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Public-private partnerships for unlocking the potential of dairy cattle productivity in Uganda for improved livelihoods

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Abstract

Complementary synergies between the private sector endowed with agro-industrial sugar cane molasses and university scientists equipped with scientific knowledge and skills were used to convert sugarcane molasses into a commercial dairy feed supplement. Scientists from Makerere University in partnership with Kakira sugar Works Ltd., Kakira Out-growers Rural Development Fund (KORD) and Dairy Development Authority (DDA) in a participatory manner tested the effect of molasses urea supplement (MUS) on dairy cattle productivity among zero grazing farmers. One hundred Friesian dairy cows were used to evaluate the effect of graded levels of MUS on milk productivity using four treatments: 1) Control, representing farmers' dairy management practice without the MUS supplement intervention, 2) control + 0.5 kg/animal /day MUS 3) control + 1 kg/animal/day MUS 4) control + 2 kg/animal/day MUS. Data was analysed using polynomial contrasts with linear and quadratic functions. Adoption of the intervention was also tested among the zero grazing farmers to find how farmers embraced the innovation.

Milk yield increased linearly with a quadratic trend. Increasing response in milk production at a decreasing rate suggested that MUS supplementation was optimal at 1 kg/animal/day. The dairy supplement has now been commercialized as "milk booster". Adoptability analysis of the innovation indicated existence of variations in milk yield across different farms even when the farms were supplied with similar levels of supplementation of MUS. It was concluded that complementary synergies between public and private sector is crucial in translating science into tangible commercial molasses urea supplement for improved dairy cattle productivity in Uganda.

Key words: agricultural research, commercialization, competitiveness, innovations, knowledge and skills, molasses urea supplement, zero-grazing dairy farmers

Introduction

Most economies in Sub Saharan Africa (SSA) are supported by agriculture but persistent low production levels are prevalent and this is partly why many rural households are living below the poverty line and many are on the brink of starvation and malnutrition (Bahiigwa et al 2005). The single commodity approach which considers crops, livestock and agro processing industries as different entities with no vertical and horizontal linkages to enable optimum exploitation of natural resources for the benefit of man has exacerbated the problem. Moreover, a growing body of evidence indicates that one of the major constraints to livestock productivity in Uganda is the prohibitive costs, scarcity and fluctuating quality and quantity of conventional animal feeds especially during prolonged dry spells (Kabi and Bareeba 2008). While annual average milk yield per cow per lactation year of 305 days in developed countries can go above 8000 kg , less than 2000 kg is obtainable from pure dairy breeds, 1000 from cross breeds and 500 kg from indigenous cows in Uganda (Fitzhugh 1992; Nabbumba and Bahigwa 2005). Such low milk productivity in Uganda is to a great extent attributed to feed scarcity that leads to poor animal nutrition. Moreover, the level of agricultural productivity at farm level greatly influence whether a given household will have a chance to live a better and health life or being condemned to a vicious cycle of extreme hunger and poverty. Paradoxically, the challenge of dairy feed scarcity in Uganda exists in amidst of plenty of agro-industrial by-products. Therefore, it was hypothesized that collaboration between livestock scientists in a public research institutions and the private sector can lead to complementary synergies in public private partnership (PPP) and is crucial for elimination of barriers to agricultural innovations. Such innovations were anticipated to lead to production of commercial dairy feed supplement as a sustainable solution to the challenges of poor milk productivity.

Uganda sugar factories annually produce 115,000 metric tons of sugar cane molasses most of which is used in local breweries. However, innovations on use of industrial molasses for manufacturing livestock feeds in combination with fertilizer grade urea (46% N) has been indicated to give a more profitable alternative superior to alcohol production (Preston and Leng 1987). Although in Uganda industrial molasses is mainly used for making local brew and spirits, in Tanzania use of molasses and urea for beef cattle feeding has been successfully developed at Mtibwa Sugar Factory. The major concern of this type of feed is that intake of molasses and urea must be limited to avoid possible toxicity problems while maintaining sufficient ammonia levels of

above 200 mg N/L in the rumen fluid. This implies that quantities of Molasses and urea recommended for dairy feed production may negatively influence animal productivity if research and development does not address the optimal levels needed for effective and efficient rumen function.

