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Adoption and Commercialization of Green Corn, Green Corn – Based Silage, Haylage and Ummb Production for Dairy Cattle in Cagayan Valley, Philippines

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ABSTRACT

This research aimed to improve dairy production and increase income of dairy farmers using locally available feed resources.
Small-scale milk producers rely heavily on available feed resources in the locality which are either indigenous in the area or introduced species for feed and nutrition of their dairy cattle and buffalos. Their milk output depends mainly on seasonal fluctuations in the quality and quantity of natural forage. Crop residues such as corn stover and rice straw which are high in fiber but low in nutrients serve as feed supplement and filler to the daily diets of dairy cattle and buffalos. Cagayan Valley is a top corn and rice producing region. The potential of crop residues as feed supplements or raw materials of dairy cattle/buffalo feedmix is great. But dairy farmers still face scarcity problem of quality feed resources for dairy animals especially during dry season. The supply of forage is very low during the dry spell. Inadequate feedmix and low nutritive value of feedmix result to low or no milk production. Producing green corn and ensiling it to produce green corn silage preserves and prolong storage life of forages. In this way a stable supply of feedmix for dairy animals is assured year-round.

Type of Paper: Empirical.
Keywords: adoption and commercialization, dairy industry, financial viability, green-corn silage production, indigenous grasses, smallholder farmers.

Introduction

The Philippines imports most of its milk requirements from leading dairy producing countries despite the availability of vast tract of lands suitable for dairy production. Cagayan Valley is a top producer of rice and corn. Hence, feed resources (to include green corn as forage or silage, rice straw, corn stover) are expected abundant for ruminants. But despite the vast rice and corn areas in the valley, dairy farmers still face scarcity problem of quality feed resources for dairy animals especially during dry season to sustain or boost dairy milk production.

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Year - round access to quality feed and roughage determines the competitiveness of the dairy sector. Raisers of ruminants need to be proficient in the management of forages as in the management of their animals. The development of a high-quality alternative feeding system in lieu of feeding forages during lean months therefore, will reduce the farmers' production costs and seasonal fluctuations in milk supply, thereby, improving operational profits. Increasing milk production from cattle and buffaloes is a national priority in the Philippines because milk is one of the most important foods in human nutrition.

Corn silage is a high energy feed resource for ruminants. Being part forage and part grain, it has characteristics of both feed types and is a valuable component of dairy rations. In terms of nutrient content, corn silage is lower in crude protein (CP) and higher in digestible energy (DE) than other forages. It also differs from other forages in that quality does not decline with advancing maturity. This is because the increasing amount of grain in the crop offsets the decline in digestibility normally associated with structural tissues (in the case of corn, stem). Compared to many crops, corn is relatively easy to ensile.

For smallholder farmers with limited production capacity, procurement of enough feed specially during summer months to maintain good milk production has always been a problem. Many are forced to use rice straw, concentrates or silage just to keep their animals alive and are unable to benefit due to the higher prices paid for animal feed in the summer months. Hence the importance of the knowledge of producing affordable but high-quality silage.

Silage are forage, which has been grown while still green and nutritious and are being conserved through a natural 'pickling' process. Lactic acid is produced when the sugars in the forage plants are fermented by bacteria in a sealed container ('silo') with no air. Forage conserved this way is known as 'ensiled forage' or 'silage' and will keep for up to three years without deteriorating. Silage is very palatable to livestock and can be fed at any time.

Green corn silage production, nutrient-enriched rice straw (as haylage), and use of UMMB has been proven to improve nutrition among dairy animals. However, adoption of these products is low more so in producing them on commercial scale.

Objectives of the Study

Generally, the study aimed to improve dairy production and income of poor dairy farmers through the utilization of silage using locally available feed resources.

Specifically, it aimed to:

- Undertake benchmarking activities in terms of available feed resources, equipment, facilities, land available for pasture, and fodder production;
- Capacitate dairy farmers trainer and innovators in the use of locally available feed resources for silage production, treated rice straw, and Urea Molasses Mineral Block for commercialization; and
- Determine the financial viability of green corn silage production, utilization and commercialization as a means of improving the economic condition of dairy farmers and dairy Industry.

