AgroLife Scientific Journal - Volume 9, Number 2, 2020
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

ON-FARM EVALUATION THE EFFECTIVE MICROBES AND UREA TREATED RICE STRAW ON PERFORMANCE OF LOCAL DAIRY COWS AND FARMERS PERCEPTION IN ETHIOPIA

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Abstract

The objective of this research was to evaluate the effect of supplementary feeding of "Effective Microorganisms (EM)" and Urea treated rice straw on milk production performance of local cows using supplementary feeding of concentrate mixture as positive control treatment, under small holder's condition in Fogera district. Assessment of the farmer's perception was also included. A total of 40 farmers owning lactating local cow(s) at early lactating stage with 1-3 stage of parity were purposively selected based on information provided by Development Agents and District Livestock experts. The farmers were trained in the principles of straw treatment, dairy cattle management, data collection and related issues. The farmers (45 cows) were randomly (lottery method) assigned three different treatments (grazing plus urea treated rice straw, grazing plus EM treated rice straw and grazing plus concentrate mixture) in Randomized Complete Block Design. All the data collected were subjected to statistical analysis. The results obtained showed that there was increase in crude protein content and reduction in total fiber fraction of rice straw as a result of treatment with both urea and EM solution. There was improvement in milk production of all the treatment groups. Mean milk production /cow/day was higher for the groups assigned to grazing plus supplementary feeding of EM treated rice straw, followed by the groups placed on grazing with the addition of supplementary concentrate mixture. The results of partial budget analysis showed that the group placed on grazing plus supplementary EM treated rice straw produced at cheaper cost of production and brought significantly higher daily net return. On the contrary, the groups placed on grazing with the addition of supplementary concentrate mixture were characterized by high cost of production compared to the others. EM treated rice straw produced at cheaper cost of production and brought significantly higher daily net return. The results of analysis of farmers' perception elucidated that all the participated farmers (100% of the respondents) reported to have impressed by the results of the technologies tested and would like to proceed with the promising one with their own resources aimed at improving the performance of lactating cows. According to the results of the current study, it can be concluded that feeding of supplementary rice straw treated with EM to dairy cows is economically viable under small holders conditions compared to the others.

Key words*: effective microbes, urea treatment, milk yield, Fogera cows.*

INTRODUCTION

Ethiopia has the largest livestock population in Africa (CSA, 2018). Livestock contributes 15-17% of national gross domestic product (GDP), 35–47.7% of agricultural GDP and 37-87% of the household incomes (IGAD, 2011; Gebre Mariam et al., 2013). It also contributes 15% of export earnings and 30% of agricultural employment opportunities (Behnke, 2010). Livestock production contributes to the nutritional status and family income (CSA, 2018). Moreover, the Ethiopian livestock sub-sector plays a significant social and economic role as a strategic tool to offset the prevailing social and economic consequences of poverty. However, productivity per animal is reported to be very low (IGAD, 2011), mainly due to feed shortage both in quantity and quality both of which are subjected to seasonal variation in availability (Alemayehu et al., 2017). The major feed resources during the dry period are crop residues. Crop residues are fibrous and inherently low in nutritive value unless corrective management strategies are designed. The feeding value of crop residues is also limited by their poor voluntary intakes and low digestibility. This situation warrants chemical treatment (among others) of crop residues was reported to be an important strategy for the enhancement their nutritive value. This being the case, the objective of this research was on-

farm evaluation of the effects of effective microorganism and urea treated rice straw on performance of local dairy cows and farmers perception in Fogera District of Northwestern Ethiopia.

MATERIALS AND METHODS

Description of Study Area

This study was conducted in Fogera District, northwestern Ethiopia. Fogera District is located in South Gondar Zone of the Amhara Regional State. It is situated at 110 58 latitude and 370 41 longitude. The land coverage of Fogera district is characterized by flat land, mountain and hills, and valley bottom accounts for 76, 11 and 13% of the land. The study was conducted at Woreta Agricultural Technical and Vocational Training Centre (TVET), found in the outskirts of the Woreta town. In the district there are three agro-ecological zones with mean annual rainfall ranging from 974 to 1,516 mm and mean annual temperature ranges from 19-20°C.

