

Soya Bean Forage as a Source of Protein for Livestock in Cuba

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Abstract

The use of milk-stage soya bean forage as a source of protein for livestock production in Cuba is still in its infancy, and perhaps, the fact that the only performance data in this entire report refers to the average weaning weight of seven, 40-day-old piglets, as 8.8 kg, definitely supports this observation. The sow's diet consisted of sugarcane juice and soy forage, and the piglets, in addition to nursing, had access to the same feeds. Presently, in more than 100 sugarcane-sector farms or coops, green soya beans are being used as a source of protein for livestock. In Cuba, 156 sugar mills and 1300 cane coops employ nearly half a million workers, and all have to be fed. Since 1983, the cane-sector, the sector responsible for cultivating one-third of total arable land on the island, has endeavoured to produce all its agricultural-based food needs and has promoted livestock production. For this, a total of 95 thousand hectares are used to produce rice, beans, tubercles and fresh vegetables, as well as some animal feeds. The development of sustainable agronomic systems has been promoted; mostly, because all available machinery, fertilizers, insecticides, herbicides and petroleum have been prioritized for the production of sugarcane.

The use of milk-stage, soya bean forage as a protein source for livestock rather than imported soya bean meal or the whole bean, presently used mostly to produce yogurt for distribution to children, is an attempt to accommodate the new, tropics-oriented, zero-grain, livestock production system (Preston and Murgueitio, 1992) to the present agronomic and/or economic reality of the sugarcane-sector state farms

and coops in Cuba.

KEY WORDS: Protein source, soya bean forage, soya bean hay, green soya, feed, pig

Introduction

Since 1983, the cane-sector, has endeavoured to produce its basic food needs and has promoted livestock production for its half-million workers and their families. For this, a total of 95 thousand hectares in 156 sugar mills is used to produce rice, beans, tubercles and fresh vegetables, as well as some animal feeds. In 1989, the sugar mills attempted to plant, for the first time, 5 thousand hectares of soya beans, for seed, in rotation with cane; it was a failure. Soon after, in 1993, the sugar mill cane plantations were reorganized into approximately 1300 cane cooperatives and most of the livestock belonging to the sugar mills, particularly the reproductive herds of pigs, rabbits and sheep, and the oxen, were given to the co-ops. All of a sudden, the co-ops found themselves, with animals to feed, sugarcane and some molasses as sources of energy, but zero protein feed resources.

Soya beans, until 1940, were used in the United States as forage, green manure, silage, and hay for horses; in fact, it was not until 1940, that production of soya beans for beans surpassed their production for hay. Recently, in Cuba, it was thought that the same plant, if fed green, while still in the milk-stage, prior to the presence of the anti-trypsin factor encountered in the seed, might serve as a source of protein for pigs. It worked, the idea spread (Perez 1995; 1996, and presently, in more than 150 cane co-ops and sugar mill farms, soya bean forage is used as the single-most important source of protein for many kinds of livestock. The system is developing at a very fast pace because it is sustainable and "farmer-friendly" and, following initial planting, within 8 or 9 weeks before the forage has had time to become insect or disease ridden, it is ready to harvest and feed. In addition, the input is very low: seeds, inoculant, water and care.

Zero-grain Livestock Production System

When grains are used for livestock, approximately one-half of the requirement for protein is met by the cereal component; however, in the case of "zero-grain" production systems in which the energy and protein components are offered separately (Table 1), due to the invariable low level of protein in the basal diet, almost all the requirements for amino acids must be supplied by the supplement (Preston 1995). In the case of the cane co-ops and sugar mill farms, they produce different energy sources, such as: sugarcane, cassava, sweet potato and bananas, but insufficient protein feed resources.

Table 1. Zero-grain pig feeding systems (20-90 kg) *

System**	Energy DM, %	ADG (g)	DM Conversion	Source
Fresh cassava	60-70	650-790	2.80-3.00	Maner <i>et al.</i> , (1977)
Cooked sweet potato	73	770	3.50-3.80	Dominguez <i>et al.</i> , (1991)
Ripe bananas	66-71	560-570	4.50-4.60	Solis <i>et al.</i> , (1985)
Palm press fiber	78	500-550	4.50-5.00	Ocampo <i>et al.</i> , (1990b)
Sugar palm juice	80	500	-	Preston (1995)
Sugar cane juice	80	650-700	3.50-4.00	Sarria <i>et al.</i> , (1990)
B molasses	70	500-550	4.00-4.50	Cervantes <i>et al.</i> , (1984)
C molasses	70	400-450	5.00-5.50	"

* current NRC (1988) performance guidelines for pigs, 50-110 kg, fed 80% maize & 20% soya bean meal: 820 g ADG and 3.40 DM conversion; **under normal farm conditions reduce performance by 10-15%

A further consideration related to the "zero-grain" feeding system is that, a fast growth rate, per se, one which would invariably involve feeding a biological optimum supply of dietary protein, is not necessarily

the most profitable. For example, for pigs from 25-90 kg, "zero-grain" can perhaps best be summarized in terms of 500 g/day of protein supplement, approximately 200 g/day protein (Preston 1995).