Conceptual Framework

The success of a dairy enterprise is dependent to a year-round availability of feeds. Sustainable and viable silage production is envisioned to address seasonal availability of forage. The use of locally available feed resources as basic raw materials in silage production. Through benchmarking and identification of locally available feed resources in the valley, problems on adoption of silage, source and use of other feed resources will be addressed.

Silage production addresses the year-round availability of green corn as main raw materials in silage production, availability of silage for dairy production will be addressed. Thus, a stable supply of silage is assured, thereby increasing milk production. In the long-term, as dairy industry expands the market of silage will also expand and make its operation viable and sustainable. The green corn production, silage production, and dairy production in a farmers' organization will be treated as a "model farm" that will showcase the sustainability of their operation as separate enterprises or complementary enterprises. Treated as a system, the model farm will also showcase the synergy of these enterprises that reinforces the enterprises along the value chain.

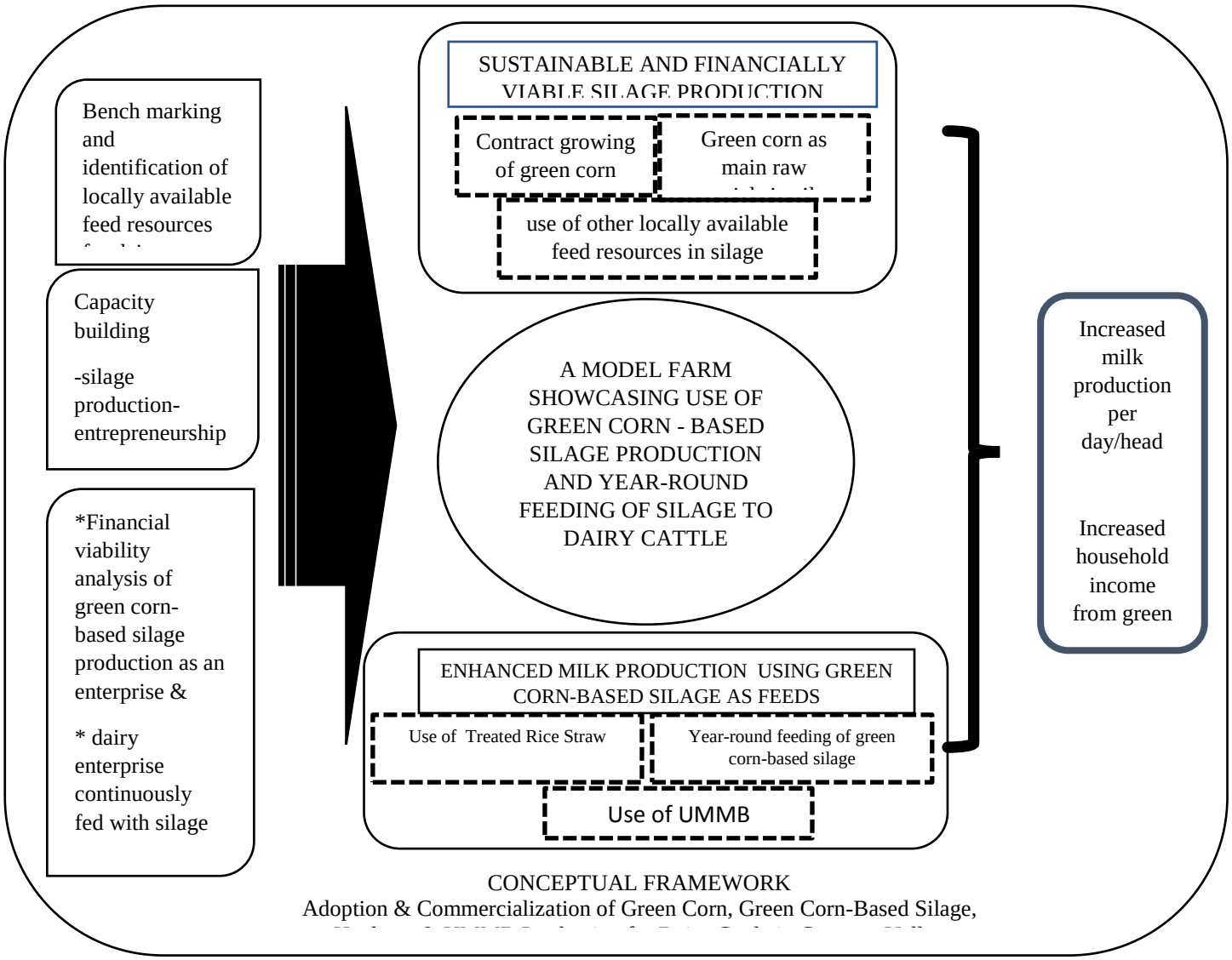

Figure 1. Conceptual Framework

Small-scale milk producers in the Philippines generally use locally available feed resources. Their production therefore depends mainly on seasonal fluctuations in the quality and quantity of natural forage. Conservation of forage as hay or silage permits the production and sale of milk during periods of feed shortage. A sustainable dairy production system can in many cases be aligned through a better utilization of locally available feed resources to complement grazing of improved open or shade pastures (e.g. under coconut plantations). There is a wide range of by-products and residues from food crops and food processing which are potentially valuable feed supplements (FAO 2019).

Shelton et al. (2005) argues that adoption of new technology is influenced by a number of factors: (a) the technology must meet the needs of farmers; (b) building relevant co-operators enhances adoption; (c) an understanding of the socio-economic context and skills of farmers and their farming systems is essential; and (d) participatory involvement of the rural communities enhances adoption.

The importance of level of education in adoption of Package of Technology (POT) was consistent with the findings of other workers on adoption of forages, e.g. Lapar and Ehui (2005), although Gebremed et. al. (2003) found that, while formal education/literacy was important in accessing information, it was not positively associated with level of adoption of technology.

