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Towards nutrition sensitive agriculture. Actor readiness to reduce food and nutrient losses or wastes along the dairy value chain in Uganda

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ABSTRACT

The growing search for potential approaches needed for nutrition sensitive agriculture has increased the attention given to reduction of food and nutrient losses or wastes. This study targeted the dairy sector in Uganda to empirically explore stakeholder readiness for a change toward a nutrition sensitive value chain. A survey was conducted among 246 supply chain actors about their general understanding of nutrition sensitive agriculture while making a link with food and nutrient loss or waste reduction strategies. By using lean manufacturing as a waste management approach, the theory of organizational readiness to change was applied and its constructs tested empirically to assess value chain actors' readiness to adopt measures against losses and wastes. Findings indicate that actors are less familiar with the term nutrition sensitive agriculture, yet they actually know or do what the concept entails. In addition, we found that unmarketable dairy products are often discarded but sometimes donated to charity. Path analysis revealed that change valence and resource availability positively influence change commitment and efficacy, respectively, to adopt lean measures against losses and wastes. Multi-actor approach only had a positive effect on change commitment but not on efficacy. In summary, value chain actors are optimistic about adopting approaches to reduce food and nutrient losses or wastes as part of nutrition sensitive agriculture. Consequently, external players such as governments, academia and humanitarian agencies need to create sustainable partnerships with the food industry to implement such initiatives.

1. Introduction

The disconnect between agriculture and nutrition has been described as an "invisible firewall" separating the two sectors with respect to their expected positive and synergistic impact (Pinstrup-Andersen, 2012). Although agriculture, which is part of the whole food system (i.e. from farm to fork), potentially influences nutrition outcomes, current commercial food value chains are often developed without a clear inclusion of nutrition objectives (i.e. nutrition sensitivity). Among other factors, this reinforces the triple burden of malnutrition (Gómez et al., 2013; Dixon and Ballantyne-Brodie, 2015), by which, for example, 795 million people are still undernourished worldwide, of which the majority also experiences inadequate intake of micronutrients (McGuire, 2015), plus the increasing burden of overweight and obesity (Ng et al., 2014).

This makes the food supply chain a priority point for interventions, rooted into the second and twelfth Sustainable Development Goals (SDGs), for which the former explicitly targets elimination of hunger, improvement of food and nutrition security coupled with sustainable agriculture, and the latter, sustainable consumption and production patterns (Charlton, 2016). To achieve these goals, current policy debates focus on strengthening linkages between agriculture and nutrition. This shift in approach is justified by evidence showing limited impact of various agricultural interventions on nutrition outcomes (Masset et al., 2012; Webb and Kennedy, 2014). Thereby, nutrition sensitive interventions, as a complement to specific interventions, are now expected to play a key role to demonstrate the expected impact during the post-2015 era (Haddad, 2013a; Pinstrup-Andersen, 2013; Ruel et al., 2013).

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Of all agriculture-based nutrition sensitive interventions that are currently implemented, it is biofortification that has shown significant cost-effectiveness and potential for scale-up (Meenakshi et al., 2010; De Steur et al., 2012), while others such as home gardening programs perform relatively lower on these indicators (Schreinemachers et al., 2016; Berti et al., 2004). With regard to biofortified foods, estimates from HarvestPlus show that 20 million people in 9 developing countries both grow and consume; iron rich beans (Rwanda, DR Congo and Uganda), iron pearl millet (India), vitamin A maize (Zambia), vitamin A cassava (Nigeria, DR Congo), vitamin A orange sweet potato (Uganda and Mozambique), zinc wheat (India and Pakistan) and zinc rice (Bangladesh). Thus, efficacy and effectiveness of these biofortified foods, in line with improving nutrition, has been established, in addition to partnerships with seed companies, government bodies and NGOs that facilitate scale up (Bouis and Saltzman, 2017; Ruel et al., 2013). However, a challenge still lies with food processors, retailers and other value chain actors who should incorporate biofortified foods into their product portfolio. Such an expansion in stakeholders could be one way to increase the number of malnourished people reached by this intervention, especially those not engaged in primary production and have to depend on markets as a source of food. A study by Sumberg and Sabates-Wheeler (2011) also illustrates how a value chain approach embedded in homegrown school feeding programs benefits family farmers financially and also enhance nutrition for their children in Sub-Saharan Africa.

Generally speaking, attention given to value chains has also come as a result of transitions in the food system that largely turned agriculture away from its primary role of subsistence for smallholder farms into a source of input for the processing industry in modern supply chains (McCullough et al., 2008). As a consequence, there is growing interest to not only focus on primary producers but instead leverage the whole food value chain for nutrition benefits (Pinstrup-Andersen, 2013; Corinna Hawkes and Ruel, 2012; Du et al., 2015; Hattersley, 2013). In the past, benefits of value chains have mainly been viewed from an economic perspective, however, the strengths inherent of value chains (i.e. coordination between actors, analytical nature, versatility and solution-orientation) create an opportunity to establish synergies between economic and nutrition benefits (Corinna Hawkes and Ruel, 2012). A recent report published by FAO identifies enhanced nutrient retention, added nutritional value and increased supply of nutritious foods (e.g. dairy products, fish, meat, fruits and vegetables), as entry points to agri-food value chains that could maximize nutrition benefits (Uccello et al., 2017). Through targeting nutrition benefits, a novel way to extend this specific form of value to the consumer, which has largely been overlooked in value chain analysis, can be achieved. Agri-food value chains hold the potential to supplement the impact of other strategies and reinforce the link with nutrition. Therefore, the concept “nutrition sensitive value chain” has been established both in literature and practice as a new approach that could make a sustainable contribution to attainment of SDGs that target food and nutrition security (Allen and de Brauw, 2017).

