Faculty of Bioscience Engineering

Academic year 2013 – 2014

Analysis of the parents' and school authorities' reactions towards the use of biofortified foods in school feeding programs.

The case of Iodine Deficiency in Uganda

JOSHUA WESANA

Promoters: Prof. dr. ir. Xavier Gellynck
Dr. ir. Hans De Steur
Tutor: Drs. Joseph Birundu Mogendi

Master's dissertation submitted in partial fulfilment of the requirements for the degree of Master of Science in Nutrition and Rural Development.
Main subject: Human Nutrition – Major: Public Health Nutrition

DECLARATION

I, Joshua Wesana, declare that this Master dissertation is my own original work and has neither been submitted here nor in another University. Acknowledgement has been made to works of other authors used accordingly. Permission for personal use of this work is to be given by the author and promoters. Copyrights laws apply for any other form of use.

Ghent University, June, 2014

Promoter:

Prof. dr. ir. Xavier Gellynck

Email: Xavier.Gellynck@ugent.be

Co-promoter:

Dr. ir. Hans De Steur

Email: Hans.DeSteur@ugent.be

Author:

Joshua Wesana

Email: wesanaj@yahoo.com

ABSTRACT

Objective: This study aims at evaluating reactions of parents and school authorities towards the use of iodine biofortified foods in school feeding programs as an alternative means to improve school performance and reduce Iodine Deficiency Disorders (IDDs).

Methods: A cross-sectional survey design based on Protection Motivation Theory was used to interview parents (n=360) of primary school children and school authorities (n=40). Data was analysed through Robust regression analysis and Ordered Probit regression analysis techniques.

Results: The results show that knowledge about iodine and iodized salt was high, as compared to poor knowledge about IDDs and biofortification. Gender was a significant predictor of coping appraisal for school authorities while age, level of education, occupation, income, household size and specific iodine knowledge among parents were significant determinants of threat, coping appraisal and/or behavioural intention among parents. In the overall model, self-efficacy (parents) and response cost (school authorities) influenced the intention to adopt iodine biofortified foods. Regarding willingness-to-pay for biofortified foods when it would be offered at a discount, various factors among which gender, age, education, knowledge, perceived vulnerability, response efficacy, self-efficacy and behavioural intention play a role. When looking at premium, only school/household size, age and response efficacy were significant.

Conclusion: As expected, self-efficacy and response cost in the main model affect the intention to adopt biofortified foods among respondents who are in addition more responsive to discount prices than to premium prices. School feeding programs that would incorporate iodine biofortified foods should strive to increase not only consumer knowledge about iodine but also its association to apparent Iodine Deficiency Disorders, boost self-efficacy and ensure that the costs incurred are not perceived as barriers of adoption.

ACKNOWLEDGEMENTS

First, I extend my gratitude to my promoters; Prof. dr. ir. Xavier Gellynck and Dr. ir. Hans De Steur for giving me an opportunity to work on an on-going PhD project at the Department of Agricultural Economics, for their tireless efforts in providing the necessary guidance and the time invested to go through my manuscripts with timely feedback. I am further extremely grateful to my tutor; Drs. Joseph Birundu Mogendi for the valuable assistance he has accorded me from the very start until the accomplishment of this research work. I highly adore his determination and desire of academic excellence. I finally owe my sincere gratitude to VLIR-OUS for awarding me a fellowship with which my research work was made a reality.

DEDICATION

This master dissertation is dedicated to my loving mother and sisters who have continuously believed in my potential to achieve at the highest level possible. May you be blessed and rewarded abundantly for you are the reason I work hard.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

HBM	Health Belief Model
IDDs	Iodine Deficiency Disorders
OLS	Ordinary Least Squares
PMT	Protection Motivation Theory
R^2	Coefficient of determination
SCT	Social Cognitive Theory
TPB	Theory of Planned Behaviour
TTM	Trans-theoretical Model of Change
UBOS	Uganda Bureau of Statistics
UN	United Nations
WHO	World Health Organisation
WTP	Willingness-To-Pay