Despite the knowledge on the importance of molasses and urea based supplement (MUS) in promoting effective utilization of fibrous feed resources by ruminant among scientists, there is a paucity of information among industrialist and farmers on its inclusion levels in dairy cattle ration in Uganda. The objective of this study was twofold: i) to assess the feasibility of using complementary synergies between the private and public institutions in translating science into a tangible sellable MUS feed product for improved dairy cattle productivity ii) to quantify the amount of MUS needed for improved milk productivity among small holder dairy farmers who majorly depend on fibrous elephant grass and cereal crop residue as basal feed.

Materials and methods

Approach to the challenge of feed scarcity

In order to establish whether use of the industrial sugarcane molasses urea supplement (MUS) could improve on dairy cattle productivity among zero grazing farmers in Uganda, a participatory on-farm inquiry involving the smallholder dairy farmers, local government staff, Kakira Sugar works (1985) Ltd, Kakira Out growers Rural Development Fund (KORD), Makerere University scientists and Dairy Development Authority (DDA) was undertaken. The study was conducted in five purposively selected districts of Jinja, Iganga, Kamuli, Mayuge and Mukono. A working partnership agreement was signed between partnering institutions. The partnership sought to complement each of the involved institution with knowledge, skills, physical resources and human resources to develop synergies in producing molasses urea dairy supplement and testing the innovation on farm. The dairy supplement was produced from sugarcane molasses which is a by- product of table sugar production at Kakira sugar works Ltd. under the instruction of scientist from Makerere university.

A technology platform for learning alliances was instituted. This platform involved consultations through several stakeholders meetings at every stage of the process of MUS production and testing. An inception workshop for stakeholders including extension agents, private sector and farmers was conducted. Through a situation analysis, farming conditions, livestock farming practices as well as market potential and constraints to improved dairy cattle

productivity was explored and documented from the point of view of the farmers, extension agents and local leaders. Constraints and opportunities for improved dairy cattle productivity were identified through diagnostic survey and stakeholders consultative meetings. As part of research planning phase, constraint and opportunities were analyzed in a participatory manner. A least cost dairy ration based on sugarcane molasses and urea together with maize bran, cottonseed cake, feed grade limestone fortified with micro and macro nutrients and mineral salts were used to formulate the molasses urea supplement (MUS) by scientists and the feed was manufactured by Kakira Sugar Works (1985) Ltd and tested on farm. A record keeping system was instituted among sampled farmers to collect the productivity data in response to the innovation.

Creating platforms for learning alliances

Discussion platforms were created to ensure complementary sharing of knowledge, skills, physical and human resources between the private sector, public institutions and the farmers. The different stakeholders were, however, known to have different incentive structures. While the scientists were interested in advancing and documenting science on use of molasses urea supplement innovations to offer solutions to dairy cattle nutrition during the dry season, the industrialists were interested in gaining access to least cost ration formulation from scientists in order to produce commercial dairy supplements. Dairy Development Authority a statutory body under the Ministry of Agriculture Animal Industry and Fisheries (MAAIF), on the other hand, was interested in evidence based data to better inform policies aimed at strengthening their mission of developing the dairy sector and offering regulatory services to ensure increased milk productivity and its consumption. Kakira Out growers Rural Development Fund (KORD) is a Non Governmental Organization (NGO) working closely with sugarcane out growers mandated to ensuring diversification of farming activities and helping farmers improve on farm efficiency and to access commercial bank loans. The incentive of KORD in this platform was to tap on the resources and expertise within the public private partnership that was anticipated to improve on dairy cattle productivity. Improved dairy cattle productivity was projected to result into increased daily cash flow which would in turn support servicing of loans got by farmers from commercial banks. The farmers and the local government were interested in any intervention that would break the barriers that have hither to prevented easy access to innovations that are vital for addressing improved dairy cattle productivity.