Although such an approach seems viable, there are two important types of stakeholders to consider. First are the policy makers, who have the responsibility to create an enabling environment that supports interventions targeting improvements in nutrition and second is the food industry, constituting value chain actors that implement (proposed) changes in the food system (McDermott et al., 2015). A study by Gillespie et al. (2013), for example, conceptualizes a framework by which a sustainable political momentum in support of nutrition can be initiated. In addition, there are already observable indications from Africa and Asia, regions hit with the highest burden of malnutrition, that policy makers are positive about the impact of food-based approaches to tackle malnutrition (van den Bold et al., 2015; Hodge et al., 2015). When it comes to value chain actors, however, this is less clear. Despite the fact that the food chain is identified as a potential avenue for nutrition sensitive agriculture, there is a lack of insights on perceptions of value chain actors towards this change (Keding et al., 2013; Jaenicke and Virchow, 2013). In producing and marketing highly nutritious and/or sustainable foods, actors normally justify high prices by costly production, but this can also be attributed to production inefficiencies (Haddad, 2013a). Once such price burden is imposed onto consumers, demand for nutritious foods is often affected, especially among those with low purchasing power (Jetter and Cassady, 2006; Rao et al., 2013). Therefore, success of value chain for nutrition approaches will not only hinge on policy makers, but also on the industrial stakeholders themselves.

There is an urgent need to create incentives for value chain actors as a motivation to transform their activities to those that are nutrition sensitive. At the outset, smallholder farmers basically need to engage in the production of nutrient-rich foods because this directly improves quality of consumption as well as their household income. This makes sense since access to foods such as dairy products, meat, fish, fruits and vegetables, is often limited to a small proportion of the population. An additional aspect to consider is the distribution mechanisms of nutrient-rich foods, which are highly perishable and require proper handling or storage as they are delivered to the final consumer. This issue is important in view of an assertion by Allen and de Brauw (2017) pointing to an imbalance in prices of nutrient-rich foods relative to grain-based calorie foods, the former being more expensive. The price difference and associated loss of purchasing power is worsened if a proportion of food is lost or wasted along the supply chain before consumption. Clearly, efforts targeting the reduction of food losses or wastes (Keding et al., 2013), in addition to nutrient losses (C Hawkes and Ruel, 2011; Irani and Sharif, 2016), represent an additional gateway to sustainable and nutritionally adequate diets, consequently improving public health (Neff et al., 2015). As such, this paper focuses on the value chain of dairy, an important source of nutrient-rich food products, which underlines the need for minimizing food and nutrient losses or wastes.

Milk is a good source of protein, calcium and other micronutrients. While there has been a decrease in consumption levels of milk in developed countries, an opposite trend has been observed in developing countries (Kearney, 2010). In Uganda for example, approximately 70% of the population is estimated to consume milk products at least once a week, resulting in an overall per capita intake of about 35 L and an estimated growth of 2.2% per year (Balikowa, 2011). With on-going efforts to improve efficiency of the dairy value chain in the country, the number of consumers and frequency of consumption is expected to further increase. This is a good indication to the dairy industry that demand for its products exists in the country and increase in production is justified. The decline in milk consumption mainly among people of European decent is partly due to reported inability to digest lactose (Yantcheva et al., 2016; Almon et al., 2013). Nevertheless, lactose intolerance is also common among people of Asian and African descent. A major public health concern with lactose intolerance is its diagnosis, which is based on symptoms similar to other disorders that affect the gastro-intestinal tract. This has led to unnecessary milk avoidance, among victims with perceived lactose intolerance, something which has been widely discouraged (Vernia et al., 2010). Although lactase activity diminishes gradually in adulthood, there is evidence of its persistence in African populations that enables adults to consume milk without complications (Jones et al., 2015). In fact, a study conducted in East Africa suggests that gene-culture co-evolution and socio-economic factors can be attributed to the increasing persistence of lactase observed in majority of East Africans (Hassan et al., 2016). In the context of nutrition sensitive agriculture, dairy products perform relatively better than other animal sources. While meat products, for example, have been linked to various non-communicable diseases (Schwingshackl et al., 2017; Micha et al., 2017), dairy product consumption has shown to reduce the risk of all-cause mortality, coronary heart disease or cardiovascular disease (Guo et al., 2017). As such, dairy products remain an important source of a healthy diet, which further underlines the need to minimize both food and nutrient losses and wastes in the dairy value chain.

Lean manufacturing, defined by Womack et al. (1990) as "a system that utilizes fewer inputs and creates the same outputs while contributing more value to customers" can potentially be an approach to implement along the chain to reduce losses and wastes, consequently input and production costs (Rahman et al., 2010; Womack and Jones, 2010), which is beneficial to both the supply and demand side. Since its inception as an approach for performance improvement in the auto-mobile sector, lean manufacturing has evolved into a strategic management and thinking philosophy that needs to be imprinted into day-to-day operations of not only one business enterprise but the supply chain (Shamah, 2013; Hines et al., 2004). The main focus here is creating value for the customer by eliminating the seven lean wastes including; overproduction, unnecessary inventory, defects, inappropriate processing, waiting, transport and unnecessary motion (Hines and Rich, 1997), collectively known as "muda" (Womack and Jones, 2010). This approach has also been applied successfully in the agri-food industry to improve performance by identifying and creating opportunities for waste reduction (Dora et al., 2016; Panwar et al., 2015). Incidentally, current evidence further shows that its application has potential to tackle food and nutrient losses along the supply chain (De Steur et al., 2016b). In a nutrition sensitive perspective, this approach could make nutritious food production more profitable given the fact that enhanced affordability expands market for food products (Gelli et al., 2015).

Nonetheless, transformation and adoption of new practices can never be assumed to happen automatically because some actors may be skeptical about the proposed change with view of specific barriers (Dora et al., 2016; Saad et al., 2006). Furthermore, in order to successfully use agri-food value chains for nutrition benefits, coordination among stakeholders is important (Gelli et al., 2015). This also applies to efforts targeting the reduction of food and nutrient losses or wastes (Göbel et al., 2015; Derqui et al., 2016), given that the occurrence of losses at a specific point might have been initiated from an earlier stage of the chain (Beretta et al., 2013).

