Milk production under grazing of different pasture grasses in small-scale dairy systems in the highlands of central Mexico

F. López-González[1], M. Rosas-Dávila[1], M.D. Celis-Alvarez[1], E. Morales-Almaraz[2], I.A. Domínguez-Vara[2] and C.M. Arriaga-Jordán[1*]

[1] Instituto de Ciencias Agropecuarias y Rurales (ICAR), [2] Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado de México Instituto Literario # 100, C.P. 50000, Toluca, Estado de México.
[*]corresponding author email: cmarriagajordan@gmail.com/ cmarriagaj@uaemex.mx
Tel. and Fax: +52 (722) 296 55 52

Journal of Livestock Science (ISSN online 2277-6214) 8: 92-97
Received on 13/1/2017; Accepted on 17/3/2017

Abstract

The objective was to assess the productive performance of milking dairy cows grazing festulolium (*Lolium multiflorum* x *Festuca pratensis* variety Spring Green) or two varieties of perennial ryegrass (*Lolium perenne*) variety Bargala and variety Payday in small-scale dairy systems in central Mexico. Six Holstein cows were used in a set of two 3 X 3 Latin Squares design. Treatments were continuous grazing for 10 h/d of Bargala, Payday or Spring Green festulolium pastures, supplemented with 5 kg of commercial compound concentrate cow/day. Animal variables were milk yield, live weight, body condition score, and fat and protein content in milk. In pastures variables were net herbage accumulation (NHA), sward height, and chemical composition of hand-plucked samples of herbage in terms of crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), and the enzymatic *in vitro* digestibility of organic matter (IVDOM). There were no significant differences (P>0.05) among treatments for milk yield, milk composition or live-weight; nor there were differences (P>0.05) for pasture variables. Spring Green festulolium performed similarly in pasture and animal variables as Bargala or Payday perennial ryegrasses. It is concluded that the three grasses under grazing are adequate for small-scale dairy systems with no advantage in using festulolium.

Keywords: Intensive grazing; Temperate grasses; Small-scale milk production.

Introduction

Small-scale dairy systems (SSDS) in Mexico are a viable option for rural development (Alfonso-Ávila et al., 2012), since they provide incomes for family labour, higher than local wages, that enable families to overcome poverty indices (Espinoza-Ortega et al., 2007). SSDS are characterized by small farms with herds between 3 and 35 cows plus replacements, which rely on family labour (Fadul-Pacheco et al., 2013). SSDS in the highlands of central Mexico have high feeding costs with a large dependency on external inputs, mainly concentrates, such that the economic scale limits their sustainability (Fadul-Pacheco et al., 2013). Intensive grazing of cultivated pastures reduce feeding costs when compared to the traditional cut and carry system in farms with access to limited irrigation (Pincay-Figueroa et al., 2016).

Climate in central Mexico is marked by well-defined rainy (mid-May to mid-October) and dry seasons (mid-October to mid-May), and farmers have access to limited irrigation plus high stocking rates. Possible effects of climate change in Mexico may produce more extreme weather events that will impact agricultural production (Zamora, 2015), which in the highlands may be erratic or less rainfall. These factors represent climatic and management stresses to crops and cultivated pastures. Therefore, there is a need in SSDS to evaluate temperate grass species better adapted to these conditions.

The intergeneric hybrid festulolium (*Lolium spp. x Festuca spp.*) is promoted as having the hardiness and resistance to management and climatic stresses of the *Festuca spp.* progenitor, with the nutritive quality of *Lolium spp.*, the other progenitor; but there is no research in Mexico that evaluates it against other grass species.

The objective of this work was to assess the productive performance of milking dairy cows under intensive continuous grazing of festulolium (*Lolium multiflorum* x *Festuca pratensis*) variety Spring Green against two varieties of perennial ryegrass (*Lolium perenne*) available for temperate cultivated pastures under irrigation in central Mexico, variety Bargala and variety Payday, in the productive conditions of SSDS.

Materials and methods

Study site

Work took place in the municipality of Aculco in the State of Mexico (the state that surrounds Mexico City), in the central highlands of Mexico located between 20° 06’ and 20° 17’ N and between 99° 40’ and 100° 00’ W; a sub-humid temperate climate and mean altitude of 2440 m. Mean annual temperature is 13.2°C and between 700 and 1000 mm annual rainfall (Celis-Alvarez et al., 2016).