CHAPTER ONE: INTRODUCTION

1.1 Background

Currently, one in eight people are undernourished and more suffer from micronutrient deficiencies due to the dependence on a monotonous diet comprised of milled cereals with low micronutrients (McGuire, 2013). Iodine deficiency, a well-known cause of preventable mental retardation, is still a major public health problem worldwide, with an estimated 240.9 million school aged children having low iodine intake levels, of which 24% are from Sub-Saharan Africa (Andersson et al., 2012; Zimmermann et al., 2008). Many children at risk to Iodine Deficiency Disorders (IDDs) live around mountainous areas with iodine depleted soils or further in-land and so have no access to fish, sea food and iodized salt (Gomez-Galera et al., 2010). While Universal Salt Iodization has been successfully used to fight IDDs in various countries, one third of the world population have no access to iodized salt and IDDs are still endemic in many parts of developing countries (Zimmermann and Andersson, 2012). Iodine deficiency has a profound effect on school performance of children as shown by poor achievement on intelligence and other learning ability tests. Feeding school children is a suitable way of improving their cognitive performance and academic achievement primarily concentrating on dietary quality rather than quantity (Whaley et al., 2003; Acham et al., 2012). However, foods used in the current school feeding programs in many parts of East Africa most likely lack adequate iodine (Murphy et al., 2007).

Biofortification has of recent attracted attention as a more sustainable approach to potentially eliminate micronutrient deficiencies. It is promoted from the premise that no single intervention strategy is self-sufficient to eradicate hidden hunger among people with one or more deficiencies (Khush et al., 2012). Lyons and colleagues have proposed to target iodine in order to improve the effectiveness of Harvest*Plus* biofortification efforts (Lyons et al., 2004). Increasing iodine content of staple foods is achieved through conventional plant breeding, provided that there is genetic multiplicity, or by applying nutrient rich fertilizers to soils (Zhu et al., 2007; Perez-Massot et al., 2013). When this is not possible, genetic engineering is a viable alternative to increase iodine concentration in staple foods (Farre et al., 2011; Yuan et al., 2011). Given its multiplier potential across time and distance at a low cost in addition to the targeted approach, i.e. towards key beneficiaries like the rural poor, biofortification of staple crops with iodine and/or other micronutrients is a suitable control measure against micronutrient deficiencies (De Steur et al., 2012a; Meenakshi et al., 2010;

Bouis et al., 2011). A school feeding program is hence an appropriate avenue for using iodine biofortified foods to reduce the risk of iodine deficiency in school aged children given the potential to adequately reach the needy poor in remote areas.

With more conventional biofortified crops expected to hit the market, consumers are likely to have varying decisions concerning its acceptance and adoption. It is important to note that although a new food innovation may be accepted; there will always be part of the population who will reject it (Braun, 2002). Food choice decisions differ among consumers based for example on their level of health consciousness and their ability to overcome challenges that deter them from eating healthy (Mai and Hoffmann, 2012). Similarly, the way consumers react to nutrient rich foods depends on a number of individual characteristics mainly related to nutrition knowledge, previous experience with similar foods and attitudes towards foods which influence consumption intentions (Verbeke et al., 2009; Pounis et al., 2011). Although consumer food preference may literally be influenced by; perceived adverse health effects, religious and cultural beliefs or even lack of interest, inappropriate marketing strategies on the side of producers and policy makers also explain why some consumers have doubt and aversion of nutrient rich healthy foods (Verbeke, 2010). It is now apparent that different people may respond in unique ways to a new phenomenon like biofortification and therefore its preference in a given country may not only vary among groups but also within groups of stakeholders and can not be generalized to consumers of other countries.

While salt iodization worked well in urban areas, rural areas may benefit more from iodine biofortification given the fact that staple foods they are accustomed to are targeted, which in turn is more sustainable. Therefore, a comprehensive understanding of consumer motivation directed towards intentions to adopt iodine biofortified foods is needed. The current study therefore aims at using the Protection Motivation Theory (PMT) to analyse parents' and school authorities' reactions towards the potential use of iodine biofortified foods in school feeding programs in the rural context of Uganda.

1.2 Problem statement and Rationale

Over a decade ago, the prevalence of iodine deficiency in Uganda as measured by total goitre rate was 60.2% and given the introduction of iodized salt, marked improvements have been made, however, many parts of rural Uganda are not reached by Universal Salt Iodization program and have continued to suffer from endemic IDDs (Bimenya et al., 2002). Presently,

biofortification of staple foods is being promoted for adoption in developing countries to fight hidden hunger. In the case of iodine deficiency, this approach once implemented would potentially reach the one third of the global population not covered by universal salt iodization. It is believed that due to the added advantages of sustainability and cost-effectiveness of biofortification, consumers do not need to adjust their current food habits because staples used are consumed daily in the developing world (Lyons et al., 2004). Nonetheless, the prospect of consumer reactions directed towards buying and eating biofortified staples is still speculative and there is no clear evidence yet suggesting higher or lower consumer preference of biofortified crops to the traditional crops in target developing countries (Bouis et al., 2011). Parent's and school authority's acceptance is key to ensure a demand-driven, participatory and sustainable implementation of biofortification in school feeding programs in these countries. Such a novel intervention could fail to achieve its objectives because the cognitive process stakeholders go through that entails an anticipated change in diet to prevent micronutrient deficiencies is not well understood.