To the best of our knowledge, this is the first study that considers adoption of lean thinking and applying associated tools as the proposed change needed to tackle food and nutrient losses or wastes in an agri-food value chain. In this study, the theory of organizational readiness to change is used as it involves examination of collective behavior changes among stakeholders so as to implement proposed interventions, is more robust since its development taps into strengths of theories applied in various fields (Weiner et al., 2008) and has been recommended to test predictions for changes involving lean manufacturing (Weiner, 2009). In addition, validity of this theory has been established in health care and so an extension to other fields is needed and timely (Shea et al., 2014; Oostendorp et al., 2015; Hannon et al., 2016; Rubenstein et al., 2014). According to Weiner (2009), readiness to change at the organizational level involves both members' change commitment and efficacy to implement organizational change. Whereas change commitment is defined as "the shared resolve to pursue the courses of action involved in change implementation", change efficacy denotes "shared beliefs in collective capabilities to organize and execute the courses of action involved in change implementation".

By applying the theory of organizational readiness to change, this study aims at evaluating readiness of supply chain actors in the dairy sector toward a lean management driven nutrition sensitive value chain in Uganda. The dairy sector in Uganda involves groups of farmers, organized in cooperative unions at the district, regional and national levels. They work closely with milk processors, traders and distributors to constitute a value chain (Balikowa, 2011), hence creating an opportunity to apply the theory in this context. Following the theory, and taking food and nutrient loss or waste reduction as the change, this study hypotheses that change valence (i.e. value attached to the proposed change) influences change commitment while implementation capability (i.e. task demands and resource availability) influence change efficacy (Fig. 1). In addition, perception towards a multi-actor approach to enhancing nutrition sensitive agriculture is hypothesized to affect both change commitment and efficacy. As such, this study also extends the theory with organizational perception of multi-stakeholder/actor approaches needed for nutrition interventions and its applicability in the agri-food industry. The second section of the paper includes a description of procedures that were followed in order to collect data. This is followed by the third section, which combines results and discussion. The final section is a conclusion of the study.

2. Methodology

This section describes the approach and tool that was used to collect data. It also expounds on the nature of respondents and their characteristics and finally gives a description of statistics used to analyze collected data.

2.1. Study design and questionnaire

A survey, based on face-to face interviews, was conducted in the central and western regions of Uganda during July to August 2016. Data was collected using a pre-tested questionnaire that comprised four sections. The first elicited characteristics of the chain actor while the second focused on an assessment of respondents' general knowledge and awareness of nutrition sensitive agriculture. Adopted from Balz et al. (2015), respondents were first asked if they ever heard of the term nutrition sensitive agriculture (yes/no). Regardless of the prior response, they were then provided with a set of four definitions of nutrition sensitive agriculture from which they selected the one considered most appropriate. The third section dealt with occurrence of food and nutrient losses or wastes and started with a brief explanation of how efforts that target their reduction are part of nutrition sensitive agriculture. Subsequently, the first question assessed whether respondents ever had milk products they could not market. If so, they were probed to state the action taken most times in such a situation. A set of four items, measured on a 5-point scale of agreement, determined the perception of respondents towards using a multi-actor approach to reducing food and nutrient losses or wastes (see also Table 2).

For the fourth section on readiness to adopt lean manufacturing, respondents were first given more information about lean practices (i.e. purpose, wastes and techniques) and its benefits (i.e. production efficiency, profitability and customer satisfaction) related to reduction of food and nutrient losses or wastes. Readiness to change was then assessed by adopting the validated scale of Shea et al. (2014) with five constructs (i.e. change valence, task knowledge, resource availability, change commitment and change efficacy). A full list of items is included in Table 2.

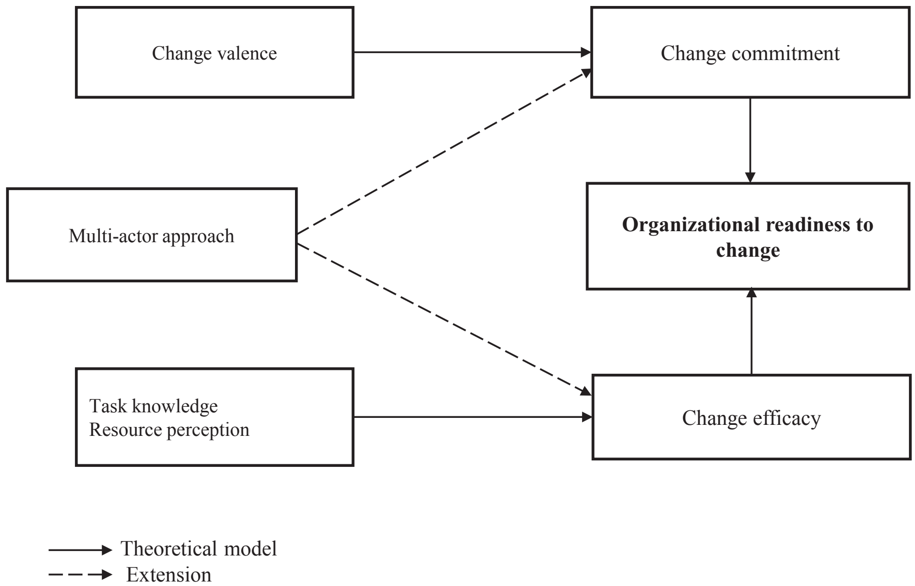

Fig. 1. Theoretical framework applied to assess actor perspectives towards lean implementation to achieve nutrition sensitivity in value chains, based on the Theory of Organizational Readiness to Change (Weiner, 2009).