Experimental procedures

The study took place following a participatory livestock research approach (Conroy, 2005), in the farm managed jointly by four (brothers) participating small-scale dairy farmers, implementing a set of two (replicated) 3X3 Latin Squares design (Kaps and Lamberson, 2004), randomizing cows and treatment sequences in the first square, randomizing cows in the second square applying a mirror image of treatment sequences to minimize carry-over effects (Celis-Alvarez et al., 2016).

Six multiparous Holstein cows in mid lactation were used, with a mean milk yield of 14.2±1.3 kg cow/day and a mean live weight of 507±11 kg before the experiment. Cows were grouped in squares (three cows each) according to mean milk yield. Treatments were established in two contiguous pastures of 1.0 ha each divided in three sub-plots where each of the evaluated grass species were sown randomly; and one of the two squares of the design took place in each pasture. Therefore, each grass species was grazed by two cows on each of three experimental periods of 14 days duration (10 days for adaptation and 4 days for measurements) following the methodology of Pérez-Ramírez et al. (2012).

Treatments were *Lolium perenne* cv Bargala (Bargala), *Lolium perenne* cv Payday (Payday) and festulolium cv Spring Green (Festulolium). Each grass species was sown with 30 kg seed ha^{-1} associated with 3 kg seed ha^{-1} of white clover (*Trifolium repens*) cv Ladino. Cows continuously grazed for 10 h/day and received 5.0 kg cow/day of a commercial compound concentrate with 18% crude protein (CP), provided in two meals of 2.5 kg during each of two milkings at 06:00 and 18:00 h.

Daily milk yield (kg/cow) was recorded for four consecutive days during measurement periods, and milk samples analysed for milkfat and protein content with ultrasound equipment. Mean values for these variables were used in data analysis. Live-weight and body condition score was recorded on the last day of each experimental period.

Herbage mass (HM) was estimated from weekly mean sward height, which was recorded with 10 measurements per plot (0.33 ha) with a rising plate grass-meter at the end of each period, using a calibration equation developed previously.

Hand-plucked samples of herbage simulating grazing were taken at the end of each period, and neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined following the ANKOM (2005) micro-bag method. Crude protein (CP) was determined with the Kjeldahl method (AOAC, 1990). Enzymatic *in vitro* organic matter digestibility (IVOMD) was determined following procedures described by Riveros and Argamentaría (1987). Herbage intake was estimated from metabolizable energy requirements from animal performance, and the estimated metabolizable energy content of feeds following Hernández-Mendo and Leaver (2006). Estimated metabolizable energy content of feeds was calculated with the following equation (AFRC, 1993):

$$ME\ (MJkg^{-1}DM) = (IVOMD)(0.0157)$$

Economic analyses

An economic analysis was done by partial budget analysis (Dillon and Hardaker, 1980), taking into consideration all feeding costs (pasture establishment, irrigation, fertilizers, as well as concentrates) and returns from milk sales as has been done in previous works (Martínez-García et al., 2015).

Statistical analysis

Results were analyzed with the following model (Celis-Alvarez et al., 2016): $Y_{ijkl}=\mu+S_i+C_{j(i)+}P_k+t_l+e_{ijkl}$

Where: Y= Response variable, μ= General mean, S= Effect of squares (i= 1, 2), C= Effect of cows within squares (j= 1, 2, 3), P= Effect of experimental periods (k= 1, 2, 3), t= Effect of treatments (l= 1, 2, 3), and e= Experimental residual term.

Results

Table 1 shows the results of animal performance variables, with no significant differences (P>0.05) among treatments for milk yield, live weight or body condition score. There were also no significant differences among treatments (P>0.05) for milk composition or for milk urea nitrogen (MUN). Table 2 shows results for pasture variables, with no significant differences among grass species and varieties evaluated (P>0.05) for sward height, herbage Mass (HM), crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), and IVOMD. Estimated herbage mass from sward height represented an herbage allowance of 9.8 kg DM cow/day.

Table 1. Milk yield, chemical composition of milk, and milk urea nitrogen.