The platform for learning alliance was therefore meant to cultivate trust among the different parties with different incentive structures and ensuring ultimate

gaining of adequate understanding of the challenges faced by dairy farmers and turning the existing challenges into opportunities from the perspective of business, science and policy. A win-win situation was discussed with the different stakeholders to enable each one including the farmers to see an opportunity out of the existing challenge of low milk productivity. It was suggested that clear identification of the opportunities out of the challenge of low milk productivity from dairy cattle would be possible if the different stakeholders with different incentive structures worked together to implement the research to unlock the potential for milk productivity. The farmers accepted to offer their dairy cattle for experimentation with the new innovation of the commercial MUS produced by the sugar industry. The study was set to enable the private sector to explore market potential of MUS supplement while getting greater access to least cost ration formulations from Makerere university scientists.

Experimental Design

Twenty on-farm primiparous and 80 multiparous Friesian dairy cows in their mid lactation were used in a completely randomized block design experiment to evaluate the effect of graded levels of MUS on milk productivity and trends. Cows were blocked by parity and were randomly assigned to one of the four treatments. Lactating cows were monitored and records were kept for seven months from October 2008 to May 2009. The four different treatments were as follows: 1) Control that represented farmers' own management conditions with no MUS supplement, 2) control + 0.5 kg/animal /day of the MUS supplement, 3) control + 1 kg/animal/day of MUS supplement, 4) control + 2 kg/animal/day of MUS supplement. The supplement was formulated to meet NRC (2001) requirements for small breed dairy cattle in mid-lactation. Treatments were compared to establish influence of graded levels of MUS supplement on milk productivity under conditions as encountered by zero-grazing farmers. Water, feeds offered to the dairy cattle and refusals were weighed on a daily basis using spring balances by the farmers under supervision of research assistants. Weight of the animals was estimated using the girth tape measure on a weekly basis. The design of the study enabled researchers to conduct adoptability analysis on the four treatments on all test farms according to the procedures by Mutsaers et al (1997). Data was analyzed using mixed procedure of SAS (version 9.1). Least square means of the parameters were analyzed using polynomial contrasts with linear and quadratic functions (SAS, 2003) to examine impacts of graded levels of MUS on milk production and trends.

Results and discussion

Challenges to dairy cattle productivity

While increased animal productivity has been identified as one of the options for increasing incomes and household nutrition of the rural households (Rottger 2004), feed shortage during dry season was unanimously identified by farmers, extension staff and local leaders as one of the biggest challenges to increased milk productivity in Uganda (Table 1). Abundance of feeds during wet season was reported and this possibly elevated milk supply above the effective local demand leading to the low prices of milk observed during the wet season. This observation was consistent with earlier findings by Njarui et al (2012) who reported an increase from 3.5 litres of milk/cow/day in Uganda during the dry season to 7.7 litres/cow/day during the wet season. Furthermore, lack of infrastructural development such as milk collection centres and coolers in the area to mop up milk which is not immediately consumed locally during the wet season coupled with lack of equipment to reduce on the drudgery of labour was reported to negatively impact on livestock productivity and on efforts by the farmers to heavily invest in the dairy sector. The generally high cost of commercial feeds irrespective of seasons in the region was attributed to scarcity of such feeds due to limited investment by entrepreneurs in value addition to the abundant agro industrial by-products. Similarly, limited value addition to the highly perishable milk rendered it rather difficult for farms to fetch reasonable prices despite its local demand right at the farms. Therefore, in agreement with earlier observation by Lukuyu et al (2011), inadequate livestock nutrition, lack of basic equipment as well as unfair balance of trade at smallholder farms (Table 1) were identified as extremely important constraints that need urgent attention if challenges that limit dairy cattle productivity are to be eliminated.