An attempt to accommodate "the role of monogastric animal species in the sustainable use of tropical feed resources" (Ly 1993), by providing them locally-produced protein in the form of soya bean forage, is the subject of this preliminary report.

Soya Bean Forage Production System

The present production system involves planting one, 7-row plot of soya beans, weekly. Nine weeks later, 63 days, one row of soya bean forage is harvested daily, from Monday to Sunday (Perez and Ochoa 1996). This means that the first-harvested row of forage will be 63-days old on Monday, whereas the following Sunday, the last row of that same plot will be 70 days old, still presumably in the early milk-stage, not yet in full expression of the trypsin inhibitor. This means that the forage can be used directly for pigs, ducks and rabbits, even chickens. The protease inhibitors, first present in the formed seed, apparently play an important role as defense agents against insect attack or micro-organism infections and would explain the need to boil the whole seed for 20 minutes prior to feeding monogastrics (EMBRAPA-CNPSA 1994). However, there appears to be very little known about this factor in the whole soya bean plant.

Depending on the time of year, and variety, temperature, humidity, irrigation and inoculation, the entire system may vary from between 49-56 to 63-70 days. Excess or older forage could be sun-dried, perhaps in a manner similar to tobacco, and used as hay for rabbits or ruminants, or perhaps even ground and heat-treated (boiled), and used as whole soya bean plant meal. In this regard, the seed or bean is 50% of total biomass.

Planting

The recommended distance between rows for forage is 35 cm, as opposed to 70 cm, when planted for seed. Each plot will be approximately 2.5 m wide. By planting 20 seeds per meter at a depth of 2 cm and with 75% germination, the yield should be about 15 plants per meter, the current

recommendation for one pig, daily. After completing the harvest of the last row on Sunday, the same plot is replanted the following week. In this manner, by replanting the same plot up to 6 times per year, a significant amount of forage can be produced in small area, and often adjacent to the enclosed animals.

In Vietnam, where soya beans have been planted in order to take advantage of 55 growing days between harvesting and planting the next rice crop, and ensiled, a total of 8.1 t/ha of soy forage was produced, the equivalent of 360 kg of protein or the same quantity that would have been obtained from one hectare of soya beans harvested as seed. Furthermore, the feed cost per kilogram of gain decreased by 24% in an experimental group of pigs that obtained 30% of their protein needs from the ensiled soya bean forage. (Chinh *et al.*, 1993). In Cuba, under commercial conditions, and a 75-day growing period, non-inoculated seeds produced a yield of 24 t/ha of forage compared to 46 t/ha, or practically double, when the seeds were inoculated (López and Frias 1986).

Inoculation of Soya Beans

The following refers to one plot of 7 rows, each row 50-meters long. Each 50 meter row should produce sufficient forage, daily, for about: 20 pigs, 40-50 rabbits and ducks, and part of the forage needs for 8-10 milking cows. Each plot will require approximately one kilogram of seeds, because: 1 m = 20 seeds; 1 g seeds = 5-8 seeds; 1 m = 3 g seeds; 50 m = 150 g seeds; and 7 rows = 1050 g seeds. To inoculate one kilogram of seeds:

1. Dissolve one teaspoon (2 g) of sugar in two tablespoons (20 g) of water or use diluted molasses or fresh cane juice.
2. Add one tablespoon (10 g) of inoculant and combine thoroughly.
3. Add this mixture to 1 kg of soya beans, mix thoroughly, place in the shade to dry.
4. Plant seeds as soon as possible, prevent contact with the sun.

Irrigation

Most of the farmers questioned agreed that for best results all plots require a weekly irrigation. Many methods are available, but perhaps, one

of the simplest systems observed was to place a 55-gallon drum at the end of each plot, fill with water, and using a pail, apply one condensed-milk can full of water, at the base of every plant, every week!