The district grows different types of crops and is suitable for different species of livestock. The ecological zones range from 1700 to 2400 masl (IPMS, 2005). The dominant soil type in the Fogera plain is black clay soil (Pellic Vertisols), while the middle and high altitude areas are Orthic Luvisols. Specifically, Yemane (2010) categorized the soil types of the district into 12% red, 20% brown, 65% black soils (vertisol), and 3% gray soils.

Selection of the Participating Households

Two Kebele's (peasant associations) i.e. Kuhar Abo and Kuhar Michael were purposively selected based on accessibility to the ATVET College, experience in rice straw utilization and dairy cattle production potential. Twenty 20 volunteers from each kebele and a total of 40 farmers were selected from the two Kebeles based on discussion held with district level experts and local development argents. Moreover, the 40 farmers selected had at least two lactating dairy cows at the mid-lactation stage based on the information provided by district livestock experts and Development Agents (DAs). The selected participating farmers were trained on treating crop residue including treatments techniques, feeding practice and principles of management of dairy animals. Adequate rice straw, urea, molasses and Effective Micro-organisms (EM) were purchased from local markets and distributed to the selected farmers.

Treatment of Rice Straw

Urea was purchased from market and dissolved in water at a concentration of 50 g of urea per liter of water. The solution was sprayed on rice straw at the rate of one liter per kg of straw. The treatment of the straw was done in pits, using polyethylene sheets as inner linings. The treated straw was made airtight for three weeks and fed to lactating cows after aeration for about an hour. On the other side, EM solution was prepared by mixing stock EM with chlorine free water in the ratio of 1:18 (stock: water). This EM solution was storing in closed large plastic barrel of 200 litter capacity until activation. The pH of the EM was checked after three weeks of storage and adjusted to pH of 4.0 which is more suitable for EM multiplication. The activated EM was thoroughly mixed and used to ensile chopped rice straw at the rate of one liter per kg of dry matter of chopped straw. The mixture was ensiled with the use of compacted and airtight plastic bags of 100 kg capacity for a period of 24 hours. These were fed to the experimental animals within three days after opening.

Management of the Experimental Animals

The experiment was carried under farmers' condition using farmers' milking cows. Forty lactating cows at early lactation stage (1 up to 3 months of lactation), but at different stages of parity were selected from the available lactating cows owned by the selected participating smallholder farmers. The weight of the experimental cows was taken using heart girth meter early in the morning before feeding. All the cows were tested for the incidence of mastitis using a standard California Mastitis Test and treated with Penstrip (Malty inject) before the commencement of the experiment. All the experimental animals were de-wormed for internal parasites with Zanisol and teraclozan (malty inject). Cows were housed in the same manner as that of farmers' traditional management system. Finally the experimental cows were randomly assigned to the treatments stated below in Randomized Complete Block Design.

All the cows were hand milked twice a day (in the morning at 7:00 am and in the evening at

5:00 pm). Milk yield measurements was taken using locally customized measurement units called 'jug' which is equivalent to a litter volume during the entire study period. The animals were offered experimental feeds for about 45 days of adaptation period before the commencement of actual feeding and data collection. The numbers of animals to be employed in each of the treatment were 15 and different data were collected for the specified days. Farmers' perception about the technology was assessed with the use of semi-structured questionnaire.

Treatments

T1 = Grazing + Urea molasses treated rice straw
T2 = Grazing + Effective microorganism (EM) solution treated rice straw
T3 = Grazing + local concentrate mixture (a mixture of wheat bran and noug seed cake)

Milk Yield

The farmers were trained in data collection using data collection format prepared in advance. Data collection monitoring was done for a period of 2 months starting from the month of May. During the monitoring period milk yield was recorded from both morning and in evening milking. Milk produced during each milking time was measured using a one liter holding plastic container locally known as "*Jog"* (holding 1 liter). In addition to milk yield farmers perception about the technology was assessed using semi-structured question. For assessment, all forty farmers participated in milk yield study were used.