Table 1: Constraints to dairy production as reported by farmers, extension and local leaders during inception

Constraints to dairy cattle productivity	Respondents by category		
	Farmers n=100	Extension staff n=15	Local leaders n=15
Feed shortage during dry season	+++	+++	+++
Feed shortage during wet season	-	+	++
Water shortage for livestock during wet season	-	++	+++
Water shortage for livestock during dry season	+	+	++
Shortage of fodder planting materials	++	++	+++
Land shortage for fodder production	+	++	+
Un availability of equipment	+++	+++	+++
Market shortage for milk during dry season	-	-	-
Market shortage of for milk during wet season	+	-	-
Low milk prices during wet season	+++	++	++
Low milk prices during dry season	+++	+	+
High cost of feeds during wet season	+++	+++	++
High cost of feeds during dry season	+++	+++	++
High incidences of livestock diseases during wet season	++	++	+++
High incidences of diseases during dry season	+	+	++

+++ Extremely important; ++ Very important; + Important; - Not important

Molasses urea supplementation intervention

Proportions of elephant grass intake as a percentage of total dry matter intake (DMI) ranged from 58 to 64% and linearly decreased with increasing levels of MUS supplementation (Table 2). High levels of elephant grass dry matter intake in the diets of dairy cattle confirms earlier studies by Kabirizi et al (2006) which indicated that elephant grass is the most dominant and more frequently used source of energy in Uganda. However, high proportions of elephant grass fed in combination with more fibrous banana pseudo stems,

banana peels and cereal crop residues with less than 7% CP generally constituted about 75% of total DMI among the control group of farmers. Moreover, the available sources of supplemental protein at the farm including *Calliandra calothyrsus* and sweet potato vines altogether only constituted 15.7 to 20% of total DMI which was far lower than the recommended optimum legume content of 30% in diets of lactating animals (Preston and Leng 1987). The current feeding regimen of dairy cattle among zero grazing farmers does not lend itself into good husbandry for highly yielding dairy cattle. Such poor supplementary regime probably explains the low milk productivity of the dairy cattle among the majority of farmers in Uganda. The linear decrease in the proportions of cereal stover residues with increasing MUS probably was an indication of substitution effect of the MUS supplement for the cereal crop residues. Since cereal crop residues were abundant at all the farms involved in the study, dairy cattle tended to consume significant quantities of the fibrous residues to fill the gut in absence of supplementation intervention (Table 2).

Table 2: Proportions of locally available feed resources used by zero-grazing dairy farmers

	Levels of MUS supplementation (kg/animal/day)					**P**	
Feed resources	**0**	**0.50**	**1.00**	**2.00**	**SEM**	**Linear**	**Quad**
Elephant grass as % of total DMI	62.1	57.6	55.8	54.4	1.88	0.0051	0.808
Legumes as % of total DMI	8.09	4.41	7.39	6.00	0.440	0.0433	0.0213
SPV as % of total DMI	11.9	11.7	10.9	9.70	0.783	0.0114	0.709
Banana peels as % of total DMI	1.19	5.23	5.41	2.86	0.246	0.0072	<0.0001
Banana pseudo stems as % of total DMI	1.47	1.44	2.45	2.13	0.114	<0.0001	0.0003
Cereal grain milling by-products as % of total DMI	7.70	8.21	8.73	7.73	0.551	0.959	0.0457
Cereal crop residues as % of total DMI	10.5	11.5	2.83	3.15	0.452	<0.0001	0.0017
MUS as % of total DMI	0.00	3.70	7.42	13.1	0.4	<0.0001	0.213

***MUS**= molasses urea supplement; **SPV** =Sweet potato vines; DMI= Dry Matter Intake*

Unlocking the potential of dairy cattle productivity

Dairy cattle used in this study were of similar live weight ranging between 395 to 415 kg (Table 3) and were in their mid lactation. Water intake and dry matter intake were similar for all the animals irrespective of the level of MUS supplementation indicating that the dairy farmers understood the importance of water in dairy cattle productivity. However, despite the uniformity in water and dry matter intake, milk yield increased linearly with a quadratic trend. The increasing response in milk production at a decreasing rate suggests that

supplementation of dairy animals with MUS was optimum at 1 kg/animal/day. Increase in milk productivity of dairy cattle on basal elephant grass supplemented with MUS was consistent with earlier studies by Preston and Leng (1987) which demonstrated that elephant grass can only support low milk yields because of its inability to supply enough protein and glucogenic energy. However, since elephant grass was the most abundant feed resource available on smallholder farms, a deliberate effort that constructively engages public private partnership to enable commercial production of dairy feed supplement is crucial in the improvement of milk productivity. In agreement with Cramb and Purcell (2001), results obtained in this study also indicated that impressive results can be achieved if private sector, farmers and scientists worked together in a public private partnership (PPP) offering solutions to existing challenges of low dairy cattle productivity.