While some studies have shown the likely health impacts and cost-effectiveness of biofortified crops as compared to other conventional micronutrient strategies (De Steur et al., 2010; Stein et al., 2008; Meenakshi et al., 2010; De Steur et al., 2012a), uncertainty lingers how affected stakeholders will respond to the use of iodine biofortified foods. Adoption of iodine biofortification as a novel strategy to prevent IDDs is most likely to involve a cognitive process leading to a motivated decision made by consumers. Social Cognition Models such as; Health Belief Model (HBM), Protection Motivation Theory (PMT), Theory of Planned Behaviour (TPB), Social Cognitive Theory (SCT) and Trans-theoretical Model of Change (TTM) are often used to explain the motivation factors of people to perform or not perform health oriented behaviours (Baban and Craciun, 2007). Except for PMT, these models only focus on threats. PMT additionally looks into coping factors which are also crucial persuasive communication elements for the success of health interventions with regards to effectiveness and the adoption potential of beneficiaries (Milne et al., 2000). Despite the fact that a few studies used PMT to analyse consumer motivation to dietary change, for instance the case of functional foods in developed countries (Cox and Bastiaans, 2007; Henson et al., 2008), none have been carried out using PMT in the context of nutritious foods in poor developing countries. The present study therefore employed a similar theoretical PMT model to predict the reactions of parents and school authorities towards future use of iodine biofortified foods in school feeding programs in Uganda. Research into

preferences for biofortification in developing countries is lacking and this needs to be investigated. This study provides relevant information not only needed by farmers to assess the demand of biofortified foods based on consumer motivation to accept these foods but also by policy makers to facilitate decision making towards a sustainable approach of improving public health through nutrition.

CHAPTER TWO: LITERATURE REVIEW

2.1 The fight against iodine hidden hunger

Micronutrient deficiency is obscure and more widespread than calorie under nutrition and is popularly referred to as “hidden hunger” affecting; growth, development and health of many poor people in Sub-Saharan Africa, South East Asia and Latin America (Stewart et al., 2010; Neumann, 2007). The deficiency of iodine in particular results into IDDs due to lack of thyroid hormones in the human body (Mina et al., 2011). IDDs represent a wide range of conditions among which are; impairment of foetal brain development, impaired mental function, cretinism and goitre mainly affecting children and women. Additionally, IDDs have been shown to have a negative impact on school performance of children determined by intelligence (Pineda-Lucatero et al., 2008; Qian et al., 2005; Zimmermann et al., 2006).

2.1.1 Salt Iodization

The advent of micronutrient interventions dates back in the mid 1980s when food micronutrient content rather than quantity was proved to be a more potent determinant of nutrition status (Nutrition, 1992). Universal Salt Iodization was among the first implemented interventions. This was made possible by adding potassium iodide or iodate in salt during the production process. However, potassium iodate is preferred because of its stability overtime as compared to the iodide hence making it suitable for use in tropical countries. During those early years, salt iodization was shown to be a clear impact strategy with considerable coverage, practicality, supported publically in research and more importantly boosted of a strong financial support from donors (Allen, 2003). However, it soon emerged that salt iodization is not without flaws than what was assumed earlier. It is indeed not sustainable in the long run due to the fact that highly deficient poor people live in rural remote areas with limited coverage and usually lack the purchasing power to buy it in preference of cheaper traditional salt. Hence this is a good example of “Push Strategies” that have often involved decisions made by policy makers and industry with minimal participation of the intended beneficiaries (Neumann, 2007; Micronutrient-Initiative, 2009). Although this intervention has not completely eradicated iodine deficiency, it has to a given extent been successful in many countries. This is shown by the high coverage rates of iodized salt but as has been highlighted before, remote rural areas are not always adequately served. The current efforts to reduce salt intake due to the increasing prevalence of cardiovascular diseases threatens to further limit

the effectiveness of iodized salt intervention unless other measures are taken to fill this gap (Pearce et al., 2013).