Laboratory Chemical Analysis

The chemical analyses of samples were done at Bahir Dar University, College of Agriculture and Environmental Sciences, Animal Nutrition Laboratory. All feed samples was analysed for Dry Matter (DM), total Ash, Organic Matter (OM), Crude Protein (CP). Dry matter content was determined by oven drying of the samples at 105^0C. Ash was determined by igniting the samples in muffle furnaces at 550^0C overnight (AOAC, 1990). Nitrogen was determined by auto-analysis (Chemlab, 1978 and 1984) and crude protein (CP) was calculated as N×6.25. Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined according to the method of Van Soest and Robertson (1985).

Farmers' Perception Analysis

For farmers' perception data, were collected from the selected participating farmers who were participated in the feeding trial. The collected data included assessment on the acceptance and sustainability of the technology. To collect the primary data, a semi-structured questionnaire was designed, pre-tested and modified for appropriateness before the actual data collection was commenced. Experienced data collectors were recruited and trained to facilitate primary data collection under the close supervisions of the researcher. To reinforce the primary data, direct observation, key informants and informal interview were carried.

Partial Budget Analysis

For partial budge analysis, all costs related to feed preparation were added to total variable cost. The total return was considered by assessing the price of milk per liter during the experimental period. The difference between cost of feed and feed preparation and selling price of milk in each treatment was considered as total return (TR).

Experimental Design and Data Analysis

A Randomized Complete Block Design (RCBD) was used to carry out the experiment. Blocking was done using individual farmers as a block with four replications. The data collected were coded and enter in to Microsoft Excel and checked for outliers. Data were analyzed with statistical package for social science (SPSS) version 20 or statistical analysis and GLM of statistical analysis system (SAS) 9.1.3 software's. The economic analysis of feed types used in the experiment and associated benefits were analyzed using Upton (1979).

Model as given below was used for most of the dependent variables of questionnaire based data such as cow treatment and individual farmers' perception. Following a step-down procedure, interactions were removed from the model unless they were significant ($p<0.05$).

Model: $Yi\,jk = \mu + Ti + Fj + \varepsilon ij$

Where:

Yi j = is the response variable;
μ = overall mean;
T = Treatments (i = Untreated straw, Urea treated straw, EM treated straw and Concentrate supplementation);
Fj = Farmers perception (j = individual farmers from farmer 1 to 40);
εijk = is the random error.

RESULTS AND DISCUSSIONS

Chemical Composition of Feeds

The chemical composition of treatment feed ingredients is shown in Table 1. As shown in the table, the mean DM% content of untreated rice straw was 91.3%, the value of which was comparable to the finding of Gulilat and Walelign (2017) who reported that the DM content of untreated rice straw was 91.9%. However, the results of the current study was higher than that reported by Kamla et al. (2015) who reported a DM of untreated rice straw of 88.2%. The CP content of untreated rice straw (4.4%) was higher than that of Gulilat and Walelign (2017) who reported CP content (3.46%) comparable to that of Kamla et al. (2015) and lower than that of Samsudin et al. (2013) who reported a CP of untreated rice straw of 5.0%. The mean CP content obtained from the current finding is below the maintenance requirement of animals which is 7-8% (Van Soest, 1994). This is also supported by Hernández-Castellano et al. (2019), who stated that majority of tropical feed resources are inherently poor in terms of protein and metabolizable energy as compared to the temperate ones. The mean CP content of urea treated rice straw is higher than that of the untreated rice straw, indicating that urea treatment enhanced the CP content of rice straw by 46.016% and is above the maintenance requirement of growing animals (Table 1). The CP increment in the current study is lower than values reported by Gunun et al. (2013) and Adugna et al. (2020) where they reported nearly 50% increment in the urea treated straw. The deviation of the current result from the previous findings might be related to type of rice cultivar used, environmental where the treatment done and amount of urea added.

