

Feeding practices characteristics of smallholder farms are shown in Table (1). As presented in Table (1), 92% and 96.8% of smallholder farmers use concentrate supplementation in herd rations in Nile Valley system and Newly reclaimed system (P = 0.58), respectively. Only 8.7% and 3.3% of smallholder farmers depend on commercial mixture in feeding their dairy animals, whereas in 47.8% and 70% formulate concentrate mixture in their farms in Nile Valley system and Newly reclaimed system, respectively, without any significant differences (P = 0.27). Corn, wheat bran, bread, wheat, wheat flour, corn flour, fava bean, soya bean, cotton seeds, peanut peel, biscuit, and cake as agro-industrial byproducts are partially the components of a farm-made formulated mixture. Concentrate was introduced to dairy animals mixed with roughage in 100% and 96.7% of smallholder farms in Nile Valley system and reclaimed system (P = 1.00), respectively. Concentrate feeding frequencies for all smallholders in Nile Valley district were twice per day at morning and evening. However, 70% of smallholders in Newly reclaimed district were feeding animals on concentrate three times per day (Table 1), (P <0.001) than farmers in Nile Valley district where fed two times (100 %). In both districts, most farmers introduce concentrate through the milking process.

For crop residues, wheat, rice, and water grass (*Echinochloa crus-galli*) straws were the roughage resources available for smallholders in Nile Valley district, whereas wheat, bean, peanut, and fava bean straws were used to fed animals in Newly reclaimed district, where these newly reclaimed lands were cultivated with these crops and vegetables. However, 54.8% of smallholders in the Newly reclaimed district (P < 0.001) use a mix of wheat, bean, peanut, and fava bean straws as shown in Table (1).

Clover, darawa (corn fodder), and water grass (cockspur) are the green forage resources available for smallholders in Nile Valley and Newly reclaimed systems. About 40% of smallholders use water grass only as a green fodder source for dairy animals in Nile Valley (P < 0.001). However, green forage resources were not available in 51.6% of Newly reclaimed farms. Smallholders that used conserved fodder (corn silage) in dairy animals' ration were 12% and 6.5% in Nile Valley and Newly reclaimed districts, respectively (Table 1). All forage types were fed to animals using a cut and carry strategy.

Feed additives, which were used in both studied villages, were minerals, vitamins, salt, yeast, etc. For mineral supplementation, about 16% and 48.4% of smallholders used minerals for their dairy animals' diet (P < 0.01), in Nile Valley and Newly reclaimed districts, respectively. Although all smallholder farmers are aware of minerals importance but some of those smallholder farmers in Nile Valley and Newly reclaimed districts that supply minerals, supplied sodium chloride only (25% and 33.3%, respectively). About 33.3% and 20% of smallholder farmers in Newly Reclaimed district use only mineral and vitamin mixture and multi-nutrient block, respectively (Table 1).

Different water sources showed significant differences (P < 0.001) which available in smallholder dairy farms were shown in Table (1). About 88% of interviewees depend on underground water at their smallholder farms in the Nile Valley district. While around 76.7% of farmers have tap water as the main source of water for dairy animals in Newly reclaimed district. The drinking process ~~to~~ for dairy cattle in both districts was a restricted system, which presented about 96% and 100% in Newly reclaimed district, respectively. About 58.3% of smallholder farms in Nile Valley system provide water twice per day, whereas 60% of smallholders provide water three times per day in Newly reclaimed district. The average watering frequency is significantly lower (P < 0.001) in Nile Valley system compared with Newly reclaimed system (2.42±0.12 and 3.5±0.11 times, respectively). The overall average is 3.02±0.61 times of the two studied areas.

Table 1: Feeding practices characteristics of smallholder farms

Characteristic	Category	District				Overall mean (n=56)		P value
		Nile Valley system (n=25)		Newly Reclaimed land system(n=31)				
		*F	%	F	%	F	%	
Practice of concentrate supplementation	Yes No	23 2	92 8	30 1	96.8 3.2	53 3	94.6 5.4	0.58
Type of concentrate supplements used	Commercial mixture only Farm-made formulated mixture Commercial and formulated mixture	2 11 10	8.7 47.8 43.5	1 21 8	3.3 70 26.7	3 32 18	5.7 60.4 34	0.27
Methods of feeding concentrate ration / concentrate offered	Total mixed ration (TMR) Mixed with roughage Separated	0 23 0	0 100 0	0 29 1	0 96.7 3.4	0 52 1	0 98.1 1.9	1.00
Frequency and time of concentrate feeding	Once (at evening) Twice/day (at morning and evening) ≥ 3 times/day (morning, afternoon, evening)	0 23 0	0 100 0	1 8 21	3.3 26.7 70	1 31 21	1.9 58.5 39.6	<0.001
Crop residues/roughage resources available/ roughage sources utilization	Wheat straw only Rice straw only Wheat, bean, peanut, fava bean straw mix Wheat and cockspur straw mix Not available	20 2 0 2 1	80 8 0 8 4	12 0 17 0 2	38.7 0 54.8 0 6.5	32 2 17 2 3	57.1 3.6 30.4 3.6 5.4	<0.001
Green forage resources available/ forage sources utilization	Egyptian clover only Darawa (Maize fodder) only Cockspur only Elephant grass only Partially all Not available	2 3 10 1 8 1	8 12 40 4 32 4	3 4 5 0 3 16	9.7 12.9 16.1 0 9.7 51.6	5 7 15 1 11 17	8.9 12.5 26.8 1.8 19.6 30.4	0.001
Using conserved fodder (Maize silage)	Yes No	3 22	12 88	2 29	6.5 93.5	5 51	8.9 91.1	0.64
Knowledge of feed additives	Yes No	25 0	100 0	31 0	100 0	56 0	100 0	---
Using feed additives	Yes No	4 21	16 84	15 16	48.4 51.6	19 37	33.9 66.1	0.01
Feed additives	Common salt only Mineral and vitamins mixture only Multi-nutrient block only Partially all	1 0 0 3	25 0 0 75	5 5 3 2	33.3 33.3 20 13.4	6 5 3 5	31.6 26.3 15.8 26.3	0.12
Supplied water/ Source of water	Underground water only Tap water only Tap and underground water Nile and underground water	22 0 1 2	88 0 4 8	3 23 4 0	10 76.7 13.3 0	25 23 5 2	45.5 41.8 9.1 3.6	<0.001
Water availability	Ad labium/ free access Restricted	1 24	4 96	0 31	0 100	1 55	1.8 98.2	0.45