2.2. Participants

The sample comprised 246 actors in the dairy value chain of which 46 represented farmer cooperatives, 56 processors, 53 wholesalers and 91 retailers. The dairy sector was selected as it is an important avenue for promotion and implementation of nutrition sensitive agriculture (C Hawkes and Ruel, 2011; de Brauw et al., 2015). In addition, milk products are perishable and more likely to be lost or wasted along the supply chain than other foods (Hodges et al., 2011; Gustavsson et al., 2011), making the dairy value chain a suitable case. The four supply chain levels were targeted because they are key hotspots and together account for a big proportion of food related losses or wastes that occur along the supply chain (De Steur et al., 2016b; Beretta et al., 2013; Lipinski et al., 2013).

For the purpose of this study and consistent with the theory of organizational readiness to change, an organization was defined as a group of people working together in a single entity and for a common purpose. Thereby, the average organizational size at the farmer cooperative and processor levels were 30 and 29 members/employees respectively, almost thrice as many for wholesalers (7) and retailers (11). Overall, the proportion of male ($n = 163$, 66.3%) was higher than female ($n = 83$, 33.7%) respondents and this trend was consistent across individual supply chain actors. The average age of respondents was 38 years.

2.3. Data analysis

Descriptive statistics were used to explain the data. Chi-square tests based on proportions were performed to assess if actors differed on variables at a 0.05 significance level. Means and standard deviations for each indicator item were computed and Cronbach's alpha was used to measure internal consistency of items used for latent variables. Structural Equation Modelling (SEM) was applied to assess relationships between selected explanatory and dependent constructs using Stata (version 13) statistical software (Anderson and Gerbing, 1988). Confirmatory Factor Analysis, based on the maximum likelihood estimator approach, was used to assess the validity of measures used in the study. The six latent variables with their indicator items (as observed variables) constituted the measurement model to produce factor loadings. Average Variance Extracted (AVE) and Composite Reliability (CR), obtained from factor loadings, were used to determine convergent validity and when the square root of AVE was compared with correlations among constructs, discriminant validity was assessed. On testing the measurement model, the structural model was determined based on the research hypotheses of the study. Two models were tested; the first was based on the applied theory and involved paths between change valence with change commitment and between task knowledge or resource availability with change efficacy (see also Fig. 1). The second model included an extension to theoretical model through the inclusion of multi-actor approach as an explanatory variable to both change commitment and efficacy. Goodness of fit of tested models was evaluated using; chi square (χ^2), chi square divided by degree of freedom (χ^2/df), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) (Kline, 2015).

3. Results and discussion

This section comprises a combination of results and discussion. Findings focus on chain actors' view on nutrition sensitive agriculture and its link with losses and wastes in the dairy sector. Furthermore, modelling results of the theory of organization readiness to change towards adopting lean manufacturing for loss and waste reduction are presented and discussed accordingly.

3.1. The perceived meaning of nutrition sensitive agriculture

Results in Table 1 indicate that the majority of respondents among processors, wholesalers and retailers (i.e. 64.3%–80.2%) had not heard of the term nutrition sensitive agriculture before. On the other hand, almost an equal proportion of farmers had (not) heard of the term nutrition sensitive agriculture. This confirms that familiarity with the term nutrition sensitive agriculture is generally low among value chain actors and indeed it is quite common that some stakeholders may be unaware of such a specific term.

However, on exposure to potential definitions, except for farmers, almost half (46.4%–54.7%) of other actors perceived nutrition sensitive agriculture as an approach that incorporates nutrition objectives and indicators into agriculture. The proportion of farmers (39.1%) who linked this concept to diverse food availability and accessibility as well as prevention of nutrient losses was nonetheless higher than processors, wholesalers and retailers. This finding is similar to what Balz et al. (2015) observed among other types of stakeholder (i.e. policy makers) and indeed similar explanations of nutrition sensitive agriculture have also been reported in other studies (Jaenicke and Virchow, 2013; Ruel et al., 2013). Although other definitions were less considered, there was generally no significant differences in the proportion of actors with respect to the perceived meaning of nutrition sensitive agriculture (Table 1).

These results still point to the non-existence of a common meaning of nutrition sensitive agriculture (Haddad, 2013b) and there are recommendations of a definition with an agri-food value chain orientation, that incorporates underlying determinants of malnutrition (Balz et al., 2015). And since Turner et al. (2013), Herforth and Ballard (2016) also assert that agriculture affects all underlying determinants of nutrition, the suggested approach seems appropriate. Although this may appear broad, it is a step towards a common understanding so as to facilitate systematic and holistic identification or development of policy alternatives targeting agri-food system interventions that can be implemented to have an impact on nutrition (Berti et al., 2016; Kanter et al., 2015).

3.2. Handling losses and wastes along the dairy value chain

Majority of actors reported they experience losses or wastes in form of milk products that could not be marketed (Table 1). The proportions across actor groups differed significantly ($p = 0.006$) and of interest is the 43.4% of wholesales who reported not to have experienced such losses or wastes, a proportion higher than any other actor. These results show that the dairy sector in Uganda is highly prone to losses or wastes and such a situation can partly be attributed to poorly developed cold chains, that would otherwise have prolonged the shelf-life of milk products (Ekou, 2014; Grimaud et al., 2007). This is further exacerbated by low adoption rates of cold chain interventions reported in many low income countries (Kitinoja, 2013). Despite the reduced efficiency of cold chains in tropical climates, it is still a priority to improve basic infrastructure, build capacity and increase public awareness to support development of such innovative approaches that target the reduction of losses or wastes in perishable food products (Kitinoja et al., 2011; Affognon et al., 2015). Simple technologies such as evaporative cooling chambers are innovative, cost-effective and suitable for use to prolong the shelf-life of fruits and vegetables in poor resource country contexts and research should also focus on the applicability of such approaches for dairy products (Yimer and Sahu, 2014; lal Basediya et al., 2013).