Commercialization is the process by which products, services, and technologies are introduced to the market for purchase. It has been proven to be a more successful method for technology dissemination because of the sense of ownership that stakeholders have in the technologies they purchase (USAID 2017).

Dairy roadmap

Under the Medium-Term Development Plan for dairy industry, development model signalled a new area for the Dairy industry. Likewise, the Department of Agriculture, the National Dairy Authority as well as other government institutions in the Philippines support the dairy activities because the country is heavily dependent on imports to meet its national demand for milk and dairy products. Most of the country's dairy milk requirement are imported mostly in powder form and are used by the dairy processing and packaging industry because the country only produces less than one percent (1%) of its total annual dairy requirement and imports the balance (NDA, 2010). The launching of the program makes the dairy cattle members increased due to the ongoing herd build-up programs of the NDA. (Mondala 2015). The Bureau of Statistics (2010) reported that considering the present and projected population of Region 02 and the supply of milk from pure and crossbred buffaloes, the sufficiency level accounts for only 4%. Pasteurized milk is the easiest to prepare and the 16-kilogram annual per capital consumption, about 20.8 litres are in the form of pasteurized milk. Although there are no available records on the volume of the Region milk candy and other milk products sold, these are readily bought by local and foreign tourists for "pasalubong" (Mondala 2015).

Urea-molasses mineral blocks (UMMB) provide N to microorganisms in the rumen and thus improve the digestion of straw. In addition, UMMB supply amino acids in a form that can bypass fermentation in the rumen and be absorbed in the lower gut of the animal. UMMB is inexpensive which contain 45-50% molasses, 12-15% urea, 6-8% dolomite limestone, 20-25% rice bran, and 3% each of salt and mineral mixture, the UMMB is consumed at 300-800 g/day. It increases the intake of crop residues by 15-20%, reduces the required concentrates, and improves daily gains and milk production by 15-20% (Kunju, 1987). Supplementation with UMMB can increase digestibility of fibrous feeds by up to 20%, increase the nutrients the animal receives and can increase feed intake by 25 to 30% (BAR, 2010). Researches indicate that optimization of harvest maturity, kernel processing, theoretical length of cut, and cutting height improve or maintain the nutritive value and milk production of lactating dairy cows (Ferraretto, LF et.al. 2013).