2.1.2 The concept of Biofortification and iodine biofortified staple foods

Biofortification has been coined as a more sustainable, comparably inexpensive, cost-effective approach to fight micronutrient deficiencies by use of staple foods poor people consume daily (Meenakshi et al., 2010). It literally refers to the "production of crops with increased bioavailability of essential micronutrients relying on the plant's biosynthetic or physiological capacity to produce or accumulate the desired nutrients" (Mayer et al., 2008). It can be done through plant breeding or genetic modification (Bouis, 2003; Zhao and Shewry, 2011). Plant breeding is made possible because of the genetic variation of micronutrients in best performing plants which when crossed can enhance mineral and vitamin content in plants over generations (Hirschi, 2009). Conversely, genetic engineering outsources favourable genes from outside the target plant taxonomy especially in case of sexual incompatibility (Gomez-Galera et al., 2010). Harvest*Plus* has in addition to iron, zinc and vitamin A considered enrichment of staples food with iodine in order to improve the iodine status of poor at risk populations (Lyons et al., 2004).

Consumption of iodine rich foods is the only natural way of avoiding deficiency, however, iodine depleted soils and limited access to fish foods has increased the number of vulnerable people (Gomez-Galera et al., 2010; Zimmermann et al., 2008). Although reports show that the coverage of iodized salt is high, the prevalence of IDDs in most parts of rural developing countries is still up because of various reasons for instance; high price of iodized salt compared to normal salt, regional variation in distribution and lack of knowledge about IDDs (Yadav et al., 2010; Zimmermann and Andersson, 2012). Staple crops are a suitable vehicle to improve the iodine status of many poor people through biofortification. Regardless of the fact that iodine biofortified crops are yet to be introduced to the market owing on-going research, development and field tests by Harvest*Plus*, possible inclusion of iodine is meant to complement on iodized salt and boost the synergistic interaction with other minerals (Lyons et al., 2004; Gomez-Galera et al., 2010).

2.2 School feeding programs

As part of the efforts to achieve the Millennium Development Goals before 2015 (UN, 2000), school feeding programs were introduced to help eradicate hunger, promote attendance and

completion of school thus removing gender disparities in Universal Primary Education in developing countries (Jomaa et al., 2011). School children are believed to spend on average six hours at school per day and ideally evidence shows that 47% of their daily energy intake is obtained from the food they eat at school (Briefel et al., 2009). Meals provided at school hence are still the most important meals for school children (Crawley, 2005). Properly designed and effective school feeding programs are capable of improving the micronutrient status of school children (Greenhalgh et al., 2007), especially when conventional food fortification and supplementation are used as boosters (Jomaa et al., 2011). A study to determine the effect of micronutrient fortification in an already existing school feeding program in rural South Africa showed at the end of intervention that the micronutrient status of children significantly improved in reference to the baseline. This great improvement importantly included iodine status which stood at levels considered not to be a public health problem a year after the end of intervention (Van Stuijvenberg et al., 1999; Zimmermann and Andersson, 2012). Similarly, in the slum areas of Kenya, Neervoort and colleagues found out that school feeding programs positively affect the nutritional outcomes of school aged children (Neervoort et al., 2012). Van Jaarsveld et al. (2005) used a randomized control design and found out that beta-carotene biofortified orange-fleshed sweet potatoes used in a school feeding program in South Africa enhanced the vitamin A status of primary school children.

School performance is linked to school attendance in that children who attend school regularly are more likely to perform better than children who are often absent. A good number of studies provide evidence of not only increased school enrolment and attendance but also improvement in school performance of children under school feeding programs (Gelli et al., 2007; Ahmed, 2004; Kristjansson et al., 2007; Neumann et al., 2007). A randomized control study by Omwami et al. (2011) in rural Kenya found out that the nutrition status of children influences their school attendance whereby the study groups with whom the fortified food intervention was implemented performed significantly better in school attendance than the control groups. Viewed as a pro-poor safety net, the school feeding program in Ghana based on locally grown foods has also shown to be an effective motivator for schooling and a promoter of education access among pupils (Essuman and Bosumtwi-Sam, 2013).