Watering frequency/ day	Twice	14	58.3	0	0	14	25.9	<0.001
	3 times	10	41.7	18	60	28	51.9	
	≥ 4 times	0	0	12	40	12	22.2	
	Mean ±SEM	2.42±0.12b		3.50±0.11a		3.02±0.61		<0.001

*F: Frequency

Table 2: Chemical composition and nutritive value of green forage and crop residues resources in the study areas

Feedstuff	District	*Chemical composition (% DM)											Nutritive value, %	
		DM	Ash	OM	EE	CP	NDF	ADF	ADL	NFC	NDICP	ADICP	TDN	DCP
Green forage														
Egyptian Clover	Nile Valley system-	92.2	9.40	90.6	2.56	11.8	50.2	36.7	10.4	26.01	4.19	1.54	53.3	9.77
	Reclaimed land system-	92.0	9.49	90.5	1.40	14.7	51.2	38.5	13.6	23.14	4.75	1.52	46.1	13.0
Darawa	Nile Valley system	91.9	9.06	90.9	1.61	8.18	67.5	35.5	16.9	13.68	5.92	1.03	37.6	7.03
	Reclaimed land system	92.7	10.9	89.0	1.27	10.1	63.7	34.9	26.1	13.82	7.42	1.29	28.5	8.72
Cockspur	Nile Valley system	92.3	8.08	91.9	2.04	7.91	66.5	36.8	7.43	15.44	5.05	0.81	51.5	7.00
	Reclaimed land system	92.7	10.6	89.4	1.78	10.2	63.2	34.2	4.30	14.07	5.54	0.59	54.9	9.59
Elephant grass	Nile Valley system	92.9	12.5	87.5	2.92	8.11	68.0	40.0	8.48	8.41	3.69	1.50	45.6	6.50
	Reclaimed land system	-	-	-	-	-	-	-	-	-	-	-	-	
Silage	Nile Valley system	93.9	9.95	90.0	4.38	10.0	46.8	27.3	7.42	28.86	2.63	0.65	58.7	9.16
	Reclaimed land system	83.1	11.9	88.0	2.97	6.72	65.0	35.9	5.18	13.35	3.55	0.78	52.9	5.85
Crop residues														
Wheat straw	Nile Valley system	93.5	14.0	85.9	2.53	3.87	73.0	44.6	6.80	6.54	1.77	0.59	45.5	3.22
	Reclaimed land system	93.3	7.61	92.4	0.77	3.41	77.8	47.3	12.9	10.37	2.16	0.70	39.9	2.67
Rice straw	Nile Valley system	94.1	20.2	79.8	1.82	5.28	71.2	43.9	12.4	1.49	2.48	0.78	31.1	4.43
Peanut straw	Reclaimed land system	91.9	9.87	90.1	1.54	7.20	41.9	30.9	8.92	39.45	2.93	1.09	54.8	6.00

Fava bean straw	Reclaimed land system	92.9	8.77	91.2	2.63	5.26	65.3	46.6	10.9	18.03	2.83	1.47	46.6	3.76
Bean straw	Reclaimed land system	92.1	10.9	89.0	1.97	6.41	58.8	45.0	12.8	21.89	2.21	1.11	43.8	5.20
Cockspur straw	Nile Valley system	93.5	9.40	90.6	0.62	5.65	74.3	41.9	7.66	10.04	3.55	0.69	46.7	4.88

*Dry matter (DM); Organic matter (OM); Ether extract (EE); Crude protein (CP), Neutral detergent fiber (NDF); Acid detergent fiber (ADF); Acid detergent lignin (ADL); NFC: Non fiber carbohydrates; Neutral detergent insoluble nitrogen (NDICP); Acid detergent insoluble nitrogen (ADICP); Total digestible nutrients (TDN); DCP: Digestible crude protein.

Sources and chemical composition of feeds

Green forages and crop residues: The proximate analysis of green forages and crop residues in both districts is presented in Table (2). The levels of energy TDN and CP contents are mainly used to measure the nutritional values of feedstuffs. The CP content of different green forages varied between investigated areas. The CP was higher in clover, darawa (green maize stover), and water grass in Newly Reclaimed district than in Nile Valley district of Egypt. However, the protein content in the silage in Nile Valley district was higher than in Newly Reclaimed district. Furthermore, elephant grass was only observed in Nile Valley district with an average protein content of 8.11%. On the other hand, the energy content (TDN) of green forages (clover and darawa) was lower in Newly Reclaimed district than in Nile Valley district, while water grass and silage had a higher TDN value in Nile Valley district than in Newly Reclaimed district, even though they had a high protein content.

For crop residues, wheat straw was the most important crop by-product of feeding animals in both districts, with a comparable CP content, but a different TDN content, and a noticeably higher content of ash in Nile Valley district, roughly twice as much as in Newly Reclaimed district. Other crop residues involved in the diet of animals in Newly Reclaimed district, such as peanut straw, fava bean straw, bean straw, and water grass straw. Moreover, in Nile Valley district, rice straw was included in dietary of animals.

Concentrate feed mixture: Table (3) shows the proximate analysis and nutritional value of the ingredients of concentrated feed mixture (CFM) resources in both studied ~~areas~~ district. The CFM in the current study can be categorized into four classes as follows; a single ingredient such as wheat bran (average 15.5% CP and 68.5% TDN) and maize (average 8% CP and 75% TDN); a commercial feed mixture contained on average about 12% CP and 70% TDN; a formulated feed mixture (handmade at home) contained ~~in~~ on average 11.67% CP (Nile Valley district) and 15.94% CP (Newly Reclaimed district), but both similar TDN content averaging 72%. The last category is a blend of commercial and formulated feeds that contained 9.0% CP and 51% TDN in Nile Valley district, while the CP and TDN content were higher in Newly Reclaimed district being 11.5% and 62%, respectively.