Methodology

The study involved two (2) dairy cooperatives in the Province of Isabela, Philippines and Local Government Units LGUs) of Mallig, and San Agustin.

In preparation for the feeding trials, test animals were dewormed and animal weights, milk performance were recorded.

Figure 2. Map of Isabela showing project sites

An average milk production of 2-4 liters per head/day and an average lactation period of 220 days were noted. The cooperating agencies showcased the following POTs: (1) corn production for silage, (2) green corn silage production, (3) haylage (urea/molasses treated rice straw), and (4) UMMB.To enhance adoption of these POTs (particularly corn production for silage, green corn silage production, haylage production, and UMMB production), the following activities were undertaken: Capacity building on green corn, silage, haylage and UMMB production and dairy entrepreneurship; application of package of technology (POT) in the production of green corn for silage, green corn silage, haylage, and urea molasses mineral block for dairy cattle and buffalo and financial profitability and viability analysis of green corn, green corn –based silage, haylage and UMMB production technologies for dairy production.

Results and Discussion

Small scale milk producers rely heavily on forages such as natural pastures, crop residues, cut-and-carry grass, forage crops and local feedstuffs for feed and nutrition of the dairy cattle and buffalos. They feed on grasses and legumes available in the locality which are either indigenous in the area or introduced species. Crop residues such as corn stover and rice straw which are high in fiber but low in nutrients serve as feed supplement and filler to the daily diets of dairy cattle and buffalos. Farmers are found to be wanting in financial access, entrepreneurial skills e.g. risk taking, opportunity seeking, demand for quality and persistence. Also postharvest facilities are inadequate

At the end of the feeding trial, almost all the participating farmers reported that by supplementing UMMB, cows consumed more roughage, maintained good health and productivity and these effects were sustained even after reduction of concentrate allowance during summer months when green fodder was scarce. All the farmers readily accepted the practice of using UMMB supplementation and were willing to continue in the future.

Corn silage is used as an energy and fiber source for dairy cows (Borreant and Tabacco, 2010, Bernardes, 2012). The nutritional value of the green corn silage would lessen the cost of concentrate feeding in the diets, without affecting the physiology and performance of the dairy animals. It is a high energy feed resource for ruminants. Being part forage and part grain, it has a valuable feed component of dairy rations in regions where corn can be grown. In terms of nutrient content, corn silage is high in digestible energy (DE) than other forages and that quality does not decline with advancing maturity. This is because the increasing amount of grain in the crop offsets the decline in digestibility due to the structural tissues (in the case of corn, stem).

It was also experienced by 41.7% of the respondents that when silage and rice straw haylage were fed and UMMB was provided as lick to the dairy animals, milk production showed to have increased by 36% for Dairy Cattle and 50% for dairy buffalo, especially during lean months period.

Table 1. UMMB supplementation to Dairy Buffalo/Dairy Cattle

Observations	UMMB	
	Co-operator 1	Co-operator 2
Number of Cows	10	10
Body weight of cow in kg		
Initial weight	345	378
Final weight	352	388
Change	+7	+10
Body Score of Cows		
Initial	2.12	2.20
Final	2.78	2.79
Milk Production (litres/ head/day		
Before feeding corn silage, UMMB and Haylage	4 lit	2 lit
After feeding corn silage, UMMB and Haylage	11 lit	4 lit

UMMB licks increased feed intake, milk yield, crop residues consumption and maintained live weight of the cows (Table 1). This finding was corroborated by the study of Misra et. al., (2005) on dairy cattle under smallholder mixed production and Tanwar, et al (2013). UMMB provide N2 to microorganisms in the rumen and thus improve the digestion of straw. In addition, UMMB supply amino acids in a form that can bypass fermentation in the rumen and be absorbed in the lower gut of the animal. UMMB is inexpensive which contain 45-50% molasses, 12-15% urea, 6-8% dolomite limestone, 20-25% rice bran, and 3% each of salt and mineral mixture, the UMMB is consumed at 300-800 g/day. It increases the intake of crop residues by 15-20%, reduces the required concentrates, and improves daily gains and milk production by 15-20% (Kunju, 1987). Supplementation with UMMB can increase digestibility of fibrous feeds by up to 20%, increase the nutrients the animal receives and can increase feed intake by 25 to 30% (BAR, 2010). Supplementation with UMMB can improve body condition score from 3.5 to 4. (Upreti, et al., 2010)

Haylage from rice straw fed to the dairy animals during the dry season is low of quality (4.6 %CP; 24-39% CF), and green forage is 7.8% CP; 26% CF, and do not meet nutritional requirements of the dairy animals (Table 2).

