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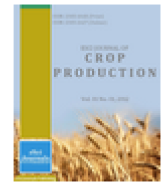

(Review Article)

POTENTIAL FOR PELLETIZED SOYBEANS AS FORAGE FOR DAIRY COWS IN SAN CARLOS, COSTA RICA

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ABSTRACT

Dairy producers in Costa Rica primarily utilize grazing systems for their production systems; however, they must supplement with high amounts of imported grain because pasture quality is low and can negatively impact milk yields or weight gain. In this research study, we used the industrial process to make forage pellets out of whole plant soybean (*Glycine max*. L. Mer var CIGRAS 06) at the R6 stage in order to provide a high quality feed that is potentially more affordable than imported feeds. During this process, the soybean was dehydrated to 24.01% moisture content (MC) to create pellets. The pellets were evaluated for their nutritional value. These samples were taken in all phases of the process including a sample of the whole plant soybean. The soybeans were planted at a density of 773,514 seeds per acre. The yield obtained was of 6.04 DM tons/acre. This low yield occurred because of the low photoperiod and high rainfall during the time frame of September, October and November. The dehydrator was built from recycled materials. The capacity of the dehydrator was of 3.49 lbs per hour of dry forage and with an evaporation of 9.88 lbs H_2O/hr. The energy required for the process was 0.278 lbs (LPG)/lb of dry forage. Pellet process was performed with a pelletizer property of Tico Fruit. The total production obtained was 0.414 tons of soybean pellets, with a 75.99% DM and a relative feed value (RVF) of level 3. The average for crude protein (CP) was 16.66%, acid detergent fiber (ADF) was 40.20%, neutral detergent fiber (NDF) was 55.11%, and fat was 3.35%. The pellets had a final size particle of 0.256 in of diameter and 1 in average of length. Production costs for the soybean pellet were 0.38 dollars per pound. The high costs were due to the dehydration of the forage because of the high content of water when the soybean was harvested in field at 81.48 % MC (Figure 2). Overall, this primary investigation leads us to a better understanding of what steps are necessary to creating a pelletized feed that could be adapted for feeding in Costa Rica.

Keywords: Costa Rica, dairy, forage, pellets, and soybeans

INTRODUCTION

Costa Rica primarily utilizes grazing systems for both dairy and beef production. These farms use high amounts of supplements like soybean (*Glycine max*), corn (*Zea mays*) and byproducts to feed. The low nutritional value and quality of pastures used in production systems, negatively impact the level of intake of forage and availability of nutrients required by the animal. This is why they use high amounts of corn and soybeans to provide higher levels of energy, protein and dry matter (DM) (Camero, 2008). With the current high prices of grains in Costa Rica, there has been decline in profitability of domestic milk production. In 2009, expenditure was 42% of total revenues of milk production spent on grain to feed cows (CEBS, 2010). There is within Costa Rica the drive to look for new food choices that are low in cost and highly nutritional for livestock systems. Tobía *et al*. (2006) suggested the use of forage soybean for supplement to help alleviate this situation in Costa Rica and he mentioned the pelletizing as a conservation alternative. This research described herein looks at the pelletizing forage process and its efficiently to preserve the quality and nutritional value of soybean variety 'CIGRAS-06'.

The dehydration of forage is a process that allows a greater amount of dry matter (88-92%) (Ortiz and Hernandez, 1989). Another benefit of dehydration is forage is collected in their optimum growing season,

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reducing the total losses of dry matter (Ortiz and Hernandez 1989). This process also produces material with favorable physical characteristics, because the pellets increase voluntary food intake, and increase the rate of passage in the rumen, decreasing the fiber digestibility and lowering the production of methane while decreasing the ratio of acetic acid and propionic acid in the rumen (Van Soest 1982). These changes tend to increase efficiency in the digestion of energy for fattening cows but decrease the milk fat in lactating cows. In addition, the decrease in fiber digestibility which is most likely due to increased rate passage may be offset by the increased intake (Van Soest 1982).

MATERIAL AND METHODS

The experiment was conducted from October 2009 through November 2009 near San Carlos, Alajuela, where the soybean field was planted. The production phase of forage soybean was located on plots belonging to the School of Agronomy of Instituto Tecnológico de Costa Rica, located in Santa Clara, San Carlos, Alajuela province. The weather has an average annual temperature is 26 º C with 85% relative humidity and annual rainfall between 2,500 to 3,000 mm. The pelleting forage practice was performed in six distinct phases: the production phase of forage soybean variety "CIGRAS 06", the construction phase of the dryer that was built in a family workshop, the drying phase, forage pelleting phase that was making in Tico Fruit industry, nutritional analysis phase of the product, and the economy analysis phase.