It is important to note that the quantity and quality of school meals matter. A study to evaluate the impact of a long-term implemented school feeding program in Chile found out that additional high calorie foods provided had no significant impact on the education outcomes of school children (McEwan, 2013). This provides an avenue to think of the quality of the food instead. A micronutrient approach would be better as it has been shown to positively enhance school performance. In their review, Jomma and colleagues believe that fortifying commonly consumed foods is imperative to realize the continued successes of school feeding programs (Jomaa et al., 2011). Because biofortification is targeting staples mainly consumed by the at-risk population, it is a state of the art innovation that fits well in school feeding programs to fight micronutrient deficiencies and complement previous recommendations made by World Food Program about inclusion of food fortification and supplementation into these programs (Bundy et al., 2009).

The biggest challenge however observed in a number of studies is the short-lived impact of conventional intervention strategies mainly related to issues of sustainability (Jomaa et al., 2011). De Moura (2007) highlighted in his study about the determinants of food rejection among school children that knowledge of sensory attributes of taste, aroma and texture play an important role in designing school feeding programs with a sole purpose of improving healthy eating of children. Similarly, Burgess-Champoux et al. (2006) observed that for a school feeding intervention to be successful; taste, appearance and texture of whole grains were important and further stressed the need of education to not only children but also to parents and teachers as far as promotion of knowledge about healthy foods at school is concerned. Nonetheless, it is projected that biofortification could be the solution to some of these problems that have made the global fight against hidden hunger seem unachievable. Given that children of school going age are much affected by IDDs, school feeding programs are indeed an ideal avenue to introduce iodine biofortified foods as part of their daily menu in many parts of Sub-Saharan Africa.

2.3 Stakeholder preference for food based interventions

Stakeholders can be the donors, researchers, national governments, farmers, and the ultimate consumers or beneficiaries. In this era of crop genetic modification, scientists may falsely assume that farmers would easily adopt new crop varieties because of the advantages they present in terms of high yield, disease resistance and high nutrient content while perceived health benefits would promote consumer adoption. But, adoption decisions of farmers may

perhaps depend on their judgment of the problem and also on consumer liking or aversion of a new innovation like biofortification (Adesina and Zinnah, 1993; Hansen et al., 2003). Current research shows that parents as consumers can be highly motivated and willing to promote healthier diets of their children (McMackin et al., 2013). But while their preference of healthy foods may be determined by the extent to which they are satisfied with the associated benefits, children's preferences on the other hand will depend on appearance and taste. A study on sensory acceptability of pro-vitamin A biofortified cassava revealed that primary school children in Kenya related colour and taste to the attractiveness and sweet nature of yellow compared to white cassava (Talsma et al., 2013). Parents have to play a crucial role as initiators in order to stimulate a healthy dietary behaviour of children. Similarly, a school environment is a suitable place to introduce new foods like biofortified staples to children where with repeated tasting, experience with peers and motivation by teachers, they will potentially increase their liking (Sondergaard and Edelenbos, 2007; Huotilainen et al., 2006). Knowledge is an important individual attribute, shown to be a potent predictor of preference to foods of enhanced nutrient qualities where informed consumers are more likely to have positive preferences than uninformed ones and, thus, when developing interventions based on improving awareness (Macharia-Mutie et al., 2009; Costa-Font et al., 2008). A study in Botswana found out that poor knowledge about cereal fortification and its benefits impended consumer intention to purchase (Mabaya et al., 2010).

2.4 Consumer Willingness-To-Pay (WTP) for nutritious foods

As far as foods with nutritional qualities are concerned, Willingness-To-Pay (WTP) has been defined as "the sum of money representing the difference between consumers' surplus before and after adding or improving a food product attribute" (Rodriguez et al., 2007). Consumer's WTP has been assessed using a number of approaches among which include; contingent valuation, choice experiments, and hedonic pricing method. The contingent valuation method uses both open-ended and closed-ended questions to elicit consumer responses with respect to product value at the market price for food products not yet on the market. In case of open-ended questions, a consumer is required to state the highest amount he/she would be willing to pay given that the consumer has considerable knowledge of the product; however its disadvantage is that it requires considerable cognitive effort for respondent. Conversely, closed-ended questions try to find out if a consumer would be willing to pay a particular price or not. They can be asked in a single-bound or double-bound method. One example is

Dichotomous Choice technique based on bids initially developed by Bishop and Heberlein (1979). The choice of the method to use depends mainly on the sample size whereby a small sample size for the single-bound method results into inefficient approximations and wider confidence intervals. The inherent strength of the double-bound method lies in the concept of the second bid offer, either higher or lower depending on the response given in the first bid and hence provides more insights about WTP.