The MUS supplement was therefore branded "milk booster" and due to its high demand, the product was launched for commercialization by private sector during the July 2012 National Agricultural show. The MUS innovation was a win-win situation for all actors including dairy farmers who desperately needed to boost their milk production and the private sector who have a new product on the market. Improved milk production as a result of innovative intervention is crucial for improved daily cash flow generated from milk trade at house hold level. Any intervention that improves on sellable items at household level is an essential driver for sustainable family economic growth and such growth is necessary for beating extreme hunger, poverty and malnutrition. On the other hand, lack of sellable items at household level due to low dairy cattle productivity can only lead to a vicious cycle of extreme hunger, poverty, malnutrition and disease which eventually burdens the poor affecting individuals, families and consequently national development and growth.

Table 3: Performance of Friesian dairy cows as affected by graded levels of MUS supplementation

Parameters	Level of MUS supplementation (kg/animal/day)				SEM	*P*	
	0	0.5	1.0	2.0		Linear	Quad
Average body weight, kg	393	401	416	414	11.4	0.298	0.544
Lactation length in months	7.73	6.99	6.89	8.02	0.536	0.648	0.212
Water intake-dry season , kg/day	69.0	66.0	71.3	67.1	4.57	0.942	0.842
Water intake-Wet season , kg/day	40.5	35.9	37.1	39.4	3.11	0.994	0.440
Total dry matter intake , kg/day	10.4	11.3	11.5	11.0	0.490	0.493	0.140
Milk yield before intervention, kg/day	9.48	9.10	9.15	9.57	0.792	0.900	0.724
Milk yield after intervention , kg/day	4.93	11.7	12.7	12.2	0.828	<0.0001	<0.0002

MUS *molasses urea supplement,* ***P=*** *Probability for the orthogonal contrasts*

The assumption of weekly rate of decline of 2.5% in milk production after the peak of milk curve that occurs 4-8 week and 10-14 weeks postpartum (NRC 2001) in primiparous and multiparous cows, respectively, was evident in milk production trends (Figure 1). However, supplemental MUS did not only arrest further decline in milk production characteristic of the control group but rather the intervention increased milk productivity during dry season. Increased milk productivity with MUS supplementation is an indication that MUS is crucial for unlocking the potential of dairy cattle productivity in Uganda. Increased milk productivity as a result of the innovation shows improved efficiency of the dairy cattle which is crucial to increased milk availability for both consumption and sale at household level.