When prompted on approaches used to deal with milk product losses or wastes, at least two in every three supply chain actors throw away milk products considered unmarketable. This is a common practice in the food industry, even for food that is still edible, and is in part perpetuated by limited knowledge about food safety and dependence on shelf life (Godfray et al., 2010; Lebersorger and Schneider, 2014). A movement to change regulations that guide the use of shelf life information is underway in order to protect the industry from unnecessary litigation, ensure food safety for consumers and as a way to reduce food losses or wastes (Bremmers et al., 2015). A lesser majority (30%) of wholesalers channel these products to charity. It is interesting that donation to charity is an option used by a segment of actors in this study. While this approach has become popular in developed countries (Schneider, 2013; Caraher et al., 2014; Richter and Bokelmann, 2016), this positive observation suggests that there is potential to also scale up this initiative in an organized way among stakeholders in the third world. Thus, future research ought to investigate mechanisms or pathways needed to bring together the food industry and non-government organizations who are active in the fight against food and nutrition insecurity among destitute communities (Garrone et al., 2016). In addition, 23.2% of retailers send back such products to suppliers. There were also few instances when milk products considered as loss or waste are given to employees across all chain actors or donated to charity among farmers, processors and retailers. Similarly, farmers, processors and wholesalers were less likely to send unmarketable products back to suppliers. These proportions differed significantly ($p < 0.001$) across actor groups (Table 1).

These findings further indicate that this issue is far from an actor-specific problem. Losses or wastes in dairy sector occur at various points along the value chain. This assertion is supported by previous studies that have also pointed out that the food value chain constitutes various hotspots (including consumption level) where losses or wastes occur (De Steur et al., 2016b; Priefer et al., 2016; Göbel et al., 2015). Hence, advocacy to complement intra- with inter- organizational mitigation strategies is rational and timely (Strotmann et al., 2017). And the fact that nearly one-third of

Table 1
Perceived meaning of nutrition sensitive agriculture, occurrence and handling food (milk product) losses/wastes.

Variable	Farmer (n = 46)	Processor (n = 56)	Wholesaler (n = 53)	Retailer (n = 91)	*p-value*
Heard of term nutrition sensitive agriculture					
Yes	24 (52.2%)	20 (35.7%)	15 (28.3%)	18 (19.8%)	0.001
No	22 (47.8%)	36 (64.3%)	38 (71.7%)	73 (80.2%)	
Definition of nutrition sensitive agriculture					
Incorporates nutrition objectives and indicators into agriculture	15 (32.6%)	26 (46.4%)	29 (54.7%)	46 (50.6%)	0.069
Diversification of food production and consumption	7 (15.2%)	3 (5.4%)	3 (5.7%)	8 (8.8%)	
Design and adoption of farming systems targeting nutritional problems	6 (13%)	8 (14.3%)	13 (24.5%)	11 (12.1%)	
Diverse food availability and accessibility and prevents nutrient losses	18 (39.1%)	19 (33.9%)	8 (15.1%)	26 (28.6%)	
Loss/waste of milk products					
Yes	35 (76.1%)	48 (85.7%)	30 (56.6%)	69 (75.8%)	0.006
No	11 (23.9%)	8 (14.3%)	23 (43.4%)	22 (24.2%)	
Dealing with loss/waste of milk products					
Thrown away	28 (80%)	38 (79.2%)	17 (56.7%)	49 (71%)	0.000
Given to employees	3 (8.6%)	0	2 (6.7%)	1 (1.4%)	
Given to charity	3 (8.6%)	6 (12.5%)	9 (30%)	3 (4.3%)	
Sent back to supplier	1 (2.9%)	4 (8.3%)	2 (6.7%)	16 (23.2%)	

N = 246.

all food produced is lost from farm to fork (Gustavsson et al., 2011), makes this a food system issue that requires the collective attention from various stakeholders (Halloran et al., 2014). This follows recent recommendations to establish sustainable collaboration along the value chain in form of information and responsibility sharing among stakeholders in order to have a united front against food related losses or wastes (Kaipia et al., 2013; Göbel et al., 2015). This proposition is not only important for developed but also developing countries, whose loss and waste management approaches are still weak (Thi et al., 2015), also pointing to the need of an integrative and evidence-based policy review in growing economies.

3.3. Measurement model

On average, the 246 respondents exhibited a modest (3.06) to high (4.61) level of agreement with individual items from the six constructs (Table 2). Internal consistency of constructs, measured by Cronbach's alpha, was high (i.e. all over 0.7, more than the recommended cut-off threshold) (Nunnally and Bernstein, 1994). From Confirmatory Factor Analysis, most items for each construct had high values of factor loadings (above 0.6), with significant associations with latent variables ($p < 0.001$), except for two items from change valence and multi-actor approach with low factor loadings. To this end, these items were subsequently dropped from those constructs and an increase in Cronbach's alpha of 0.033 and 0.181 units was observed for change valence and multi-actor approach, respectively. Except for the chi-square test that was significant ($p < 0.001$), other goodness of fit statistics for the measurement model were satisfactory. The chi-square to degree of freedom ratio was 1.822, less than 3 as recommended. The CFI and TLI were both greater than 0.9. RMSEA (0.058) was very close to 0.05 and smaller than 0.08 while SRMR was less than 0.05 as recommended (Hu and Bentler, 1999). With results indicating internal consistency of items, high factor loadings and acceptable goodness of fit indices, there was enough information to also consider unidimensionality of the scales and data.

Table 3 shows results from the assessment of construct validity. For each construct, Composite Reliability (CR) values ranged from 0.781 to 0.952 while Average Variance Extracted (AVE) values ranged from 0.534 to 0.832, all approximately equal or higher than the acceptable level of 0.8 and 0.5, respectively (Ping, 2004). The former suggested and the latter demonstrated convergent validity of constructs used in this study. In addition, the lowest square root of AVE was 0.731 in contrast to 0.565 which was the highest correlation between constructs, hence indicating that constructs are less related (i.e. discriminant validity).