In line with closed ended questioning, Mitchell and Carson (1989) also invented a payment card methodology which requires one to select from a given range of dollar amounts representing the maximum WTP and hence controls for starting point bias since there is no bidding made and interviewer bias whereby participants may give responses influenced by the interviewers' needs. With these as its strengths, payment card approach further demands less effort while answering and so the researcher is not overworked. A cheap talk script is usually used with the payment card method in order to minimize the hypothetical bias that respondents face while relating an imaginary to a real purchase situation (Cummings and Taylor, 1999). Van Tra et al. (2011) used the payment card method and found out that the high willingness-to-pay for functional foods among consumers in Vietnam is affected by education, income, experience with similar foods and mass media. The effect of mass media on willingness-to-pay has further been characterized into positive and negative information that increases and decreases consumer WTP respectively (Hu et al., 2006).

Other approaches are based on non-hypothetical values where experimental auctions are used to determine WTP and have shown to perform better than the contingent approach with respect to overestimation of values (Balistreri et al., 2001; De Steur et al., 2012b). This is further backed up by the work of Demont and his team whose model proved that consumer WTP for quality rice in Senegal was clearly manifested using experimental auctions (Demont et al., 2013). Among urban consumers in Kenya, while using a customized semi-double bounded model, De Groote and Kimenju (2008) discovered that an average discount of 37% is needed for consumers to purchase yellow biofortified maize in preference to the white maize. De Steur et al. (2012b) similarly employed experimental auctions and found women's WTP for folate biofortified rice in a high risk region in china to be high. In their study in rural Zambia, Meenakshi et al. (2012) used a Discrete Choice experiment to determine WTP for orange maize where respondents were presented with white, yellow and orange maize and after tasting were asked about their WTP based on choice set questions. It was later found out

that a discount was also necessary for consumers to prefer orange and yellow maize to white maize.

Social demographic factors have been shown in a number of consumer studies to influence consumer willingness-to-pay for nutrient enhanced foods. De Groote and Kimenju (2008) discovered that income and education negatively affected WTP while men had a higher WTP than women. However, in their study about second-generation GM foods in Brazil, Gonzalez et al. (2009) showed that the WTP for biofortified cassava was higher among females than males. In another study to assess consumer willingness-to-pay for GM food, it was found out that in addition to the above factors, income also had a positive and significant effect on WTP among well off consumers in Kenya (Kimenju and De Groote, 2008). In line with this is a study by De Steur et al. (2012b) who after consolidating socio-demographic characteristics of education and age into one target group variable, observed a significant effect on WTP, however, the effect of each factor remains uncertain.

2.5 Conceptual framework based Protection Motivation Theory (PMT)

From its advent as a fear-arousing theory (Rogers, 1975), PMT evolved into a more comprehensive persuasion model explaining how the cognitive process of threat appraisal interacts with coping appraisal to generate an intention to a health related behavioural change (Maddux and Rogers, 1983). On the basis of protection motivation, it involves a decision making process by which an individual evaluates the gravity of, and exposure to, an imminent risk and chooses a suitable alternative to deal with the threat (Cameron, 2009; Cameron and DeJoy, 2006).

Generally speaking PMT incorporates maladaptive as well as adaptive behaviour, which, respectively, constitute threat and coping appraisal. Important is the adaptive coping behaviour which relates to protection motivation of an individual faced with a potential health threat. When evaluating a threat, arousal of fear must be apparent for one to perceive danger (severity) and to consider the individual extent of the risk involved (perceived vulnerability) (Neuwirth et al., 2000). The interaction among these three components results in the so called “threat appraisal” which decreases the probability that a maladaptive behaviour occurs. Similarly, there are three coping appraisal components with which inevitable motivation intentions are expected: the consideration of the ability of the actions to effectively eliminate the threat (response efficacy) and one’s belief or confidence to

successfully undertake the health preventive action (self-efficacy). Both increase the possibility that an adaptive behaviour occurs. Furthermore, there is the evaluation of the costs involved in execution of the adaptive behaviour (response cost) which negatively influences the latter (Henson et al., 2008; Rogers and Prentice-Dunn, 1997).