The mean ash content of the untreated straw was 11.1%, the value of which was lower than that of Kamla et al. (2015) and Samsudin et al. (2013) who reported total ash content of untreated rice straw of 14.2%. The mean NDF content of untreated rice straw was 69.4%, the value of which was comparable to that of Gulilat and Walelign (2017) who reported NDF content of 69.1% but lower than that (82.8%) of Samsudin et al. (2013). However, the NDF content of the current study was lower than that of Gunun et al. (2013), who reported 75.5% of NDF for untreated rice straw. The ADF content of untreated rice straw recorded from the current study was 44.6%, the value of which was lower than that of Samsudin et al. (2013) who reported 66.5% ADF from untreated rice straw in Malasiya. The ADL content of untreated rice straw was 21.66% which is higher than that reported (4.3%) by Samsudin et al. (2013). The difference in chemical composition of the untreated rice straw might be attributed to variations in the management of the straw, environmental variations and cultivar of the rice.

According to the results of the current study, urea molasses treated rice straw showed increase in percent CP and reduction in NDF, ADF and ADL contents. These result were in agreement with that of Adugna et al. (2020), Chalchissa and Arega (2018); Gashu (2014), Nasia et al. (2013). There are adequate evidences indicating that urea-molasses treatment of rice straw increase the CP content and decrease the crude fiber fraction (Paudel et al., 2015; Nguyen et al., 2019 and Nguyen et al., 2001). According to the results of the current study, treatment of rice straw with Effective Microbes showed slight increment in CP and reduction in NDF, ADF and ADL contents, in agreement to that of Adugna et al. (2020), indicating that the uses of biological treatment of rice straw have potential in the enhancement of nutritive value as compared to the use of expensive chemicals associated with environmental pollution (Kamla et al., 2015). According to the results of the current study, urea and EM treatment of rice straw could be an option suitable for small-scale farmers to improve the quality of straws (Sarnklong et al., 2010). Nguyen et al. (2001) also indicated that the treatment of rice straw with lime and/or urea improved the nutrient utilization and production performance of cattle in China.

The results of the current study is in line with the earlier reports that state, combination of chemical treatments and addition of protein supplements offers a wide range of improvement in the composition of the diets of dairy cows with positive effects on dairy production and feed costs as suggested by (Wittayakun et al., 2005; Oddoye et al., 2002).

Table 1. The chemical composition of treatment feeds

Treatment	DM %	Ash %	CP %	NDF %	ADF %	ADL %	HC%	CL%
Untreated straw	90.85	11.1	4.375	69.355	44.59	21.65	24.765	22.94
Urea treated straw	91.3	17.55	6.39	61.74	43.655	10.97	18.085	32.685
EM treated straw	90.45	14.4	5.03	63.04	43.285	18.35	19.755	24.935
Concentrate mixture	91.74	6.14	23.45	52.88	32.8	12.43	20.08	20.37
Mean	91.09	12.30	9.81	61.75	41.08	15.85	20.67	25.23
SD	0.56	4.88	9.13	6.79	5.55	5.01	2.87	5.31

EM=Effective microorganism; DM=Dry matter; CP=crude protein; NDF=Neutral Detergent Fiber; ADF=Acid detergent fiber; ADL=Acid detergent lignin; HC=Hemicellulose; CL=Cellulose.

Similar study also elucidated that in dairy heifers, a combination of urea-treated rice straw and addition of cottonseed cake resulted in optimal weight gain and lower feed costs. Rice straw treated with urea-molasses and mixed with rice bran improved live-weight gain, weight of calves and milk yield (Hari Singh et al., 2001). The general tendency is that supplementation of local cows with available and accessible feed resource could enhance milk production performance under farmers' management condition in the highlands of Ethiopia.

Milk Production Performance

The results of milk production of Fogera cows assigned to the different treatments diets are presented in Table 2. As indicated in the table, for Kuhar Abo Kebele which is located in themajor rice cultivation area, there was significant difference (P<0.05) between the treatment groups in mean daily milk production. Significantly higher (P<0.05) mean milk production of 2.81 liter/cow was obtained from the groups placed on grazing plus EM treated rice straw, followed by the groups placed on grazing with the addition of concentrate mixture. There was no significant difference (P>0.05) between the groups fed on grazing plus urea treated rice straw and grazing plus concentrate mixture in mean daily milk production. The difference in milk yield for Kuhar Abo farmers might be related to the farmers' management practice and the difference between individual farmers. For Kuhar Michael Kebele, there was no significant difference between the all the treatment groups in mean daily milk production, indicating that all the three supplementations are equally effective in enhancing milk production under the current management condition.