Harvesting and Chemical Analysis

Harvesting is done by hand and, if the seeds were inoculated prior to sowing, the forage should preferably be cut in order to leave the roots with adhering nodules in the soil. The following information (Table 2) was obtained using milk-stage soy forage (INIFAT V-9) grown on non-fertilized, garden-leached soil in Havana. Even though the crude protein level of the forage was low, the *in vitro* ileal digestibility of nitrogen was 67%, which compares favorably to the average digestibility of this nutrient in soya bean meal, 75%, and to the average digestibility of nitrogen in most forages, reportedly, of between 35 and 40 percent.

Table 2. Proximal analysis and essential amino acid composition of the aerial part of soya bean plant*

Proximal components	% DM	Essential amino acids	% DM
Ash	9.97	Arginine	0.46
Calcium	1.38	Cystine	0.17
Phosphorus	0.51	Isoleucine	0.43
Crude fat	4.75	Leucine	0.72
Crude fibre	34.23	Lysine	0.44
Crude protein	12.62**	Methionine	0.13
		Threonine	0.34
		Valine	0.57

IIP (1995); * non-inoculated seeds; ** *in vitro* ileal digestibility, 67%; The dry matter (DM) was 29.4% and Mj/kg DM was 16.65.

Soya Bean Forage for Livestock: Guidelines

The use of soy forage for livestock is too recent to publish guidelines, hopefully, this communication will help remedy that situation. In fact, the only performance data for this entire report was the 8.8 kg average

weaning weight of seven, 40-day-old piglets, from a sow fed free-choice sugarcane juice and soy forage in a sugar mill pig farm in central Cuba. The piglets received no additional feed but had access to the sow, and naturally, some of the same ration.

PIGS: feed twice-daily soya bean forage, approximately one meter/pig/day, and a free-choice source of energy: sugarcane juice, diluted molasses, cassava or ripened bananas. Change diets over a one week period, approximately. In several provinces, the present idea is to set up small pig fattening units directly in the banana plantations, adjacent to the weighing/grading stations, and completely enclose one pig pen to use it as a banana ripening room. The protein will be planted alongside: soya bean forage.

RABBITS: growers and fatteners can be fed exclusively on free-choice soy forage, however, for good teeth maintenance in the reproductive herd, in addition to soy forage, sugarcane stalks are sometimes offered. One meter of soy forage, depending on the quality, should be enough for 4 to 5 growing rabbits, daily. One sugar mill farm reported cutting 0.8 t daily for a total of 527 rabbits or about 1.5 kg/rabbit/day. The leftover lower stems were fed to ruminants.

DUCKS: after starting ducks on concentrates or green-feed, described for chickens, they can be fattened using a free-choice energy source, cane juice or diluted molasses, and fresh, whole soya bean plants. Once accustomed to soy forage, they will devour the leaves and most of the stem. The lower stem can be collected for feeding pigs or ruminants.

LAYING HENS: cassava and soy forage, in a 50:50 ratio, ground together, is being promoted as "green-feed" for layers.

COWS: soy forage is being promoted for milk cows until the co-ops and sugar mills produce sufficient forage from protein trees. Depending on the quantity and quality of the other feed resources, the present recommended amount is one meter per cow per day.

Conclusions: Concerns and Problems

The author has been re-called to sugar mills, where the use of soy forage, formerly promoted, was questioned, because the younger pigs, 25-50 kg, were not growing as fast as previously. The answer appeared to be in the age of the forage, more than 70-80 days, and definitely, with some pods showing near full-size green beans. There appears to be a "point of no return", that is, a precise moment at which time "something" drastic happens, that "something" possibly meaning the appearance in the bean of the trypsin inhibitor, and its subsequent effect on effective protein digestion. This, hopefully, will constitute a key area of research, along with determining, for the tropics, the preferred forage varieties for the wet and dry seasons. Interestingly, it has already been suggested, that the "inhibitor" problem could be avoided by using a strain of soya beans, the Kunitz strain, that does not produce the major inhibitor (e-mail/G. Seidel /14/08/96).

In conclusion, certain aspects are already obvious: 1) that, for the low-income farmer that cannot obtain soya bean meal, soy forage is an interesting and local alternative as a source of protein, and fatty acids, since it does contain almost 5% crude fat (Table 2); 2) that, this technology requires only 60-70 days, approximately half the time required to produce the dry bean; 3) that, because it requires a shorter growing period, there is less probability for insect and disease attack; 4) that, soy for forage, if inoculated, and planted 15 days after planting first crop irrigated cane, could improve cane yields by up to 19% (Perez *et al.*, 1992), and finally, 5) reportedly, for some legume forages, more protein per hectare is obtained when the forage is harvested in the milk stage (Oyawoye *et al.*, 1990).

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