Table 2. Chemical Composition (Mean±SE) of locally available feedstuffs and green corn-based silage, haylage, UMMB offered (% on DM basis) to Dairy Cattle and Buffalo, Isabela, Philippines.

Nutrient	Corn Silage	UMMB	Rice Straw (RS)	RS haylage	Corn Stover	Mixed dry grasses	Napier based
DM	30.15±2.2	90.19±0.5	89.71±1.37	50.5±1.2	90.6±0.7	88.21±1.2	25.44±1.8
CP	8.2-10.6±0.9	36.28±1.7	3.72±0.5	5.8±0.9	6.2±0.4	5.48±0.7	7.80±0.7
CF	--	4.18±0.9	38.50±2.4		24.4±1.2	29.32±1.6	25.71±1.8
Ca	0.52±0.8	5.81±0.71	0.25±0.06		0.33±0.5	0.73±0.04	0.63±0.07
P	0.48±0.5	1.67±0.40	0.07±0.03		0.36±0.5	0.38±0.13	0.53±0.06

Wanapat (1995) showed that feeding with UTRS during dry season in the villages of Thailand improved performance (weight gain, reproductive performance, physical appearance, ensure rumen functions and economically viable) of the buffalo. Higher ruminal NH3-N concentration occurred when steers were fed with UTRS because of the relatively high levels of soluble CP for UTRS than for RS (5.4% vs 2.5% CP), which would likely have caused higher rumen ammonia levels, particularly immediately after feeding. Highstreet et. al., 2010 claimed that urea-treated rice straw supplied more moisture (51.0% DM) than untreated rice straw (93.7% DM), indicating that urea treated straw was highly palatable. The increase in palatability might be due to the blending and processing of less palatable fibrous straw (Jaglan and Kishore, 2005). Vu, et al (1999) also claimed that milk production increased by 10.3% - 11.9% and milk fat content increased by 3%-5%, therefore profit of farmers increased by US$0.55 to 0.73 per cow per day.

Profitability Analysis

With the introduction of green corn silage, a traditional corn farmer is now given seven (7) options such as:

OPTION 1 – plant corn and sell it as grain (as usual practice)

OPTION 2 – plant corn and sell it as green corn for silage

OPTION 3 – Plant corn, process it as green silage and sell it as silage

OPTION 4- Plant corn, process it as green corn silage, feed it as silage to dairy Cattle owned by the family. The revenue will be sales of milk produced.

OPTION 5 – Plant corn, process it as green corn silage, feed it as silage to dairy buffalo owned by the family. The revenue will be sales of milk produced

OPTION 6- Plant napier grass (pachong) and feed it ad libitum as forage to dairy Cattle

OPTION 7- Plant napier grass (pachong) and feed it ad libitum as forage to dairy buffalo

Table 3. Summary of Cost and Return Analysis of the Different Options

Particular	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Revenue	48,000.00	66,500.00	299,250	134,000.00	95,200.00	34,000.00	31,200.00
Cost	29,000.00	35,000.00	152,685	62,815.37	62,815.37	5,845.33	5,845.33
Net Revenue	19,000.00	31,500.00	146,565	71,184.63	32,384.63	28,154.67	25,354.67

Small hold farmers can have positive net income from all the different options, but to go in Option 3 (Plant corn, process it and sell it as silage), they can have the greatest net profit of around Php146,565.00 annually..