Table 2. Milk yield of local cows supplemented with EM and urea treated rice straw and concentrate mixture

Treatment	Kuhar Abo (Mean±SE)	Kuhar Michael (Mean±SE)	Overall Mean
Grazing + UTRS	1.91±0.17[b]	2.19±0.18	2.05±0.17
Grazing + EMTRS	2.81±0.099 [a]	2.5859±0.04	2.71±0.07
Grazing + CM	1.95±0.14[b]	2.7383±.0.29	2.35±0.21
Mean	2.23±0.13	2.51±0.11	2.37±0.12
P Value	0.001	0.141	-
SL	***	NS	

P=probability; SE=Standard error.

The mean daily milk production of all the groups fed on grazing plus urea treated rice straw was 2.05 litter per day per cow. The results of the current study, was lower than that of Hussien (2018) who reported that average daily milk production of local cows in the highland and midland was 2.2 and 2.3 liter per day per cow respectively in Dawro Zone, Southern Ethiopia. The average daily milk production of highland Zebu cattle was reported to be 1.5-2 liters over 150-180 day lactation period (Kassa, 2019). In another study, Tekliye et al. (2018) reported that Urea treated rice straw has a potential for ruminant animals in Ethiopia and there was improvement in the performance of sheep fed on urea treated supplementary rice straw.

The results of the current study, was in agreement with that of Teshome et al. (2019) who reported that there was increment in milk yield of cross bred cows supplemented with dietary protein source. The average milk yield obtained from the current study, was comparable to that of Beriso et al. (2015) who

reported mean milk yield of local cows of 2.21 per day. According to the review made by Kassa (2019) the average milk yield of local cows ranges between 1.5 and 2 liter per day. The results of milk yield of the current study, was higher than that of Hussien et al. (2013); Melku (2016), CSA (2018) and Assefa et al. (2015) who reported mean daily milk production of local cows to be 1.44, 1.86, and 1.37 and, 1.25 liter per day per cow respectively. The inconsistency of the results might be related to differences in feedings management, breed variation and environmental differences.

Farmers' Perception

The socioeconomic characteristics of respondents participated in the study is shown in Table 3. Regarding the gender of research participants the majority were male headed households in both study sites. This is in line with reports of (Abebe et al., 2020) where majority of respondents were male headed households in northwestern Ethiopia. Of the respondents, the majority of (80%) were literate which is in agreement with Abebe et al. (2020) but disagrees with Asmare and Mekuriaw (2019) who reported that majority were illiterate. The higher proportion of respondents in the current study is important to easily adopt agricultural technologies as stated by Weir (1999). The reason why male household heads are common in agricultural production systems might be due to the nature of the task where males are more exposed to outside work.

Table 3. Socioeconomic characteristics of on-farm research participants

	Kuharabo		Kuhar Michael		Mean (%)	
Characteristics	N	%			N	%
Male	11	73.33	15	100	26	86.87
Female	4	26.2	0	0	4	13.13
Mean age of HH	47.27		40.47		43.87	
Education level						
Illiterate	3	20	0	0		
Literate	11	80	15	100		
Mean family size	5.67		6.07		5.87	

The major feed resource for all dairy cows during dry season is rice straw which is used as a supplement for ruminant livestock which is in line with Asmare et al. (2016), Asmare and Mekuriaw (2019). The participated smallholder farmers had positive attitude towards their respective treatments during the experiment. All the respondents (100%) reported to have liked to continue the feeding package for dairy production. This result was in agreement with that of Shiferaw et al. (2018) who reported that the households interviewed on the acceptance of improved forage production and utilization could benefit the households. The results of the current study was comparable to that of Geleti (2014) who indicated that feed development particularly forage development practices by smallholder farmers increased from time to time. However, the general adoption rate of feed technology under mixed crop livestock farming systems of Ethiopia is weak and require more extension service or a different approach of agricultural extension service delivery, and this fact was supported by Teklu et al. (2011).