This model has a superior capacity to determine and describe health preventive behaviour because it covers more components that have been underpinned by a wide array of empirical and theoretical research (Maddux and Rogers, 1983; Hodgkins and Orbell, 1998; Rogers and Prentice-Dunn, 1997). Therefore the conceptualization of this model entails someone's stimulation, maintenance and direction of an action to protect one from a threat (Ch'ng and Glendon, 2013). Although health preventive intentions are associated with actual health behaviour (Milne et al., 2000), the latter also depends on intention stability over time which is in turn affected by a number of individual factors such as feelings of remorse for not performing an adaptive behaviour (Cooke and Sheeran, 2004). Within this model lies a remarkable aspect that fear alone may not lead to increased protection motivation. Nevertheless, fear is a dominant factor influencing threat appraisal given an individual's perception of vulnerability and severity. It is also natural to expect that an individual faced with a high perceptible threat may not have the means to act (high response cost) and/or both response and self-efficacy are relatively low hence a continued maladaptive coping behaviour (Scarpa and Thiene, 2011).

As was in the early years of its discovery, today PMT is still being used in health related research to predict health preventive intentions, such as genetic testing for breast cancer risk (Helmes, 2002), knowledge and risk perception of cervical cancer (Gu et al., 2012), consumption of omega-3 rich food (Cox et al., 2008), selenium enriched foods (Cox and Bastiaans, 2007), or functional foods (Henson et al., 2008) and consumer compliancy with dietary guidelines (Henson et al., 2010a). Although both types of appraisal have shown a significant association with behavioural intention, meta-analyses suggest that coping appraisal is a stronger predictor (Milne et al., 2000; Floyd et al., 2000). Thereby, self-efficacy is considered the strongest motivator of behavioural intention. A study on foods rich in phytosterols to decrease the risk of cardiovascular diseases showed that self-efficacy followed by response efficacy were more crucial predictors (Henson et al., 2010b). Cox and Bastiaans (2007) in their analysis of consumer motivation towards the use of selenium enriched foods, found that the independent variables of both appraisals explained 36% of the variation. Response efficacy of coping appraisal was the strongest predictor of the intention

to consume seven selenium enriched foods as a whole, however, for each specific food, self-efficacy was the strongest predictor of intention explaining a much greater variation percentage. In consumer food research, however, there are often variations in the effect of PMT according to the health related product. Henson et al. (2008) for example, examined purchase intention for three products with lycopene and showed that both appraisals positively affected the likelihood of Canadian men to consume tomato juice and the snack product but not for the non-prescription pill. As far as cross-sectional studies are concerned, it is worth noting that complex statistical interpretation of the relationship between threat appraisal and behaviour intention maybe a possible cause of a weak association. There is a possibility of a two-directional relationship either a positive one given an individual adopts an advocated behaviour or a negative one resulting from unperceivable vulnerability once the protective behaviour is adopted (Milne et al., 2000).

Also socio-demographic characteristics may play a role. Whereas age, for example, was found to be the most important positive factor of consumer intention to purchase lycopene containing food products (Henson et al., 2008), the effect of self-efficacy was similar between male and female consumers in South Korea or Australia (Renner et al., 2008; Cox and Bastiaans, 2007). With respect to knowledge, only few studies found a negative effect (Henson et al., 2008). Talsma et al. (2013) showed that increasing knowledge about Vitamin A deficiency risks boosted consumer intentions to adopt biofortified cassava in Kenya. Mabaya et al. (2010) also reported a positive effect of knowledge on cereal fortification adoption in Botswana.

The aforementioned internal and external factors are incorporated in the conceptual framework to evaluate the reactions of parents and school authorities towards iodine biofortified legumes for use in school feeding programs in order to prevent IDDs and improve school performance (**Figure 1**). It hypothesizes that study participants will be first encountered with a threat of IDDs which in turn may translate into perceived fear, vulnerability and severity. Consecutively, protection motivation with regard to preference of iodine biofortified food will only be achieved when respondents believe that continued practice of maladaptive behaviour is of little benefit, that iodine biofortified foods will reduce the risk and severity of IDDs in the future, but when they are also certain and confident to perform this advocated adaptive behaviour while perceiving few hurdles such as time constraints and financial costs. The higher threat and coping appraisal are, the higher

protection motivation will be, as shown by a positive change in consumer preferences for iodine biofortified food in school feeding programs and by a positive willingness-to-pay.