Characteristics of feed intake and estimated requirements

The data in Table (4) represents the nutrient intakes and estimated nutrient requirements for cattle and buffalo at both sites through the season of conducting this study. The data shows that under the old system of farming in the Nile Valley district cattle and buffalo were supplied with a larger quantity of green forage ($P < 0.05$). However, the Nile Valley district had fewer varieties of crop residues ($P < 0.05$) compared to Newly Reclaimed district. The dry matter intake (DMI) from forage was 9.33 and 9.40 kg/h/d for cattle and buffalo, respectively, versus 6.12 and 6.84 kg/h/d for Nile Valley and Newly Reclaimed districts, respectively. Similar patterns were observed in DMI from CFM. Buffalo in Nile Valley farms had ($P < 0.05$) more DMI from CFM than Newly Reclaimed farms (5.70 vs. 3.78 kg/h/d). However, the differences in DMI from CFM between cattle in Nile Valley and Newly Reclaimed farms were not significant ($P = 0.38$). For DMI from straw, both cattle and buffalo farms in the Nile Valley district had a significantly ($P < 0.001$) less DMI than farms in the Newly Reclaimed district.

Table (4) shows the estimated animal requirements for TDN and CP according to the nutritional allowance of NRC (1988). Data show no significant differences in energy and protein requirements for maintenance (TDN_m and CP_m). However, the requirements for milk production were significantly differed between both districts ($P < 0.05$). Both cattle and buffalo farms in Nile Valley district had ($P < 0.05$) a higher production requirement for energy and protein (TDN_l and CP_l). In addition, Nile Valley farms had a significantly higher ($P < 0.05$) total daily requirement for energy and protein compared to farms in Newly Reclaimed district. The total daily requirements were 6.61 and 7.49 kg TDN/h/d ($P < 0.05$), and 1.20 and

Table 3: Chemical composition and nutritive value of ingredient of concentrate feed mixture resources in the study areas

Feedstuff	District	*Chemical composition (% DM)											Nutritive value, %	
		DM	Ash	OM	EE	CP	NDF	ADF	ADL	NFC	NDICP	ADICP	TDN	DCP
Wheat bran	Nile Valley system	91.0	5.02	94.9	3.70	16.0	44.4	12.4	4.25	30.9	5.13	0.54	68.9	15.8
	Reclaimed land system	90.9	5.01	94.9	4.11	15.0	39.2	12.5	3.67	36.7	5.09	0.52	71.7	14.9
Corn	Nile Valley system	-	-	-	-	-	-	-	-	-	-	-		-
	Reclaimed land system	90.8	2.05	97.9	4.57	8.30	31.8	9.01	3.53	53.2	3.11	0.90	78.1	7.68
Commercial mixture	Nile Valley system	91.6	8.24	91.7	4.29	12.3	29.2	12.8	4.48	45.9	3.15	1.63	71.6	11.9
	Reclaimed land system	91.0	6.44	93.6	3.45	11.9	25.3	12.6	4.49	52.9	2.87	0.73	61.5	9.97
Formulated mixture	Nile Valley system	91.8	8.44	91.6	5.02	11.7	28.6	10.4	3.52	46.3	3.28	0.97	77.2	11.2
	Reclaimed land system	90.9	4.73	95.3	4.15	15.9	29.0	11.5	4.31	46.1	3.83	1.00	76.0	15.6
Commercial + Formulated mixture	Nile Valley system	92.5	12.3	87.7	5.48	9.07	49.0	28.9	10.6	24.1	3.84	1.22	56.8	9.31
	Reclaimed land system	91.6	6.52	93.5	5.07	11.5	45.2	25.5	7.54	31.6	3.72	1.00	63.9	9.86

*Dry matter (DM); Organic matter (OM); Ether extract (EE); Crude protein (CP), Neutral detergent fiber (NDF); Acid detergent fiber (ADF); Acid detergent lignin (ADL); NFC: Non fiber carbohydrates; Neutral detergent insoluble nitrogen (NDICP); Acid detergent insoluble nitrogen (ADICP); TDN: Total digestible nutrients; DCP: Digestible crude protein.

Table 4: The nutrient intakes and estimated nutrient requirements for cattle and buffalo at both sites

Items	District	Cattle			Buffalo		
		N	Mean ± SEM	P value	N	Mean ± SEM	P value
Feed intakes							
Forages							
Intake as fed, kg/h/d	Nile Valley system	14	39.3 ± 4.03	0.02	19	40.2 ± 3.66	0.19
	Reclaimed land system	17	25.8 ± 4.42		8	30.0 ± 6.00	
Intake as DM basis, kg/h/d	Nile Valley system	14	9.33 ± 0.95	0.03	19	9.40 ± 0.86	0.16
	Reclaimed land system	17	6.12 ± 1.09		8	6.84 ± 1.54	
Concentrate							
Intake as fed, kg/h/d	Nile Valley system	15	5.10 ± 0.37	0.41	17	6.21 ± 0.50	0.002
	Reclaimed land system	26	4.76 ± 0.23		11	4.14 ± 0.28	
Intake as DM basis, kg/h/d	Nile Valley system	15	4.67 ± 0.34	0.38	17	5.70 ± 0.47	0.005
	Reclaimed land system	26	4.34 ± 0.21		11	3.78 ± 0.26	

Straw							
Intake as fed, kg/h/d	Nile Valley system	15	3.93 ± 0.25	< 0.001	18	4.11 ± 0.24	< 0.001
	Reclaimed land system	24	7.22 ± 0.64		10	7.65 ± 0.95	
Intake as DM basis, kg/h/d	Nile Valley system	15	3.68 ± 0.23	0.004	18	3.84 ± 0.22	0.01
	Reclaimed land system	24	6.36 ± 0.67		10	6.89 ± 0.96	
Estimated requirements (Maintenance and production)							
[1]TDN_m, kg	Nile Valley system	14	3.80± 0.06	0.45	20	4.55 ± 0.09	0.22
	Reclaimed land system	27	3.83 ± 0.04		11	4.43 ± 0.12	
[2]CP_m, kg	Nile Valley system	14	0.45 ± 0.01	0.51	20	0.54 ± 0.02	0.19
	Reclaimed land system	27	0.44 ± 0.01		11	0.53 ± 0.04	
[3]TDN_l, kg	Nile Valley system	14	2.81 ± 0.30	< 0.001	20	2.93 ± 0.20	0.09
	Reclaimed land system	27	1.44 ± 0.12		11	2.17 ± 0.39	
[4]CP_l, kg	Nile Valley system	14	0.76 ± 0.08	< 0.001	20	0.80 ± 0.06	0.09
	Reclaimed land system	27	0.39 ± 0.03		11	0.59 ± 0.11	
Total TDN, kg	Nile Valley system	14	6.61 ± 0.30	< 0.001	20	7.49 ± 0.20	0.03
	Reclaimed land system	27	5.27 ± 0.13		11	6.59 ± 0.38	
Total CP, kg	Nile Valley system	14	1.20 ± 0.08	< 0.001	20	1.34 ± 0.06	0.06
	Reclaimed land system	27	0.83 ± 0.03		11	1.12 ± 0.10	