The forage samples for the nutritional analysis were taken on all phases; the test of forage samples was made in the Animal Nutrition laboratory belonging Instituto Tecnológico de Costa Rica. These samples were place in an oven for 8 hours at 105 °C. Upon removal from drying oven, were weighed and recorder. The crude protein (CP) concentration was determined from total nitrogen combustion Dumas. The structural carbohydrates were performed from method described by Van Soest and Robertson (1985) used the technology system Ankom for acid detergent fiber (ADF) and neutral detergent fiber (NDF) (Ankom 2000), and relative feed value (RFV) was calculated from variables of dry matter intake (DMI), digestible dry matter (DDM), and this values were determine the percentage from NDF and ADF (Undersander and Moore, 2002).

RESULTS AND DISCUSSION

The forage production in the soybean crop is relatively stable when the field had a density between 371,287 and 742,574 plants per acre (Tobía *et al*., 2006); however, the density of plants obtained was 225,866 plants per acre. This low density plant obtained, could be contributed to the factors such as saturate soil and bad drainage in the area, that causes anoxia in some seedlings. The period from September to November 2009, the weather had on average 15.75 in of rainfall and the annual average is 10.5 in (Figure 1). The yield of the crop was 36.04 tons/acre and a 16.8% of DM, and the DM yield was 6.04 tons/acre. Tobias *et al*. (2006) reported 18.07 DM ton/acre of forage harvested soybean, where we contribute our low yields because of the decreased photoperiod.

In the dehydration phase, we used recycling materials to construct the machine, which was composed of a dry cylinder, turbine, burners, motors to move the dry cylinder and truck chassis to pick up. The fuel used in this drying machine was Liquid Propane Gas (LPG). The capacity of the dehydrator was of 3.49 lbs/hour of dry forage and evaporation 9.88 lbs H_2O/hr. The energy required for making this dryer functional is of 4.711 lbs/hr of LPG. The dry forage out R6 stages of whole plant soybean, because the plant in this stage has the maximum DM performance and started to moisture decrease (Undersander, 2001). The forage harvested had 0.273 in size of particle, this permit that the dry forage is efficient, because the particle have a high exposition area to dry. The forage harvested moisture was 81.48%, the minimum moisture obtained in the forage dehydrated were 28%, the charge drying (relation water: forage dry) was 3.06:1 with a expenditure energy of 0.278 lb (LPG)/lb of dry forage (Figure 2). The drying load for 81.48% MC forage it is higher 4:1 than 2:1 from 70% moisture forage (Raymond *et al*, 1977). For the pelleting phase was used a pelletizer, this has 3 ton/hrs of production capacity, when the crop enter in to process pelleting, the forage should have 13.5% moisture, because the high moisture increased the temperature (Campos, 2009), denatured the protein compounds and cause losses of nutrients in dry forage, in the pelleting process the losses of protein was 0,23%. The total production obtained was 0.414 tons of soybean pellet. The matrix into machine used to make pellets had 0.256 inches of size holes, this size is adequate to making forage pellets, the physical characteristic pellets were 0.256 inches of diameter and an average of 1 inches of length. Campos (2009) and Raymond *et al*. (1977) described, the finality pellets moisture should be 13.5% to maintain the quality of the product for six mounts. The high temperature and moisture affect the storage life; a first fungus appears and secondly causes alcoholic fermentation (Kammel 1996).