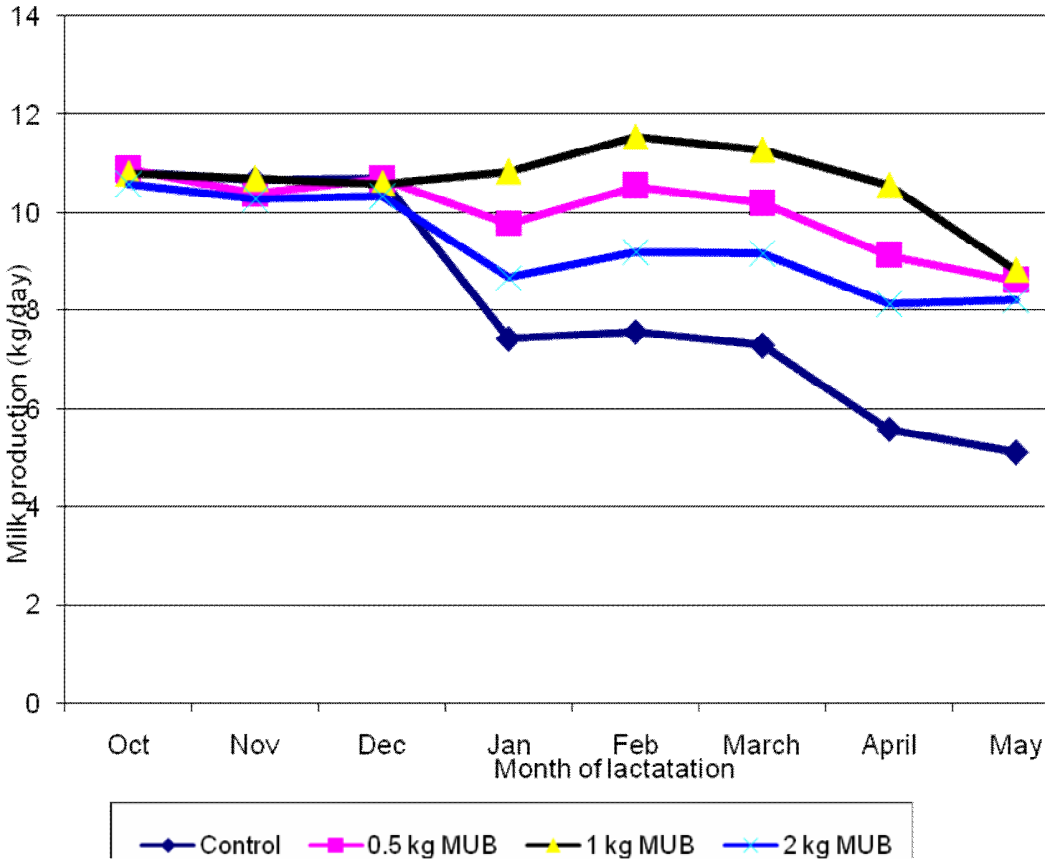

Figure 1: Effect of graded levels of molasses urea supplement on the trends and productivity of lactating Friesian cows fed basal elephant grass and cereal stovers

Adoptability analysis (Figure 2) indicated that milk yields varied across different farms even when subjected to similar supplementation regimes. The variation was possibly due to differences in management practices at different farms. This means that even with good innovations, increment in milk productivity can only occur if accompanied with adequate basal feed supply, water availability and ensuring overall better animal health and suitable genetics as part of routine farm management practices. In practical terms this implies that even with excellent livestock innovations, extension services that build good stockman ship at the farmer is indispensable.