[1]TDN_m:Total digestible nutrients for maintenance; [2]CP_m: Crude protein for maintenance;
[3]TDN_l: Total digestible nutrients for lactation; [4]CP_l: Crude protein for lactation.

Table 5: Livestock efficiency of lactation characteristics

Items	District	Cattle			Buffalo		
		N	Mean ± SEM	P value	N	Mean ± SEM	P value
Lactation, No.	Nile Valley system	14	4.54 ± 0.48	0.32	18	4.20 ± 0.55	0.68
	Reclaimed land system	27	4.18 ± 0.47		10	4.55 ± 0.54	
Lactation, Month	Nile Valley system	14	3.62 ± 0.69	0.09	19	5.97 ± 0.47	0.36
	Reclaimed land system	27	5.68 ± 0.60		11	6.68 ± 0.59	
Gestation, Month	Nile Valley system	14	1.55 ± 0.50	0.75	18	3.13 ± 0.48	0.91
	Reclaimed land system	27	1.73 ± 0.35		11	2.91 ± 0.79	
Milk yield, kg/d	Nile Valley system	14	7.86 ± 0.79	< 0.001	19	6.75 ± 0.44	0.004
	Reclaimed land system	27	4.94 ± 0.35		11	4.14 ± 0.76	
[1]FCM, kg/d	Nile Valley system	14	8.20± 0.91	0.001	19	6.22 ± 0.39	0.08
	Reclaimed land system	27	4.43 ± 0.33		11	4.71 ± 0.85	
Fat, %	Nile Valley system	12	3.18 ± 0.41	0.78	17	6.25 ± 0.38	0.09
	Reclaimed land system	24	3.11 ± 0.36		11	8.05 ± 0.93	
Protein, %	Nile Valley system	12	3.14 ± 0.17	0.3	17	3.96 ± 0.10	0.13
	Reclaimed land system	24	3.18 ± 0.07		11	3.60 ± 0.25	
Lactose, %	Nile Valley system	12	4.97 ± 0.11	0.08	17	6.23 ± 0.37	0.15
	Reclaimed land system	24	4.78 ± 0.10		11	5.41 ± 0.37	
Ash, %	Nile Valley system	12	0.73 ± 0.02	0.08	17	0.88 ± 0.02	0.14
	Reclaimed land system	24	0.70 ± 0.02		11	0.80 ± 0.06	
[2]SNF, %	Nile Valley system	12	9.02 ± 0.18	0.08	17	10.7 ± 0.24	0.15
	Reclaimed land system	24	8.70 ± 0.19		11	9.81 ± 0.69	
Total solids, %	Nile Valley system	12	12.2 ± 0.49	0.28	17	16.9 ± 0.26	0.48
	Reclaimed land system	24	11.8 ± 0.48		11	17.8 ± 1.18	

[3]F:P ratio	Nile Valley system	12	0.71 ± 0.29	0.91	17	1.64 ± 0.13	0.08
	Reclaimed land system	24	0.96 ± 0.10		11	2.58 ± 0.47	
[4]MUN, (mg/dl)	Nile Valley system	11	23.6 ± 3.01	0.03	17	22.7 ± 1.42	< 0.001
	Reclaimed land system	27	15.9 ± 1.03		11	15.2 ± 1.06	

[1]FCM: Fat corrected milk; [2]SNF: Solids non-fat; [3]F: P ratio: Fat: protein ration in milk; [4]MUN Milk urea nitrogen.
Fat corrected milk for cow milk was calculated on basis 3.5% fat as follow equation: FCM 3.5% = ((0.35 * milk yield) + 18.57 * (milk yield * fat% / 100)) according to Parekh (1986); while Fat corrected milk for buffalo milk was calculated on 7% fat as follow equation: FCM 7% = ((0.265 * milk yield) + 10.5 * (milk yield * fat / 100)) according to (Raafat et al. 1963)

Table 6: Pearson correlation coefficients between milk urea nitrogen (MUN) and milk yield and DM, CP, TDN and CP/TDN ratio of concentrate, forage, and straw.

	Concentrate intake			Forages intake			Straw intake			Total intake			CP/TDN
Item	**DM**	**CP**	**TDN**	**DM**	**CP**	**TDN**	**DM**	**CP**	**TDN**	**DM**	**CP**	**TDN**	
[1]MUN	0.07	0.04	0.06	0.54	0.49	0.52	-0.35	-0.20	-0.32	0.34	0.41	0.33	0.29
P value	0.56	0.75	0.62	<.001	<.001	<.001	0.005	0.11	0.01	0.01	0.001	0.01	0.02
Milk yield	0.21	0.23	0.25	0.36	0.29	0.43	-0.36	-0.22	0.31	0.36	0.28	0.46	0.31
P value	0.04	0.03	0.02	0.01	0.01	<.001	0.001	0.11	0.01	0.001	0.01	<.001	0.02

DM: Dry matter; CP: Crude protein; TDN: Total digestible nutrients (TDN); MUN: Milk urea nitrogen; CP/TDN: Crude protein/ Total digestible nutrients ratio

1.34 kg CP/h/d for cattle and buffalos, respectively.