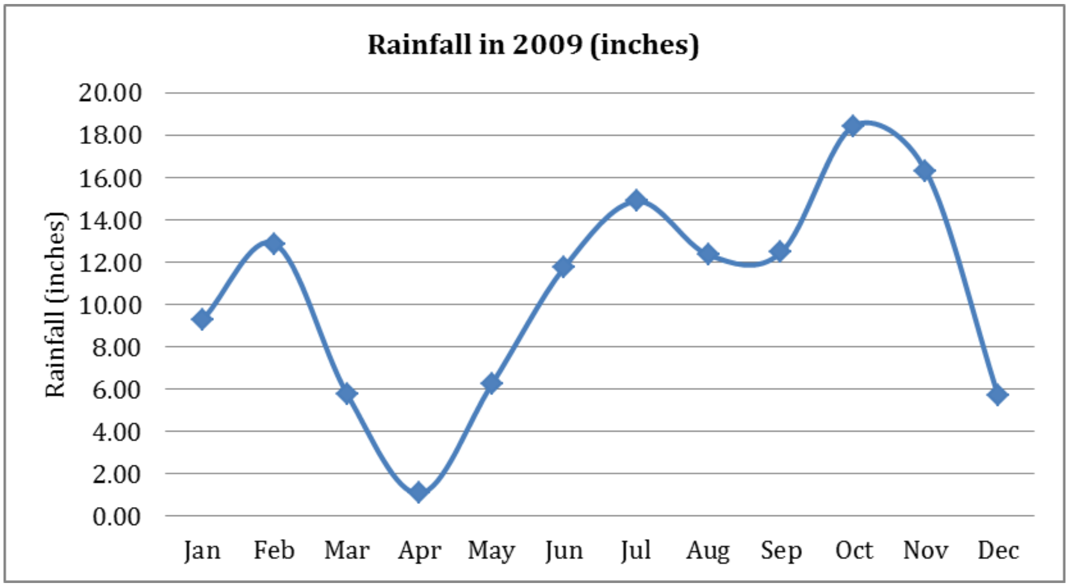

Figure 1. Rainfall behavior in San Carlos, Costa Rica, 2009.

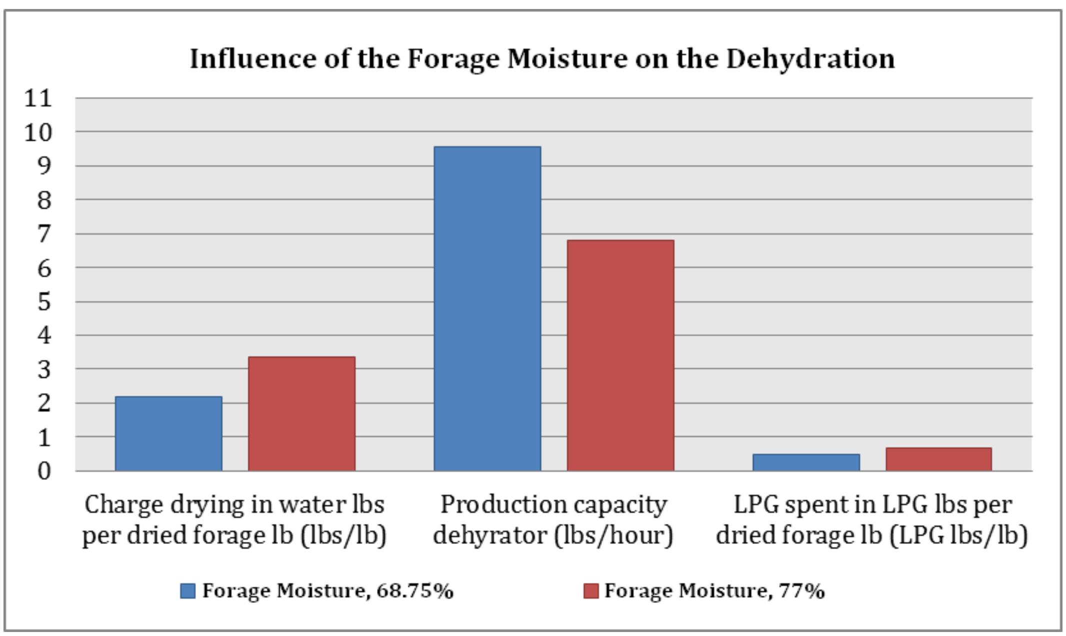

Figure 2. Efficiency and energetic cost to dry soybean forage harvested with two different of moisture level.

The pellets lasted 3 days because; the finality pellets moisture was 24.01%. The nutrition value of soybean pellets were a 75.99% of dry matter, CP 16.66%, ADF 40.20%, NDF 55.11%, fat 3.35% and RVF of 97.19, the losses of RVF are due to low value 98.47 of wet forage harvested, because this forage includes the forage weeds, the RVF to soybean plant was 107.59. The production costs for the soybean pellet were 0.38 dollars per pound, the high cost is mainly due to the dehydration, the forage harvested have 81.48% of moisture, this cause major energetic cost.

CONCLUSIONS AND IMPLICATIONS

In conclusion, the soybean pellets feed, could be an interesting option that provides highly nutritious forage for livestock feed. The physical structure of food facilitated the transportation, marketing, storage and delivery to the animal. Its high content of dry matter, would offer the animal a higher dry matter intake by using low volumes of feed. However, during both processes agronomic crops, such as industrialization must be optimized to significantly reduce costs. The management of crop moisture content and design of efficiently dehydrated prototype forage are some major challenges.

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