Table 2
Mean of items, internal consistency and factor loadings per construct.

Construct	Mean	SD	CFA loadings
Change valence ($\alpha_1 = 834$, $\alpha_2 = 0.867$)			
This change is of value	4.09	0.74	0.715**
It is a good idea to implement this change	4.10	0.77	0.711**
This change will make things better	4.19	0.65	0.694**
This change is cost effective[a]	4.08	0.76	0.290*
This change will benefit consumers	4.16	0.72	0.645**
This change is compatible with our values	3.95	0.81	0.868**
Task knowledge ($\alpha = 0.953$)			
We know how much time it could take to implement this change	3.06	1.27	0.877**
We know how much effort may be needed to implement this change	3.09	1.30	0.910**
We know what resources we may need to implement this change	3.12	1.29	0.938**
We know what each of us may have to do to implement this change	3.19	1.30	0.923**
Resource availability ($\alpha = 0.938$)			
We may have the resources we need to implement this change	3.20	1.38	0.922**
We may have the expertise to implement this change	3.20	1.36	0.925**
We may have the skills to implement this change	3.35	1.22	0.872**
We may have the equipment we need to implement this change	3.18	1.26	0.911**
We may have the time we need to implement this change	3.79	0.90	0.695**
Change commitment ($\alpha = 0.874$)			
We can be committed to implementing this change	3.98	0.86	0.827**
We can be determined to implement this change	3.93	0.78	0.834**
We can be motivated to implement this change	4.16	0.71	0.620**
We can do whatever it takes to implement this change	3.73	0.98	0.866**
Change efficacy ($\alpha = 0.945$)			
We can keep momentum going in implementing this change	3.95	0.80	0.774**
We can manage the politics of implementing this change	3.42	1.28	0.930**
We can support people as they adjust to this change	3.37	1.27	0.910**
We can get people invested in implementing this change	3.39	1.26	0.916**
We can coordinate tasks so that implementation goes smoothly	3.72	1.10	0.866**
We can keep track of progress in implementing this change	4.00	0.77	0.808**
Multi-actor approach ($\alpha_1 = 0.549$, $\alpha_2 = 0.730$)			
Coordination enhances the ability to reduce food/nutrition losses	4.34	0.77	0.882**
Coordination improves efficiency of value chain activities	4.33	0.71	0.678**
Effective communication and information sharing is key to loss reduction	4.61	0.59	0.637**
Loss/waste responsibility should be shared across the supply chain[a]	3.99	1.13	0.097[ns]

N = 246.
Items were measured on a 5-point Likert scale.
α Cronbach's alpha, α_1 & α_2 Cronbach's alpha before and after item was dropped.
*, ** indicate significant at $p < 0.01$ and $p < 0.001$, respectively.
ns indicates not significant.
Goodness of fit: Chi-square (342) = 623.204, $p < 0.001$; chi-square/d.f. = 1.822, CFI = 0.956, TLI = 0.948, RMSEA = 0.058 (pclose = 0.038), SRMR = 0.044.
[a] Indicates item that was dropped due to low loading value.

Table 3
Construct validity of the measurement model.

Constructs	1	2	3	4	5	6	CR	AVE
1. Change valence	**0.731**						0.850	0.534
2. Task knowledge	0.358	**0.912**					0.952	0.832
3. Resource availability	0.279	0.499	**0.870**				0.939	0.756
4. Change commitment	0.263	0.471	0.393	**0.793**			0.870	0.628
5. Change efficacy	0.276	0.565	0.535	0.407	**0.870**		0.949	0.756
6. Multi-actor approach	0.031	0.042	0.018	0.030	−0.034	**0.740**	0.781	0.548

N = 246.
CR: Composite reliability, AVE: Average Variance Extracted.
Numbers in bold on the main diagonal are square roots of the AVE, others are correlation coefficients.

3.4. Structural model (path analysis)

Results from the hypothesized paths are illustrated in Table 4. In the theoretical model, change valence exhibited a positive relationship with change commitment (i.e. for a unit change in the former, change commitment significantly ($p < 0.001$) increased by 0.291 units). Similarly, resource availability was shown to be the strongest positive predictor of change efficacy ($\beta = 0.687$, $p < 0.001$). However, the expected effect of task knowledge on change efficacy was not significant, hence not supported by the model. Assessment of whether the theoretical model had a good fit of data indicates acceptable indices. The chi-square to degree of freedom ratio was 1.732 while the CFI and TLI were 0.973 and 0.967, respectively. RMSEA was 0.055 with a non-significant pclose ($p = 0.202$) and SRMR was 0.031.

The proposed extension to the theoretical model produced similar results. The relationship between change valence and change commitment was positive and significant ($\beta = 0.242$, $p = 0.002$). Results further indicate that a one unit change in multi-actor approach significantly ($p = 0.004$) increased change commitment by 0.128 units. Like in the theoretical model, there was not enough evidence to suggest an expected positive effect on change efficacy not only for task knowledge ($p = 0.336$) but also multi-actor approach ($p = 0.443$). However, a one unit change in resource availability resulted into 0.683 significant unit increase in change efficacy ($p < 0.001$). The goodness of fit indices for the proposed model were close to those of the theoretical model and hence acceptable as a suitable representation of the data (chi-square/degree of freedom ratio, 1.743; CFI, 0.966; TLI, 0.959; RMSEA, 0.055; pclose, 0.152; SRMR, 0.038). For both models, the conventional chi-square test for goodness of fit was significant ($p < 0.001$) but this could possibly be due to the sensitivity of this test to large sample sizes (Barrett, 2007). Despite this observation, other indices explained above show that the two models perform relatively well and hence justify reported parameter estimates.