Livestock efficiency characteristics assessment

Lactation characteristics: Table (5) shows the average daily milk yield and composition of the farms in Nile Valley and Newly Reclaimed districts. The data shows a significant difference in daily milk yield between both Nile Valley and Newly Reclaimed farms (P < 0.05) throughout the studied season. Farms located in Nile Valley district produced more milk yield (kg/d) for both cattle (P < 0.001) and buffalo (P = 0.004) (7.86 and 6.75 kg/d, respectively). Also, fat-corrected milk (FCM, 4% fat for cattle and 7% fat for buffalo) was higher in Nile Valley farms (P < 0.001 for cattle; P = 0.08 for buffalo) (8.20 and 6.22 kg/d, respectively). However, no significant differences were observed in milk fat, protein, lactose, solids not fat, total solids, and ash between farms. In general, farms in-Nile Valley district had lower numerical values for the milk fat to protein (F: P) ratio. Cattle in all areas under this study showed a lower F: P ratio than the optimal ratio. Buffalo's milk contains more fat than cattle's and has an F: P ratio of about 2. Data show that the F: P ratio in all farms in the Newly Reclaimed district is numerically higher (P = 0.08) than in Nile Valley district. Most Newly Reclaimed district buffalo farms had F: P ratios above 2, whereas El-Atf farms had values below 2.

The concentration of MUN was significantly different (P < 0.05) between the two locations (Nile Valley and Newly Reclaimed districts). MUN levels in cattle and buffalo milk were higher in Nile Valley farms (23.66 and 22.76 mg/dl, respectively). Small-scale dairy farms showed a significant difference (P = 0.001) in MUN levels (Fig. 3). The normal MUN level (12-18 mg/dl) was recorded in 19.23 % and 47.37% of farms in Nile Valley and Newly Reclaimed districts, respectively. While low MUN levels (12 mg/dl) were found in 7.69% and 26.32% of farms in Nile Valley and Newly Reclaimed districts, respectively, high MUN levels (> 18 mg/dl) were found in 73.08% and 26.32% of farms.

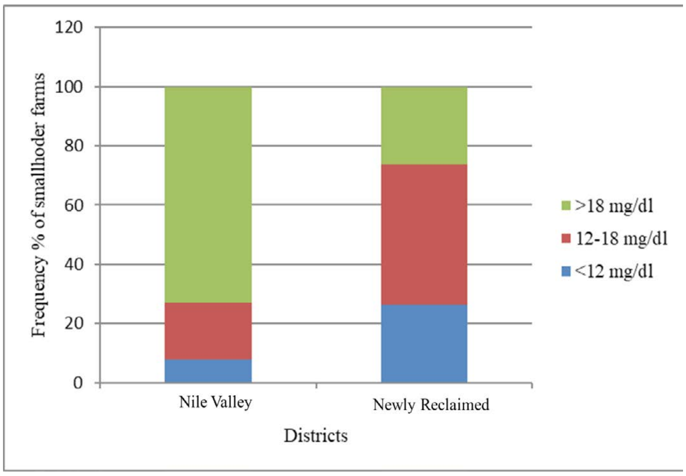

Figure 3: Frequency percentage of smallholder farms with different milk urea nitrogen (MUN) level (>18, 12 – 18, <12 mg/dl) in Nile Valley system and Reclaimed system districts

Moreover, correlation coefficients among MUN and milk yield, DMI, CP, and TDN are shown in Table (6). MUN was found to be positively and significantly ($P < 0.001$) correlated with forage DM, CP, and TDN intakes. Meanwhile, negative and significant correlations were found among MUN and DM, CP and TDN intakes of straw. Also, it was obvious that the correlation coefficient among MUN, CP, TDN ratio were positive and significant ($P = 0.021$). Moreover, positive and significant ($P < 0.05$) correlation coefficients were found between milk yield and DMI, CP, and TDN of concentrate and green forages offered to dairy animals. Whereas a negative and significant ($P < 0.05$) correlation was found between milk yield and crop residues offered to animals (Table 6).

Feed cost indicators

Data in Table (7) shows the feed cost and utilization for cattle and buffalo on smallholder farms in both districts. Whereas the higher cost of green fodder per head and per 1 kg of milk produced/day was noticed in the Nile Valley farms ($P < 0.05$). Meanwhile, the cost of crop residues per head and per 1 kg of milk produced/day was higher in Newly Reclaimed farms ($P < 0.05$). However, total feed cost per head was higher ($P < 0.05$) in Nile Valley compared to Newly Reclaimed district, whereas the total feed cost to produce 1 kg of milk was higher ($P < 0.05$) in Newly Reclaimed than in-Nile Valley district, as well as the cost of concentrate. So, the total feed cost represents about 80.37% and 73.67% of total milk income in Nile Valley district compared with 128.09% and 100.35% in Newly Reclaimed district for cattle ($P < 0.001$) and buffalo ($P = 0.04$), respectively. The ratio of concentrate feed offered for animals to produce 1 kg of milk was significantly ($P < 0.05$) higher in Newly Reclaimed district compared with Nile Valley district smallholder dairy farms, whereas the total dry matter intake to produce 1 kg of milk did not differ significantly between the two studied areas. The percentage of forage DM feed to dairy animals in Nile Valley farms was numerically greater than ($P = 0.01$) in Newly Reclaimed farms, whereas the percentage of crop residues was significantly ($P = 0.01$) higher in Newly Reclaimed district. However, there was no significant difference in the percentage of concentrates offered to cattle between farms in both districts.

Feeding practices protocol

In Table (8) shows indicator parameters that used to assessment the feeding practices and the slandered values for each indicator. Concentrate DM/kg milk ratio where farmers tend to minimize purchased concentrate feed cost price to improve the profit, where ranged from 0.26 in the fourth quartile to 1.29 in the first quartile. Moreover, the concentrate DM/Kg milk ratio and total feed cost per daily milk (kg) gave higher estimates for newly reclaimed land than Nile valley land. The CP and TDN ratio were used as a diet balance for dairy cattle. Milk fat- protein ratio indicated that in newly reclaimed land 50 % of animals less than the normal range (1.2-1.4) while 50 % of animals in Nile valley land over the normal range. FCM was higher in Nile valley land compared to newly reclaimed land.

In Figure (4) Clearfield the protocol that could be conducted at smallholder dairy farms to check and aliment the feeding practices to achieve good profitability at on a small scale. The suggestion assessment protocol was started with survey analysis merged with milk sampling and analysis for feed and milk. Calculation for nutritional requirements was conducted to identify the nutritional gap through statistical analysis and standardized parameters. Farms parameters deviations from standards were considered to formulate recommendation for farmers.