Treatment	MY (kg cow/day)	Milk Fat (g/kg)	Milk Protein (g/kg)	MUN (g/dl)	Live Weight (kg)	BCS (1-5)
Bargala	15.5	34.3	32.88	11.6	521.3	2.7
Payday	15.8	34.12	32.18	11.7	524.1	2.5
Festulolium	15.8	34.26	31.76	11.9	513.0	2.7
Mean	15.7	34.23	32.27	11.7	519.0	2.6
SEM	1.23^{NS}	1.23^{NS}	0.83^{NS}	0.78^{NS}	24.3^{NS}	0.13^{NS}

^{NS} P>0.05, MY= Milk yield, MUN= Milk urea nitrogen, BCS= Body condition score, SEM= Standard error of the mean, ^{NS} P>0.05

Table 2. Sward height, herbage mass (HM) and chemical composition of herbage.

Treatment	Bargala	Payday	Festulolium	Mean	SEM
Sward height (cm)	5.5	6.1	5.8	5.8	0.12^{NS}
HM (kg DM ha^{-1})	1678	1815	1748	1747	957^{NS}
CP (g kg DM^{-1}	176.2	179.7	183.8	179.9	6.6^{NS}
NDF (g kg DM^{-1})	530	530	515	525	10.2^{NS}
ADF (g kg DM^{-1})	276	281	265	274	8.6^{NS}
IVDOM (g kg DM^{-1})	711.5	716.7	736.2	721.5	12.96^{NS}
eME (MJ/kgMS)	11.1	11.2	11.5	11.2	0.19^{NS}

HM= Herbage mass, NDF= Neutral detergent fibre, ADF= Acid detergent fibre, IVDOM= *In vitro* enzymatic digestibility of organic matter, eME= Estimated Metabolizable energy, SEM= Standard error of the mean, ^{ns} P>0.05

Table 3. Estimated feed intake (kg MS cow/day)

	Treatments				
	Bargala	Payday	Festulolium	Mean	SEM
Concentrate	4.51	4.51	4.51	4.51	
Estimated herbage intake	7.37	7.41	7.11	7.30	0.19^{NS}
Total intake	11.88	11.92	11.62	11.81	0.19^{NS}

SEM= Standard error of the mean, ^{NS} P>0.05

Table 3 shows results for intake, with on statistical differences among treatments (P>0.05), with a mean estimated herbage intake of 7.30 kg DM cow/day. Table 4 and 5 present the economic analysis, with a higher feeding cost under festulolium compared against the two perennial ryegrass varieties given the higher cost of seed, resulting in a higher income from grazing Bargala and Payday perennial ryegrasses.

Table 4. Pasture Production costs (US$)

Pasture	**Festulolium (US$/ha)**	**Bargala (US$/ha)**	**Payday (US$/ha)**
Land preparation and sowing	100.89	100.89	100.89
Seed	381.54	297.86	301.42
Fertilization	110.03	110.03	110.03
Irrigation	94.96	94.96	94.96
Total cost ha^{-1} $year^{-1}$	687.42	603.74	607.30
Daily cost ha^{-1}	1.88	1.65	1.66

Table 5. Feeding costs and returns (US$)

Variable	**Festulolium**	**Bargala**	**Payday**
Feeding costs			
Concentrate (US$)	123.38	123.38	123.38
Grazed pasture (US$)	79.09	69.47	69.86
Total (US$)	**202.47**	**192.85**	**193.25**
Returns			
Milk production (kg in 42 days)	1327.2	1302.0	1327.2
Sale price (US kg^{-1})	0.33	0.33	0.33
Returns from milk sales (US$)	433.21	424.99	433.21
Margin over feeding cost (US$)	230.74	232.14	239.96
Feeding costs (US$/kg)	0.15	0.15	0.15
Returns/feeding costs (US$)	2.14	2.20	2.24

Discussion

Mean milk yield for the three grass treatments was 15.7 kg cow/day , higher than reports from Alfonso-Ávila et al. (2012) and Martínez-García et al. (2015) for SSDS in the study area under conventional feeding strategies; and similar to reports by Guadarrama-Estrada et al. (2007) of 15 kg cow/day. However, milk yields are lower from other reports of grazing dairy cows in SSDS in central Mexico (Heredia-Nava et al., 2007, Anaya-Ortega et al., 2009; Hernández-Ortega et al., 2011; Albarran et al., 2012), with milk yields over 18 kg cow/day; and lower the near 20 kg cow/day reported by Miguel et al. (2014) in south Brazil, although there, cows were heavier.