The average scores on the agreement scale imply that value chain actors are optimistic about adopting lean manufacturing philosophy as an approach that can be adopted in their activities to minimize food and nutrient losses or wastes. The perceived value of lean implementation, as shown by change valence, is clearly high and is supported by previous studies that provide further evidence of the benefits associated with performance improvement in the agri-food sector (Engelund et al., 2009; Dora et al., 2013b; Zokaei and Simons, 2006; De Steur et al., 2016b). In addition, awareness of tasks and resources (i.e. information assessment) needed to implement lean is relatively high. This was an interesting finding because expertise and skill development of personnel are part of information assessment and, thus, important success factors of lean implementation (Dora et al., 2013a; Panwar et al., 2015). In order to sustain this knowledge, players in the agri-food industry should prioritize continuous personnel involvement, development and communication at all levels. The idea of multi-actor collaboration in form of coordination, effective communication and sharing responsibility regarding losses or wastes is acceptable to actors. This is in line with previous stakeholder studies that support the promotion of partnerships for lean implementation in the agri-food sector (Cox and Chicksand, 2005; Perez et al., 2010). Furthermore, actor commitment and efficacy (i.e. readiness to change) to adopt measures against losses or wastes in the dairy sector is considerable. Commitment to change influences perception among stakeholders concerning their ability to implement proposed changes successfully and this should be monitored and continuously strengthened (Scherrer-Rathje et al., 2009; Losonci et al., 2011; Turesky and Connell, 2010).

The positive association that was found between change valence and commitment concurs with previous assertions that perceived benefits enhance personnel obligation and momentum to implement proposed organizational changes, in general (Fedor et al., 2006), and also lean manufacturing approaches, in particular (Jansen et al., 2015). While knowledge about tasks needed did not

Table 4
Structural equation parameter estimates that explain readiness to change to a nutrition sensitive value chain based on lean manufacturing.

Model	Paths	Std.β	*p*-value	Result
Model 1 (Theoretical)	Change valence → Change commitment	0.291	0.000**	Supported
	Task knowledge → Change efficacy	0.095	0.359	Not supported
	Resource availability → Change efficacy	0.687	0.000**	Supported
Model 2 (Proposed)	Change valence → Change commitment	0.242	0.002*	Supported
	Task knowledge → Change efficacy	0.101	0.336	Not supported
	Resource availability → Change efficacy	0.683	0.000**	Supported
	Multi-actor approach → Change commitment	0.128	0.004*	Supported
	Multi-actor approach → Change efficacy	0.030	0.443	Not supported

N = 246.
*, ** Significant at $p < 0.01$ and $p < 0.001$, respectively.
Goodness of fit.
Model 1 (theoretical); Chi-square (223) = 386.142, $p < 0.001$; chi-square/d.f. = 1.732, CFI = 0.973, TLI = 0.967, RMSEA = 0.055 (pclose = 0.202), SRMR = 0.031
Model 2 (proposed); Chi-square (290) = 505.317, $p < 0.001$; chi-square/d.f. = 1.743, CFI = 0.966, TLI = 0.959, RMSEA = 0.055 (pclose = 0.152), SRMR = 0.038

significantly affect change efficacy, respondents' perception about required resources was a positive predictor of change efficacy. Ideally, both factors are expected to increase change efficacy if, in line with previous research (Shaw et al., 2013), the prevailing situational factors are also favorable. This implies that a chain actor group with an organizational culture which, for instance, already considers multi-actor approaches (a possible situational factor) in their operations may have higher confidence in its ability to appropriately organize tasks and mobilize resources needed to implement a change. However, a significant positive association was observed between multi-actor approach and change commitment. It appears that value chain actors are more likely to implement and support lean methods (i.e. be committed) to tackle losses or wastes with knowledge that other actors at the vertical or horizontal axis of the chain are doing so and subsequently, efficacy could later emerge. Hence, it is crucial that collaboration along the chain is promoted with focus on sharing information and responsibility in order to establish sustainable commitment to advocated change. This assertion is in line with previous studies that have shown the importance of corporation and integrating supply chain activities so as to enhance performance (Qrunfleh and Tarafdar, 2013; Prajogo et al., 2016; Eksoz et al., 2014). The same has been observed in studies that specifically advocate a multi-stakeholder approach in efforts targeting the reduction of food related losses or wastes in supply chains (Halloran et al., 2014; Derqui et al., 2016; De Steur et al., 2016b). However, as a critical success factor for adoption of lean thinking to tackle losses or wastes, it is important that the benefits of collaboration along the entire agri-food supply chain are shared by all players and measures ought to be put in place to avoid a situation that some actors reap most value at the expense of others (Cox and Chicksand, 2005).

This study is relevant to current policy debates and also has implications for the public and food industry. Findings indicated familiarity with the concept of nutrition sensitive agriculture is relatively low among value chain actors. This is a clear manifestation of limited awareness of terminologies used at the top level (i.e. development agencies and policy makers) to refer to issues that are to be implemented at the lower levels (i.e. agri-food value chains). It is often normal practice that global development goals are drafted, discussed and concluded upon by experts at the top level with minimal consultation of target beneficiaries because of resource constraints (Abbott and Bernstein, 2015). Subsequently, a communication gap may be created with regards to concepts used which often appear new to stakeholders at a lower level. Nonetheless, results further showed that observed low awareness of terminology was countered by a better understanding of more elaborate definitions of nutrition sensitive agriculture. To go forward, deliberate efforts are needed for a closer engagement of the food industry and the public with regard to clear and practice oriented communication of nutrition sensitive agriculture and related concepts. Hence policy initiatives should pick interest in continuous public awareness campaigns, using various channels, to enhance widespread comphrehension of implemented interventions.