The majority of the respondents, who participated in the on-farm trial were capable of reading and writing of agricultural manuals the results of which was in agreement with that of Asemu et al. (2016) who stated that many of the respondents were illiterate in northwestern Ethiopia, which in turn results in high literacy level and acceptance of the technology. All the respondents (100%) indicated that the current on farm trial has positively influenced the participant to adopt the supplementary dairy cow feed technology tested. The results of this study calls for further and wider level of interventions and the placement of special attentions in the future small scale dairy production in the study district and beyond. The current result is in line with that of Victoria et al. (2018), who reported that farmer perceptions of the innovations and their interest to adopt the agricultural innovations. The positive feedback of farmers in the current study is in line with earlier reports by Haile et al. (2017) who found similar finding for on-farm experiment conducted on the promotion

of urea treated rice straw in the ration of fattening oxen in the Ethiopian highlands. This indicates that farmers could use their respective feeding options for their animals to improve milk yield and related animal performances.

Partial Budget Analysis

The results of partial budget analysis of local cows assigned to the treatment rations under farmers' management condition are shown in Table 4. As indicated in the Table, the total variable cost required to produce a unit of milk is highest in the case of concentrate supplementation. A total of 13 birr was required to produces a liter of milk by the groups placed on grazing with the addition of concentrate mixture. Such a comparatively high cost of production might be due to the escalated price of concentrates which in turn attributed to the increment in market price of concentrate feed ingredients. On the other side, a total of 10 Birr was required to produce a liter of milk by the groups placed on grazing plus urea treated rice straw associated with an increased market price of urea fertilizer and molasses. A total of 3 Birr was required to produce a liter of milk by the groups placed on grazing plus EM treated rice straw indicating that the cheapest treatment diet in the current study is the use of effective microbes for rice straw treatment. Relatively low market price was required to acquire EM solution to treat a kg of straw under the current Ethiopian circumstances. Significantly higher net return of Birr 17.20 was recorded from the groups assigned to grazing plus EM treated rice straw, followed by the groups (Birr 13.00) assigned to grazing plus urea treated rice straw. Significantly lower net return of Birr 5.00 was recorded from the groups placed on grazing with the addition of concentrate mixture.

Table 4. Partial budget analysis of local cows supplemented with different feed treatment and concentrates under on-farm condition

Parameters	T1(UTRS)	T2(CM)	T3(EMTRS)
Total supplement diet intake (kg/day)	3.5	2.5	3.5
Mean milk yield (liter/day/cow)	2.05	2.35	2.71
Total variable cost (ETB/day/cow)	20.825	30	7.625
Gross income (ETB/day/cow)	47	41	54.2
Total return (ETB/day/cow)	26.175	11	46.575
Net return (ETB/liter) of milk	12.77	4.69	17.19

ETB=Ethiopian birr; T1=Grazing+urea treated rice straw; T2=Grazing+Concentrate supplementation; T3=Grazing+Effective microbe treated straw supplementation.

Hence, based on the results of the current study, it can be concluded that feeding of supplementary rice straw treated with EM to dairy cows is economically viable followed by feeding supplementary rice straw treated with urea molasses.

CONCLUSIONS

The current study was conducted to evaluate the milk performance of local cow placed on grazing plus urea treated rice straw, EM treated rice straw and addition of concentrate mixture. The result obtained revealed that there was increase in CP content and decrease in the fiber fractions of rice straw treated with either urea molasses or effective microorganism. There was no significant difference between all the treatment groups in milk yield. The results of farmers' perception analysis indicated that the participating farmers were happy with the introduction of the feed treatment technology. From economic analysis point of view, the treatment of rice straw with EM was found to be economically viable, followed by rice straw treatment with urea.

To address the problems of feed shortage in the mixed crop livestock systems of the Ethiopian highlands crop residue improvement is the first option. Based on the current initial on-farm testing the following research focus areas were suggested:

- Further research on the validity of different levels EM solution in treating different crop residues.
- Study on the effect of EM treated crop residues supplementation on the milk composition of local and crossbred milking cows.
- Scaling of EM technologies in different agro-ecologies.

ACKNOWLEDGMENTS

The authors would like to appreciate the Canadian ATTSVE (Agricultural Transformation Through Stronger Vocational Education) project for financing this research work.

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