Enterprise Viability Analysis

Green corn silage production is one of the promising industries in the Cagayan Valley region specifically in the province of Isabela where vast corn production is located. Considering a high demand of silage in dairy and feedlot producing provinces in the Philippines like Batangas, Bulacan, Pangasinan, etc. this can be an alternative livelihood of the dairy farmers in the locality where they can engage production on it. . An estimate of 2 million metric tons a month for the aggregate domestic demand of corn silage from the said locations. Aside from that, there is a huge demand for corn silage in international markets like Korea and Japan. The farmers have options to engage in green corn silage production: either they will engage in planting corn ensile it and sell; buy a standing crop for silage; and plant corn and sell it as standing crops to the individuals who will engage in silage production. There are existing consolidators who are engaged in transporting and selling the product in the market which the farmers can also sell their produced silage to them if they cannot bring their product to the end-users due to lack of transport facility.

Commercialization of Silage

Option 1 - Plant corn, ensile it and sell it as silage
Option 2 - Make business with silage making and sell
Option 3 - Plant corn and sell it standing crop

The foregoing options for the dairy farmers to engage as their business for commercialization are all recommended. If the dairy farmers have no capital to use in acquiring the processing equipment for silage production, they will go to option 3 where they can plant corn and sell it as standing crop to the silage processors. Anyway, it has better economic analysis results as compared to the two options (1 and 2). The first and second options are recommended to those dairy farmers capable of investing capital to acquire assets for processing of silage. The second option has the shortest business engagement which results in a fast cycle of capital as compared to options 1 and 3.

Dairy Milk Production

Option 4 - Cattle Production fed with green corn silage+ UMMB+ Concentrates
Option 5 - Carabao Production fed with green corn silage+ UMMB+ Concentrates
Option 6 – Dairy Cattle ad libitum fed with grasses (Napier, etc)
Option 7 – Dairy Carabao ad libitum fed with grasses (Napier, etc)

Table 4. Summary of financial and economic Information

Particular	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Ave. margin of Profit	666,225.00	978,075.00	354,375.00	353,646.00	337,896.00	102,000.00	93,600.00
Ave. Cost of Production	546,268.91	860,143.91	191,563.91	185,733.90	181,470.90	17,535.99	17,535.99
Ave. Net Operating Profit	119,956.09	117,931.09	162,811.09	167,912.10	156,425.10	84,464.01	76,064.01
Return on Investment (ROI)	43.62%	42.88%	135.68%	58.40%	54.41%	29.38%	26.46%
Payback Period (Years)	2.52	2.6	0.82	2.03	2.21	4.65	>5
Benefit-Cost Ratio	1.05	1.06	1.38	1.9	1.86	5.82	5.34
Net Present Value (Php)	150,152.03	142,852.35	459,634.71	317,785.54	276,377.48	16,973.85	(13,306.27)
Internal Rate of Return	31.10%	30.22%	124.21%	50.95%	46.29%	14.36%	10.11%

Based on Table 4, farmers will generate more income if they feed their dairy animals green corn silage+ UMMB +concentrates than just feeding them ad libitum with grasses like napier, etc.

Summary

In the Philippines, small scale milk producers rely heavily on forages such as natural pastures, crop residues, cut-and-carry grass, forage crops and local feedstuffs for feed and nutrition of their dairy cattle and buffalos. Crop residues such as corn stover and rice straw which are high in fiber but low in nutrients serve as feed supplement and filler to the daily diets of dairy cattle and buffalos.

Cagayan Valley is a corn and rice producing region. In 2017 approximately 4,498 mt (1,841 mt corn + 2,651 mt rice) crop residues are available as potential feed resource for dairy.

Despite the enormous supply potential of corn stover and rice straw, crop residues can only serve as feed supplement or raw materials of a certain feedmix for dairy animals. Forages are the common feedstuff for dairy animals in the region. Dairy farmers still faced with scarcity problem of quality feed resources for dairy animals especially during dry season. The supply of forage is very low during the dry spell. The wet season on the other hand, is the peak season wherein quality feeds are high in supply, therefore contributing to the good milk production of cows.

Entrepreneurial competencies of the officers and members of the two partner cooperatives were found very low in risk taking, and low in almost all other entrepreneurial competencies. These weaknesses were enhanced through coaching and mentoring.