Results demonstrate that feeding strategies based on grazing good quality temperate pastures in SSDS of the highlands of central Mexico at a stocking rate of 3.0 cows/ha, and moderate concentrate supplementation, are able to meet cow requirements for milk yields between 15 and 20 kg cow/day, depending on stage of lactation and season.

Milk fat and milk protein content were above Mexican standards for raw milk; with values similar to those reported by Alfonso-Ávila et al. (2012) from work in the study area, and from international work, similar to reports from Bustamante-Cordoba et al. (2016) from work in Colombia, and from Morales-Almaraz et al. (2011) and Hernández-Ortega et al. (2014) from work in Asturias in Spain; but lower than reports by Castro-Hernández et al. (2014) who report 36.7 g/kg. Protein content of milk was similar to reports by Alfonso-Ávila et al. (2012) in the study area, and to work by Morales-Almaraz et al. (2011) and Hernández-Ortega et al. (2014) in northern Spain. Mean milk urea nitrogen (MUN) concentration in milk was 11.7 mg/dL, similar to findings by Alfonso-Ávila et al. (2012) in the study area under conventional feeding strategies with a mean value of 11.5 mg/dL. Observed values are within typical MUN concentration between 10 a 16 mg dL^{-1}, reported by Wattiaux et al. (2005) for high yielding dairy cows in the Midwest of United States of America. Obtained results indicate an adequate protein nutrition of the milking cows during the experiment (Nousiainen et al., 2004).

There were no significant differences (P>0.05) on the mean estimated herbage mass during the experiment, denoting a limiting herbage availability for the grazing cows of 9.8 kg DM cow/day; similar to other reports evaluating grazing of cultivated perennial ryegrass-white clover pastures in SSDS with high stocking rates under continuous grazing (Heredia-Nava et al., 2007; Anaya-Ortega et al., 2009; Hernández-Ortega et al., 2011). Mean grass-meter sward height was within recommended sward heights under continuous grazing to avoid restricting intake (Mayne et al., 2000). Observed grass-meter sward height was above reports by Heredia-Nava et al. (2007) and Albarran et al. (2012), although these authors reported higher milk yields. Mean crude protein content for the three grasses evaluated was nearly 180 g/kg DM, similar to other reports of CP content in ryegrass pastures in Mexico (Hernández-Ortega et al., 2011) although lower than reports by Garduño-Castro et al. (2009) and Heredia-Nava et al. (2007). Structural carbohydrates determine both herbage intake (NDF) as well as the digestibility (ADF) of herbage. NDF in the evaluated grasses was around 500 g kg^{-1} DM, and ADF just under 280 g kg^{-1} DM, which indicate high quality of herbage, as shown by the IVOMD over 700 g kg^{-1} DM. These results are similar to other reports on perennial ryegrass-white clover pastures in central Mexico (Heredia-Nava et al., 2007; Hernández-Ortega et al., 2011), although Garduño-Castro et al. (2009) and Albarran et al. (2012) reported higher NDF and ADF contents. Estimated herbage intake was similar for the three grasses evaluated with a mean intake of 7.30 kg DM/cow/day of pasture herbage, much lower than reports from (Hernández-Mendo y Leaver (2004; 2006) who report daily herbage intake of 10 and 12 kg DM/cow, but with larger cows and higher milk yields, and much lower than the 14 kg DM cow/day mean daily pasture intake reported by Miguel et al. (2014) but with higher yielding cows.

Feeding costs were influenced by a 27% higher cost of festulolium seed, which represented slightly higher feeding costs (13.5%) than for the two perennial ryegrass varieties; although it was only reflected in marginally higher margins over feed costs; with a marginal difference (3.8%) of a higher return/cost ratio for the ryegrasses.

Conclusion

Animal productivity and pasture variables were not significantly different among the evaluated grass varieties. Both the Bargala and Payday perennial ryegrass and the Spring Green festulolium performed similarly, so that there is no advantage of using the more expensive festulolium seed in small-scale dairy systems.

Acknowledgements

Authors express gratitude to the farmers who participated in this experiment who had knowledge of the objectives of the work and were duly informed at all times, and their privacy and that of their family is respected by not disclosing their names. This work was undertaken thanks to funding by *Consejo Nacional de Ciencia y Tecnología - CONACYT* (grant 129449 CB-2009).