This study also highlighted that value chain actors predominantly throw away milk products considered as loss or waste while others donate to charity. For solutions, any effort that targets reduction of food and nutrient losses or wastes can be considered a promising agri-food based nutrition sensitive approach and an additional gateway to better link agriculture and nutrition. Hence, the use of cost-effective but innovative measures against losses and wastes should be prioritized in policy debates especially for growing economies. This is needed as a foundation for research into possible alternative uses or create systems where food products considered unfit in a given market can be diverted to other more acceptable markets. These and similar measures should work for the entire value chain taking into account the policy, economic, social and cultural spheres in which they operate.

Reinforcing partnerships among actors should be recognized as key to the success of innovations and to ensure long lasting impact of a collective endeavor against losses or wastes. Hence efforts targeting collaboration among supply chain actors could also look beyond the chain and be inclusive to external players that potentially impact chain activities. This implies that the food chain could, for example, lobby policy players that provide impetus and normally a conducive environment (i.e. policy directions) in which nutrition sensitive interventions such as the one discussed in this paper could be implemented successfully. In addition, this can be complemented by establishing linkages between the food industry and academia as a way of acquiring continuous evidence-based knowledge on how to improve chain operations and also be in a strategic position to confront policy actors with practical solutions. A closer engagement between the food industry with the local and international humanitarian agencies creates an additional opportunity for food that would be lost or wasted to be accessed by the destitute who in fact, are target beneficiaries of at least three SDGs.

From this study, there are some aspects that future research should take into account. A pooled analysis was performed and reported for Structural Equation Modelling with the whole sample of all supply chain actors that were interviewed. Although this approach may be criticized because of possible differences in perspectives, between groups of actors, concerning adoption of strategies to tackle food and nutrient losses or wastes, performing a sub-group analysis was not justified. This was so because stratification of the sample reduced the statistical power in the models. It became evident that almost all goodness of fit indexes were unsatisfactory once sub-group models were run. However, the effect and direction of sub-group path coefficients were relatively similar to the pooled SEM analysis and so our results still give reliable indications of the perspectives among dairy supply chain actors in Uganda. In addition, respondents were given information prior to asking some questions. We do not discount the possible effect this may have had on responses given by participants. A similar aspect has been discussed extensively in adoption studies whereby information given may influence responses (De Steur et al., 2016a; Aadland and Caplan, 2006). Thus, future research should aim at higher number of respondents per actor to readily carry out statistical comparisons and also test and quantify the impact of information bias. Some cultural information such as respondent ethnicity and languages were not included in the survey. It is possible that such factors might influence respondents' views on the company/actor, hence could also help to shape the reality in which studies are conducted. Therefore, future research should also use study designs and tools capable of capturing such information. Furthermore, this study focused on Uganda dairy value chain. There is need to expand this research to other countries faced with similar problems and also to other nutrient-rich food value chains. Finally, consumers were not included as respondents, though they are important actors of value chains and also barely studied as far as nutrition sensitive agriculture is concerned. This was so because the methodological approach used (i.e. theory of organizational readiness to change) was unsuitable for collecting data from consumers. Future studies ought to explore approaches that can be applied to furnish literature with consumer preferences for nutrition sensitive agriculture.

4. Conclusions

The interest to establish evidence-based links between agriculture with nutrition grew remarkably towards the climax of the Millennium Development Goals (Webb and Kennedy, 2014). Nutrition sensitive agriculture emerged into the limelight and, as illustrated at beginning of this paper, shaped the post-2015 agenda discussions, not only about strategies but also the role key stakeholders ought to play to improve nutrition. The current study has made an attempt to empirically synthesize actor perspectives concerning nutrition sensitive agriculture, linked to reduction of food and nutrient losses or wastes, along the dairy value chain.

First, this study showed possible weaknesses in policy dialogues between developers or advocates of nutrition sensitive agriculture with food industrial players, which subsequently results in a systematic unawareness of on-going initiatives. Without inclusive consultations, policy directives to promote nutrition sensitive agriculture run a risk of failure because they may sound foreign to the actual implementing stakeholders. To counter this, extra efforts have to be made to promote ownership of initiatives among value chain actors. Future research and programmes in developing countries, for example should conceptualize and validate innovative pathways in which industrial players, with limited knowledge of nutrition sensitive approaches, could be engaged to better understand and adopt such approaches. There is also a general interest to tackle food and nutrient losses or wastes among value chain actors. The possibility to apply lean thinking, as a mitigation approach, in an intra- and inter- organizational (value chain actor) context could be determined by change valence, resources availability and collaboration. As far as nutrition sensitive value chains that tackle food related losses and wastes are concerned, findings from this study indicate a positive attitude towards change, when actors are aware of potential benefits. For factors (i.e. change valence, resources availability and collaboration) to favorably influence change, incentives such as reduction of transactions costs along the chain have to be ensured. Thereby, public investments in Uganda and similar settings have to target efficient food processing as well as storage and transport systems, as a way to establish an enabling environment for chain actors to adopt and implement approaches promoting nutrition sensitive value chians. This could also be complemented with targeted education campaigns and trainings among chain actors on the benefits and implementation process of lean manufacturing. As a starting point, Value Stream Mapping should be used more often not only at one stage of the chain but also involving all value chain actors so as to have a holistic identification of the problem of food and nutrient losses or wastes (De Steur et al., 2016b). Other lean tools (e.g. 5S, Just-in-Time, cellular manufacturing, Kanban etc.), relevant to a given context can then be implemented. More attention is hence needed from governments, academia and non-profit humanitarian agencies to create lasting partnerships with the food industry for innovative approaches against losses or wastes.

While our findings are case specific and generalisability may be limited, given possible differences in food chains within and across countries, experiences of food related losses or wastes are relatively similar everywhere in nearly all food groups. Therefore, it is our hope that the current study is applicable to many contexts and contributes to global discussions on important issues dealing with nutrition sensitive agriculture and food related losses and wastes.

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