Silage when fed to the animals with UMMB, milk production shall increase by 36% and 50% to dairy cattle and buffalo, respectively. Silage production is more economical when entrepreneurs have sufficient resources because the production requires equipment and warehouse. It is also found out that better informed farmers may be more capable of recognizing the benefits of the technology.

Several package of technologies (POTs) for dairy cattle and buffalo were introduced to two partner cooperatives. These are the POTs of: (1) production of green corn for silage, (2) green corn silage production processing, and storage, (3) production of haylage (Urea-Molasses Treated Rice Straw), and (4) UMMB (Urea Molasses Mineral Block).

The green corn for silage showcased in the two partner cooperatives were processed into green corn silage. After ensiling, nutrient analysis of the green corn silage was done and found containing the desired nutrients contained in a green corn silage for lactating dairy animals. These were fed to test animals. Similarly, haylage and UMMB were given to test animals.

Survey results showed that the feeding trial in both cooperatives resulted to increased milk production, improved body weight, calving efficiency, and reduced calf mortality among others.

In the case of dairy buffalo, an increased milk production per head per day from 2 litres per day to 4 litres per day was attained. This was the effect of combined feeding of green corn silage, concentrates from Philippine Carabao Center (PCC), and licking of UMMB.

Feeding trials and licking of UMMB resulted to increased dairy cattle milk production per head per day from 4 litres to 10 litres. This is in addition to increased body weight, physical appearance, and calving efficiency. Reduced calf mortality was also observed.

Financial profitability and viability of the following options that may be adopted by farmers was also conducted:

OPTION 1 – plant corn and sell it as grain (as usual practice)

OPTION 2 – plant corn and sell it as green corn for silage

OPTION 3 – Plant corn, process it and sell it as silage

OPTION 4– Plant corn, process it as green corn silage, feed it as silage to dairy animals owned by the family. The revenue will be sales of milk produced.

OPTION 5 –Plant napier grass (pachong) and feed it ad libitum as forage to dairy animals owned by the family. The revenue will be sales of milk produced.

It showed that all options are profitable. But Option 3 (plant corn, process it as silage, and sell it as silage) is superior to Option 2 (plant corn and sell it as green corn for silage) and Option 1 (plant corn and sell it as corn grain). If market for green corn silage exists and accessible to them, there are several advantages for a traditional corn farmer to sell his corn crop as green corn rather in grain form.

Financial viability analysis showed dairy cattle and buffalo milk production is found viable if fed with green corn silage + UMMB+ haylage.

6. Conclusion

The implementation of the Project Workplan led to increased awareness of alternative nutrient-rich feedmix (green corn silage, haylage, UMMB) for lactating dairy cattle and buffalo in a corn and rice producing community. The capability-building activities proved effective in increasing the knowledge about the "what, how, and why" of the technologies introduced. It enhanced the skills in producing green corn for silage, ensiling green corn as silage, producing urea-molasses treated rice straw (or haylage), and producing UMMB. Showcasing of the products developed through demonstration feeding to test animals created positive attitudes of dairy farmer co-operators and their communities towards the products showcased, hence, technology adoption is enhanced.

Financial profitability and viability analysis of green corn production for silage, ensiling (green corn silage), feeding silage to dairy cattle and dairy buffalo showed that all these options are profitable and viable enterprises and are superior to the traditional corn production sold as grain. Feeding green corn silage + UMMB + haylage have been found complementary to dairy production and can increase

revenue from milk. The project was not able to show other benefits in feeding silage, haylage plus UMMB. More time is needed for the test animals to manifest expected changes such as enhanced physical appearance, increased body weight, increased lactation period, improved calving efficiency, and reduced calf mortality.

On green corn silage commercialization pathway, engaging the small-scale dairy farmer groups such as the two partner cooperatives as entrepreneurs along the dairy value chain faced the same constraints and difficulties just like in other countries. While the market for green corn silage is large, they lack the entrepreneurial competencies needed, and they have limited capital, low accessibility to lending windows to engage in the trading of green corn silage.

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