References

1) AFRC. 1993. Energy and Protein Requirements for Ruminants. An advisory manual prepared by the AFRC technical committee on response to nutrients. CAB International, Wallingford, UK.
2) Albarran B, García A, Espinoza A, Espinosa E, Arriaga CM. 2012. Maize silage in the dry season for grazing dairy cows in small-scale production systems in Mexico’s Highlands. Indian Journal of Animal Research 46: 317-24.
3) Alfonso-Ávila R, Wattiaux MA, Espinoza A, Sánchez E, Arriaga CM. 2012. Local feeding strategies and milk composition in small-scale dairy production systems during the rainy season in the highlands of Mexico. Tropical Animal Health and Production 44: 637-46.
4) Anaya-Ortega JP, Garduño-Castro Y, Espinoza-Ortega A, Rojo-Rubio R, Arriaga-Jordán CM. 2009. Silage from maize (Zea mays), annual ryegrass (Lolium multiflorum) or their mixture in the dry season feeding of grazing dairy cows in small-scale dairy production systems in the Highlands of Mexico. Tropical Animal Health and Production 41: 607-16.
5) ANKOM. 2005. Procedures (for NDF, ADF, and in vitro Digestibility). ANKOM Technology Method. http://www.ankom.com.
6) AOAC. 1990. Official Methods of Analysis. En: Helrick K. (Ed), 15th Edition, pp: 69-88. Washington, USA: Association of Official Analytical Chemists.
7) Bustamante-Córdoba LM, Sepúlveda-Valencia JU, Restrepo-Molina DA. 2016. Effect of the climatic period on the nutritional quality of cow’s milk in Antioquia. Revista de la Facultad Nacional de Agronomía 69: 7855-65.
8) Castro-Hernández H, González-Martínez FF, Domínguez-Vara IA, Pinos-Rodríguez JM, Morales-Almaráz E, Vieyra-Alberto R. 2014. Efecto del nivel de concentrado sobre el perfil de ácidos grasos de la leche de vacas Holstein en pastoreo. Agrociencia 48: 765-75.
9) Celis-Alvarez MD, López-González F, Martínez-García CG, Estrada-Flores JG, Arriaga-Jordán CM. 2016. Oat and ryegrass silage for small-scale dairy systems in the highlands of central Mexico. Tropical Animal Health and Production 48: 1129-34.
10) Conroy C. 2005. Participatory Livestock Research. ITDG Publishing, Bourton-on-Dunsmore, Warwickshire, U.K.
11) Dillon J. and Hardaker JB. 1980. Farm management research for small farmer development. FAO Agricultural Services Bulletin 41, Food and Agriculture Organization (FAO), Rome, Italy.
12) Espinoza-Ortega A, Espinosa-Ayala E, Bastida-López J, Castañeda-Martínez T, Arriaga-Jordán CM. 2007. Small-scale dairy farming in the highlands of central Mexico: technical, economic and social aspects and their impact on poverty. Experimental Agriculture 43: 241-56.