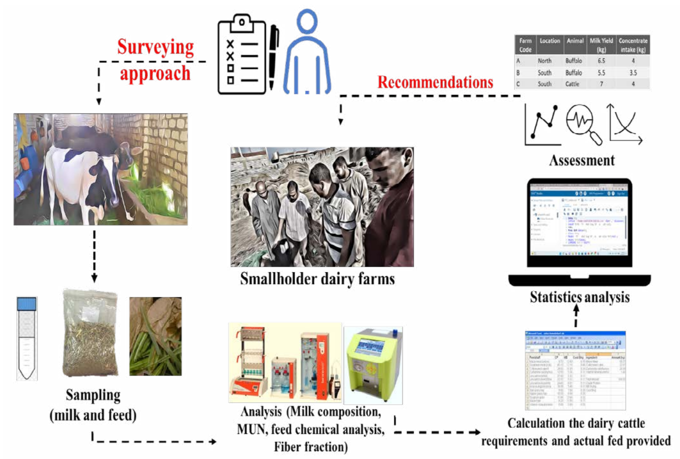

Figure 4: Assessment feeding practices protocol at smallholder dairy farm.

DISCUSSION

Characterization of feeding practices, intakes and feed sources

Assessment of feeding practices could be shed light on feeding problems that face smallholder dairy farmers. However, the reports related to assessment of feeding practices and productivity in smallholder dairy farmers are limited. So, the present results will be compared with previous reports to develop an assessment protocol to evaluate feeding practices at small dairy farms. In present study smallholder farmers depend on all forage types as well as commercial mixture in feeding their dairy animals that were similar to those reported by Khalil and El-Ashmawy (2009), who found the crop pattern of small farmers in their investigation, was concentrated on sorghum, darawa, and alfalfa in summer, with the average milk yield for buffalo and cow being 5.5 kg/head/day. It also found the farmers in Upper Egypt need simple and innovative feeding methods to improve animal productivity.

Additionally, most farmers in both studied districts use

Table 7: Feed cost and utilization indicators for cattle and buffalo of smallholder farms at two districts

Items	District	Cattle			Buffalo		
		N	Mean ± SEM	P value	N	Mean ± SEM	P value
Forages cost, LE/h/d*	Nile Valley system	14	10.6±1.83	0.02	19	10.7±1.29	0.57
	Reclaimed land system	17	4.09±1.46		8	5.70±1.81	
Forages cost, LE/kg milk/d**	Nile Valley system	14	1.57±0.24	0.03	19	1.83±0.22	0.83
	Reclaimed land system	17	0.90±0.19		8	1.42±0.35	
Concentrate cost, LE /h/d	Nile Valley system	15	26.2±1.65	0.08	17	28.8±2.58	0.13
	Reclaimed land system	26	22.5±1.31		11	21.4±4.02	
Concentrate cost, LE/kg milk/d	Nile Valley system	15	3.46±0.34	0.14	17	4.38±0.45	0.54
	Reclaimed land system	26	4.59±0.27		11	5.90±0.70	
Straw cost, LE /h/d	Nile Valley system	15	7.55±1.28	0.02	18	8.37±0.73	0.01
	Reclaimed land system	24	12.8±1.02		10	13.0±1.13	
Straw cost, LE/kg milk/d	Nile Valley system	15	1.01±0.26	0.01	18	1.40±0.26	0.001
	Reclaimed land system	24	2.40±0.20		10	3.22±0.41	
Total feed cost, LE /h/d	Nile Valley system	15	45.3±2.28	0.04	19	47.7±2.31	0.34
	Reclaimed land system	26	40.2±1.81		11	42.6±3.59	
Total feed cost, LE/kg milk/d	Nile Valley system	15	5.96±0.52	0.04	19	7.60±0.55	0.02
	Reclaimed land system	26	7.40±0.40		11	10.0±0.85	
% Total feed cost/milk income	Nile Valley system	15	80.4±9.84	<0.001	19	73.7±5.58	0.04
	Reclaimed land system	26	128±7.62		11	100±8.67	
Concentrate DM/milk ratio	Nile Valley system	15	0.67±0.15	0.02	17	0.84±0.26	0.01
	Reclaimed land system	26	0.98±0.11		11	1.05±0.35	
Total DM intake offered, kg / Milk yield, kg	Nile Valley system	15	2.81±0.51	0.16	19	3.38±0.80	0.13
	Reclaimed land system	26	2.84±0.39		11	4.24±1.05	
%Concentrate intake DM / Total DM intake	Nile Valley system	15	0.29±0.04	0.32	17	0.27±0.03	0.79
	Reclaimed land system	26	0.34±0.03		11	0.28±0.04	
%Forage intake DM /Total DM intake	Nile Valley system	14	0.48±0.06	0.01	19	0.52±0.05	0.01
	Reclaimed land system	17	0.25±0.05		8	0.29±0.06	
%Straw intake DM /Total DM intake	Nile Valley system	15	0.23±0.05	0.01	18	0.21±0.04	0.01
	Reclaimed land system	24	0.41±0.04		10	0.42±0.05	
CP/TDN ratio	Nile Valley system	15	0.17±0.01	0.13	19	0.18±0.01	0.28
	Reclaimed land system	26	0.15±0.01		11	0.16±0.01	

* Forages cost, LE/h/d: Forage cost, Egyptian Pound/head/day.