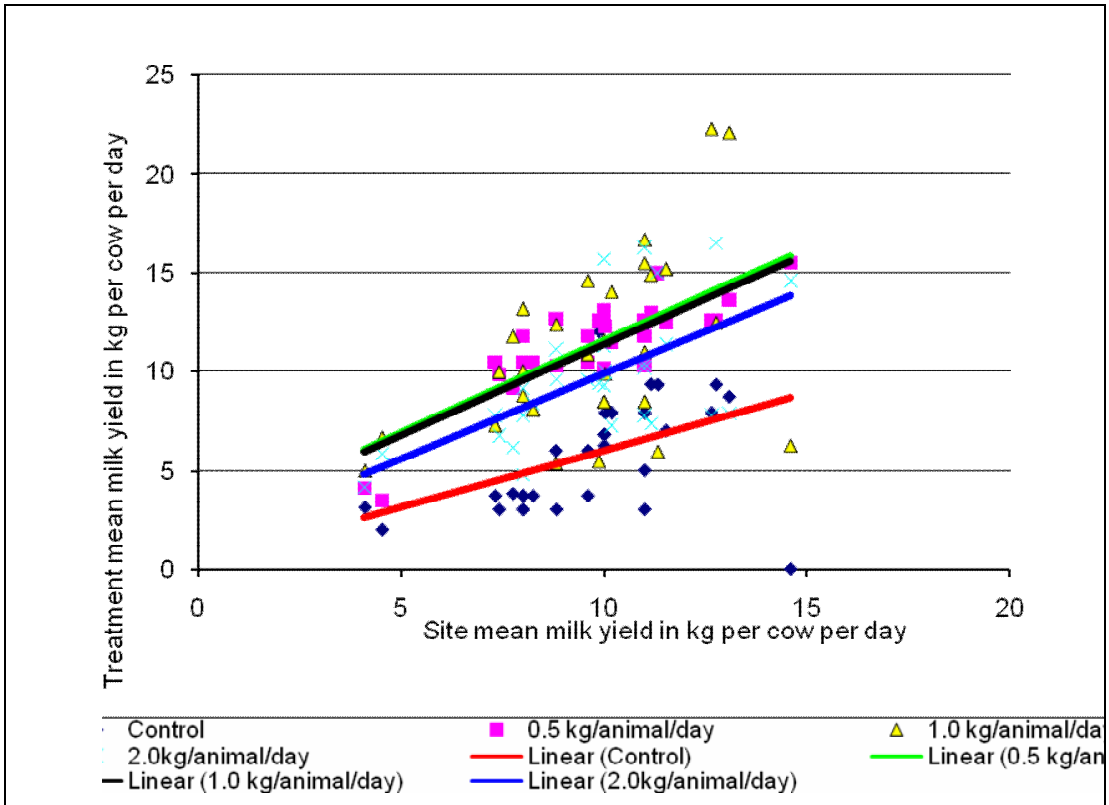

Figure 2: Relationship between site mean milk yield in kg/d of Friesian cows offered graded levels of molasses urea supplement

Public private partnership

In agreement with the development theorists cited by Hartwich (2005), this study has demonstrated that public private partnership is one of the essential ingredients needed to create platforms necessary for eliminating the barriers to the translation of agricultural research science into innovative solutions to addressing the challenge of low milk productivity in Uganda. Through complementary collaborative efforts, each of the partners contributed to the planning, intellectual and physical resources needed to produce the supplement. The public private partnership exploited synergies with industrial partners endowed with resources including machinery to mix and pellet the highly

viscous molasses mixed with urea, maize bran, cottonseed cake and mineral ingredients into a competitive commercial feed supplement. While industrial process of producing the dairy supplement was complemented with knowledge and skills from the scientists, little attention and support by the necessary legal institutional structures in the public sector was paid to the collaboration framework agreement, confidentiality and non-disclosure agreement framework. Emphasis was rather put on execution of the project tight timelines and deliverables that led to the production of the tangible sellable feed supplement. However, as a result of different incentive structures between the collaborating institutions, the challenge of intellectual property rights (IPR) emerged and still exists between private sector and the researchers. The disagreement between the collaborating institutions was exacerbated by the weak intellectual property legal framework in university and Uganda National Council for Science and Technology (UNCST). Such structures are crucial to supporting, rewarding and encouraging innovations carried out by scientists in partnership with the private sector. Unless legal structures are put in place to support scientists, disagreements over IPR will continue to hamper PPP collaboration and related challenges of making research results publically available in light of the confidentiality and non-disclosure principle (Wollweber 2005).

While PPP faced challenges of IPR, the partnership has resolved some of the barriers that have hitherto prevented the smallholder dairy farmers from gaining access to the existing agricultural research knowledge vital to addressing dry season feeding of dairy cattle. The partnership has also resulted in a vibrant network where several joint proposals with private sector are in pipeline to address challenges faced by farmers. It is evident that different incentive structures within PPP need to be carefully taken care of especially in Uganda where there is almost a monopoly by the few existing industrialists who may not clearly discern need for competitiveness in product development and diversification through research. Universities and public research scientists can only meaningfully engage with the private sector to provide solutions to the challenges of the farming communities if legal structures are strengthened to ensure a compelling win-win situation for all partners.

Conclusion

- Complementary synergy between the private sector endowed with physical resources such as the equipment and feed resources in form of industrial by-products can work together with public research institutions

with knowledge and skills to transform industrial molasses into a commercial molasses urea supplement needed by dairy farmers as a solution to improving dairy cattle productivity.

- Supplementation of dairy cattle fed a basal diet of elephant grass and cereal crop residues with molasses urea feed (MUS) was optimal at 1 kg/animal/day.

- Even with good innovations in animal nutrition, improvement in milk productivity is only possible if routine farm management practices such as adequate basal feed supply, adequate watering and overall animal health are adhered to.

- Despite the success in producing a commercial dairy feed supplement (MUS) in a PPP, the challenge of intellectual property rights (IPR) still exists between private sector and the researchers and this is attributed to the different incentive structures and weak legal support to scientists in universities

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