13) Fadul-Pacheco L, Wattiaux MA, Espinoza-Ortega A, Sánchez-Vera E, Arriaga-Jordán CM. 2013. Evaluation of sustainability of small-scale dairy production systems in the highlands of Mexico during the rainy season. Agroecology and Sustainable Food Systems 37: 882-01.
14) Garduño-Castro Y, Espinoza-Ortega A, González-Esquivel CE, Mateo-Salazar B, Arriaga-Jordán CM. 2009. Intercropped oats (*Avena sativa*) common vetch (*Vicia sativa*) silage in the dry season for small-scale dairy systems in the Highlands of Central Mexico. Tropical Animal Health and Production 41: 827-34.
15) Guadarrama-Estrada J, Espinoza-Ortega A, González-Esquivel CE, Arriaga-Jordán CM. 2007. Inclusion of Maize or Oats-vetch Silage for Grazing Dairy Cows in Small-scale *Campesino* Systems in the Highlands of Central Mexico. Journal of Applied Animal Research 32: 19-3.
16) Heredia-Nava D, Espinoza-Ortega A, González-Esquivel CE, Arriaga-Jordán CM. 2007. Feeding strategies for small-scale dairy systems based on perennial (Lolium perenne) or annual (Lolium multiflorum) ryegrass in the central highlands of Mexico. Tropical Animal Health and Production 39: 179-88.
17) Hernandez-Mendo O and Leaver JD. 2004. Effect of replacing time available for grazing with time available for eating maize silage and soyabean meal on milk yield and feeding behaviour in dairy cows. Grass and Forage Science 59, 318–330.
18) Hernandez-Mendo O and. Leaver JD. 2006. Production and behavioural responses of high- and low-yielding dairy cows to different periods of access to grazing or to a maize silage and soyabean meal diet fed indoors. Grass and Forage Science 61, 335–46
19) Hernández-Ortega M, Heredia-Nava D, Espinoza-Ortega A, Sánchez-Vera E, Arriaga-Jordán CM. 2011. Effect of silage from ryegrass intercropped with winter or common vetch for grazing dairy cows in small-scale dairy systems in Mexico. Tropical Animal Health and Production 43: 947-54.
20) Hernández-Ortega M, Martínez-Fernández a, Soldado A, González A, Arriaga-Jordán CM, Argamentería A, de la Roza-Delgado B, Vicente F. 2014. Effect of total mixed ration composition and daily grazing pattern on milk production, composition and fatty acids profile of dairy cows. Journal of Dairy Research 81: 471-78.
21) Kaps M, Lamberson WR. 2004. Biostatistics for animal science. CABI Publishing, Wallingford, U.K.
22) Martínez-García CG, Rayas-Amor AA, Anaya-Ortega JP, Martínez-Castañeda FE, Espinoza-Ortega A, Prospero-Bernal F, Arriaga-Jordán CM. 2015. Performance of small-scale dairy farms in the highlands of central Mexico during the dry season under traditional feeding strategies. Tropical Animal Health and Production 47: 331-37.
23) Mayne CS, Wright LA, Fisher GEJ. 2000. Grassland management under grazing and animal response. In: A. Hopkins (Ed), *Grass: Its Production and Utilization*. Chapter 10, 3rd. Edition, British Grassland Society and Blackwell Science, Oxford, UK, pp. 247 – 291.
24) Miguel MF, Ribeiro-Filho H, Mendonça NA, De Andrade EG, Moraes TC, Delagarde R. 2014. Pasture intake and milk production of dairy cows grazing annual ryegrass with or without corn silage supplementation. Animal Production Science 54: 1810-16.
25) Morales-Almaraz E, de la Roza-Delgado B, González A, Soldado A, Rodríguez ML, Peláez M, Vicente F (2011) Effect of feeding system on unsaturated fatty acid level in milk of dairy cows. Renewable Agriculture and Food Systems 26: 224–29
26) Nousiainen J, Shingfield KJ, Huhtanen P. 2004. Evaluation of Milk Urea Nitrogen as a Diagnostic of Protein Feeding. Journal of Dairy Science 87:386–98.
27) Pérez-Ramírez E, Peyraud JL, Delagarde R. 2012. N-alkanes v. ytterbium/faecal index as two methods for estimating herbage intake of dairy cows fed on diets differing in the herbage: maize silage ratio and feeding level. Animal 6: 232-44.
28) Pincay-Figueroa PE, López-González F, Velarde-Guillén J, Heredia-Nava D, Martínez-Castañeda FE, Vicente F, Martínez-Fernández A and Arriaga-Jordán CM. 2016. Cut and carry vs. grazing of cultivated pastures in small-scale dairy systems in the central highlands of Mexico. Journal of Agriculture and Environment for International Development 110: 349 – 363
29) Riveros E, Argamentaría A. 1987. Métodos Enzimáticos de Predicción de la digestibilidad In Vivo de la Materia Orgánica de Forrajes. Avances en Producción Animal 12: 59-75.
30) Wattiaux, MA, Nordheim EV, Crump P. 2005. Statistical Evaluation of Factors and Interactions Affecting Dairy Herd Improvement Milk Urea Nitrogen in Commercial Midwest Dairy Herds. Journal of Dairy Science 88: 3020-35.
31) Zamora-Martínez M.C., 2015. Editorial: Cambio Climático. Revista Mexicana e Ciencias Forestales 6: 4-6.