**Forages cost, LE/kg milk/d: Forage cost, Egyptian Pound/kg milk/day.

CP/TDN ratio: Crude protein/ Total digestible nutrients ratio

Table 8: Assessment indicators standards of feeding efficiency

Indicator	District	Overall average	Frequency % of smallholder farms more than overall average	Average of quarters (Q)				Standardization
				Q1	Q2	Q3	Q4	
Concentrate DM/kg milk ratio	Nile Valley system	0.76	45%	1.29	0.86	0.65	0.26*	As minimum as possible
	Reclaimed land system	1.02	39%	2.34	1.18	0.79	0.44*	
Total feed cost, LE/kg milk/d	Nile Valley system	7.35	41%	12.25	7.80	5.87	3.64*	As minimum as possible
	Reclaimed land system	9.23	46%	17.74	10.94	7.42	5.14*	
[1]CP/TDN ratio	Nile Valley system	0.17	50%	0.23	0.18	0.16	0.13	
	Reclaimed land system	0.16	39%	0.19	0.16	0.15	0.13	
[2]MUN	Nile Valley system	22.97	65%	31.77	25.54	20.76	12.73*	Ranged 12-18 mg/dl
	Reclaimed land system	15.72	62%	22.44	16.60*	13.35*	10.36	
[3]Milk F:P ratio	Nile Valley system	1.38	54%	2.17	1.51	1.21*	0.71	Ranged 1.2 – 1.4
	Reclaimed land system	1.47	29%	3.05	1.39*	0.88	0.56	
[4]FCM, kg/d	Nile Valley system	7.06	45%	10.55*	7.21	6.48	3.98	As maximum as possible
	Reclaimed land system	4.51	39%	7.30*	4.60	3.68	2.26	

[1]CP/TDN: Total digestible nutrients/Crude protein ratio: [2]MUN Milk urea nitrogen. [3]F: P ratio: fat: protein ratio in milk; [4]FCM: Fat corrected milk

concentrate to fed their animals, which is formulated at home and mixed with roughage at feeding times. While on Newly Reclaimed district, farmers fed animals three times more than Nile Valley district (two times). They also used mixed roughages compared with Nile Valley district that fed on one type of roughage, mainly wheat straw. The green crop pattern differed in both studied districts, where water grass was the majority in both districts followed by darawa and clover. While on Newly Reclaimed system at that time, most farmers did not have a crop pattern (51.6 % of the farmer's interviewer). However, all farmers know about feed additives, but less than 50 % of farmers in two studied villages use them. On Nile Valley system, farmers used underground water while tap water was popular on new reclaimed land. This observation related to the location of the animal pen where in old land pen was located nearby cultivated land while in new reclaimed land the animal pen was close to farmers home that used the tap water. Also, free access to water was not a popular practice. Farmers introduced water two to three times on Nile Valley system, compared to Newly Reclaimed land that was introduced three to ≥ four. These results could ~~be~~ linked with feeding green crops (provide part of water) which fed more in old land.

Moreover, the ability to assess the quality of locally produced/available roughages is a crucial skill in feed management (Dairy Training Centre, 2017). Recent reports showed that roughages generally have the following characteristics: low TDN (+ less than 65% on a DM basis) and high crude fiber content (30% or more) as well as long particles that can increase rumen activity, commonly known as effective dietary fiber (Dairy Training Centre, 2017), which is consistent with current values. In addition, variations in chemical composition could be due to management strategies, soil fertility, and/or crop varieties used to explain the differences between regions (Chalchissa et al., 2014). Overall, the CP and TDN content of crop residues ranged from 3.41 to 7.20% and 28.59% to 52.53%, respectively, and this result is in agreement with that reported by Van Soest (1982) and Chalchissa et al. (2014).

However, concentrates, as opposed to roughages, are feedstuffs that digest quickly in the rumen and have a high energy and protein content. Additionally, concentrates are usually combined with an appropriate source of dietary fiber to meet the animal's needs. According to the Dairy Training Centre (2017) report, the concentrate feed mixture (CFMs) were grouped into three categories of CP content, which are used in the management of dairy cattle herds: low protein mixes of 10–15% CP/kg DM; medium protein mixes of 15–18% CP/kg DM; and high protein mixes of 18–25% CP/kg DM. Following this classification, the current CFM is categorized as having low protein content at both investigated villages. Generally, farmers were required to purchase most of the ingredients in concentrate feed or commercial mixtures from feed suppliers or small feed mills; while some farmers had the ability to formulate concentrate feed at home from their own farm crops, particularly corn grain. However, this practice (on-farm mixing) is usually cheaper and more confident in the ingredients in the formula, but it may not be advisable unless the farmer lacks all the necessary materials or mixing skills (Pandey and Voskuil, 2011).

Moreover, the animal requirements of energy (TDN form) and protein (CP form) estimated at current study estimated in both areas were showed no significant differences in energy and protein requirements for maintenance between cows and buffaloes according to NRC recommendations (1988). However, animals in Nile Valley system, on the other hand, had higher energy and protein requirements because they produced more milk.

Livestock efficiency characteristics assessment

Many factors could be assigned to evaluate livestock efficiency characteristics. A lactation characteristic such as the average daily milk yield and milk composition of the farms could be beneficial tools for practical dairy herd management. Additionally, milk fat: protein ratio (F: P) is a heritable trait that can be obtained through routine milk-recording schemes is a better predictor of the cow's energy status and was more sensitive to changes in dietary factors (Čejna & Chládek, 2005; Negussie et al., 2013). Cattle in all areas under this study showed a lower F: P ratio than the optimal ratio proposed by (Grieve et al., 1986; Toni et al., 2011). Moreover, many factors, including genetics, nutrition, management, and the environment, could influence milk fat and protein (Atasever and Stadnik, 2015; Dhaoui et al., 2019). However, nutrition and feeding systems are considered the most important remedies to any milk fat or protein problem (Dias and Fischer, 2021) and recording of daily milk yield and analysis of various milk components might be beneficial tools for practical dairy herd management . In addition, the fat and protein content of milk can provide insight into the ration, nutrition, metabolic status, lactation, fertility, and state of health (Atalay, 2019).

Nutrition, nutritional conversion, and metabolism can be evaluated by estimating the milk fat to milk protein ratio (Čejna & Chládek, 2005). Heuer et al. (1999) proposed threshold values for identifying health issues in dairy cows using milk composition analysis. Energy balance was found to be negatively related to milk fat percent (-0.07 to -0.65), positively related to milk protein percent (0.12 to 0.47), and negatively related to milk fat to protein ratio (-0.36 to -0.74) (Grieve et al., 1986). The most accurate test for subclinical ketosis was a protein-to-fat ratio of less than or equal to 0.75 (Duffield et al., 1997). The optimal F:P ratio is between 1.2 and 1.4. The low F:P ratio is caused by subclinical rumen acidosis, which impairs reproduction performance and results in mineral shortages (Atalay, 2019). Additionally, a F:P ratio greater than 1.4 indicates subclinical ketosis, which is detected by the presence of ketone bodies (Berge and Vertenten, 2014). Richardt (2004) reported that dairy cows with high values (over 1.5) may have a 1.5-fold increased risk of mastitis, a 7.5-fold increased inclination to lameness, and a 3.5-fold increased risk of ketosis. Toni et al. (2011) investigated the F:P ratio in three large Italian dairy herds, 35.8% of which were in their first lactation, and reported that the group with the lowest disease prevalence was found to be between 1 and 1.5. On the other hand, cows with F:P ratios lower than 1 were more likely to get sick (Richardt, 2004). But it looks like these threshold values should be used with care and changed to fit the dairy cow herd that is being studied.

Besides, milk constituents that could serve as marker for cow health and nutrition component levels also have a direct effect on farm income. The proportion of fat, protein, and other dairy solids in milk is used to determine milk prices in most milk marketing orders. The observed low F:P value could be an indicator of the high possibility of developing acidosis. Rumen acidosis is developed when an animal is fed a ration with a low level of NDF or physical effective fiber or when feeding a large amount of fast fermentable carbohydrates (McDonald et al., 2011). The feeding system usually used in most smallholder farms under this study was the component fed herds versus total mixed ration. However, increasing time without available feed may limit DMI as well as increase slug feeding and subacute rumen acidosis (Stone, 2004). Also, many farms were fed feedstuff containing high levels of fast fermentable carbohydrates such as wheat and corn as a feed supplement. Moreover, Buffalo's milk contains more fat than cattle's and usually has a F:P ratio of about 2. The current data shows numerically higher values for the F: P ratio in all farms located in the Newly Reclaimed district compared with Nile Valley district. Most El-Emam Malik buffalo farms had F: P ratios above 2, whereas Nile Valley farms had values below 2. While, cattle in all areas under this study showed a lower F: P ratio than the optimal ratio.

Additionally, the MUN reflects the feeding practices and could be used to predict nitrogen excretion and utilization efficiency in lactating dairy (Nousiainen et al., 2004), as MUN content is the milk trait that can give information about the dietary protein supply (a regimen contains too much or too little protein) and the nitrogen balance in the rumen (Baset et al., 2010; Glatz-Hoppe et al., 2020). The observed high levels of MUN in Nile Valley farms may reflect an imbalance between energy and protein in animal diets, followed by high feed costs and low production efficiency. Roy et al. (2003) reported that buffalo diets failed to assess nutrient requirements, resulting in adverse effects on milk production, reproduction, and health status on traditional Indian farms. In addition, the nitrogen released through the breakdown of body protein also contributes positively to the blood and milk urea content (Glatz-Hoppe et al., 2020). The MUN could be useful to reduce losses and maximize nitrogen use efficiency (Roy et al., 2011; Hof et al., 1997). Moreover, MUN has often been used to give an indication of the efficiency of N use and to predict N emissions to the environment (Nousiainen et al., 2004). Overall, in old lands, MUN was higher, which indicates an unbalanced protein: energy ratio. This feeding practice needs to change to decrease the costs and keep animals in a healthy status. The MUN had a positive correlation with forage intake and the ratio of CP/TDN and a negative correlation with straw intake as is present in (Table 6).

The feed intake in terms of concentrate and green fodder for fed buffalo and cow were higher on old land, while the feed intake of roughage was higher on New Reclaimed land. This observation interpreted the superiority of animals in the ~~old~~ Nile Valley land district, while the lactation period and days in milk were similar in both districts. Also, the fat content of buffalo milk was higher in New Reclaimed land, which was affected by more roughage types and the quantity of roughage fed. This result agrees with Shan-shan et al. (2016) and Peres et al. (2012), who reported that quantity and types of roughage are considered the key factors to improving milk production, fat content, and animal health. Further, the cost of producing one kg of milk was higher on New Reclaimed land than on Nile Valley land, which could be linked to the efficiency of producing milk yield. This large range gives an opportunity for improvement which could be related to availability of land for cultivating forage (Radwan, 2016). In addition, total feed cost price per each one kg milk is correlated with quantity of forage feeding and negatively correlated with off farm concentrate feed costs (Radwan, 2016). The observed rang that was 12.25 for Q1 while it estimated by 3.64 for Q4 proved the possibility of decreasing feeding costs at small dairy farms, indicated that total feed cost price at small scale was associated with parasitic control, on farm forage production and high genetic potentiality in feed conversion ratio. Moreover, the CP and TDN ratio were used as a diet balance for dairy cattle. Yoon et al. (2004) indicated that normal ranged from 12 to 18 mg/dl as ration diet balance indicator was on the range of 31.77 to 10.36 that proved the high variability in feeding practices and subsequent metabolism, newly reclaimed land farms tended to give narrow range compared with old land farms range, this could be attributed to introducing more balanced ration, which confirmed through the same narrow range trend for CP/ TDN on newly reclaimed land. This feeding practice needs to change to decrease the costs and keep animals in a healthy status through set up gathering both survey data and lab work including milk analysis and feed analysis data could deliver valuable protocol for feeding system analysis, by which extension people could identify strengths and weaknesses of feeding practices for each farm, developing standards and comparing individual farms with standards.

CONCLUSION

Feeding practices at small-scale dairy farming systems should be evaluated to conserve farmers' money, animals' health, and productivity. Mixed roughage types had a positive effect on fat%. Providing green fodder throughout the year could decrease the cost and enhance productivity. Milk analysis in terms of chemical composition and MUN could be used as diagnostic tools for feeding practices. Feeding practices assessment protocol should be based on both data collected through survey and lab work including feed and milk analysis, that could help to develop a simple check list-based protocol fitting small scale dairy farms.

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CONFLICT OF INTEREST

All authors declare that there are no present or potential conflicts of interest among authors and other people or organizations that could inappropriately bias their work.

AUTHORS CONTRIBUTION

Sherif Abdelghany: Set Work plan, participate in writing, questioner design and reviewing. Hossam Mahrous Ebeid: Manage and conduct lab. analysis, Participate in writing, participate in sampling process. Ahmed Abdelkader Aboamer: Conduct statistical analysis , participate in lab analysis. Mohamed Ali Radwan: Data tabulation, data collection, milk analysis and participated in writing. Rania Agam: Participated in writing, data editing and preparation for analysis.

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