2.6 Objectives of the current study

2.6.1 General objective

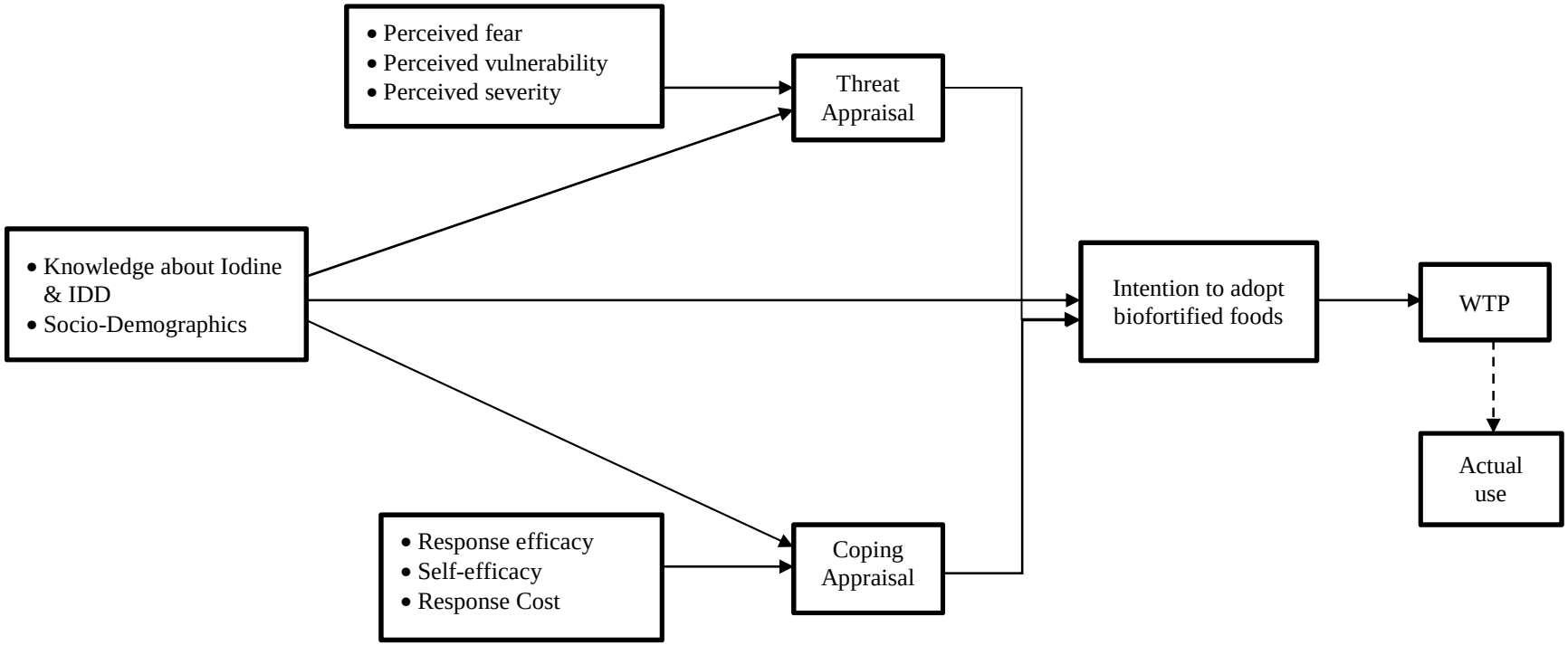
To evaluate the reactions of parents and school authorities towards the inclusion of iodine biofortified foods in school feeding programs aiming at improved school performance and prevention of IDDs.

2.6.2 Specific objectives

1. To determine the external factors (knowledge about iodine, related disorders, interventions and social demographics) that influence PMT components.
2. To assess the importance of PMT components of threat appraisal (perceived fear, vulnerability and severity) and coping appraisal (response efficacy, self-efficacy and response cost) with respect to iodine deficiency and iodine biofortified foods.
3. To analyse the relative importance of external and PMT factors on the intention to adopt iodine biofortified foods.
4. To evaluate consumer willingness-to-pay for iodine biofortified foods and their determinants.

2.7 Research questions

1. Which external factor(s) has/have an effect on PMT individual components of threat appraisal, coping appraisal and intention to adopt iodine biofortified foods?
2. To what extent do external factors, PMT components of threat and coping appraisal explain the variation observed in the intention to adopt iodine biofortified foods?
3. How do external factors and PMT components affect the anticipated behaviour measured by willingness to pay for iodine biofortified foods?



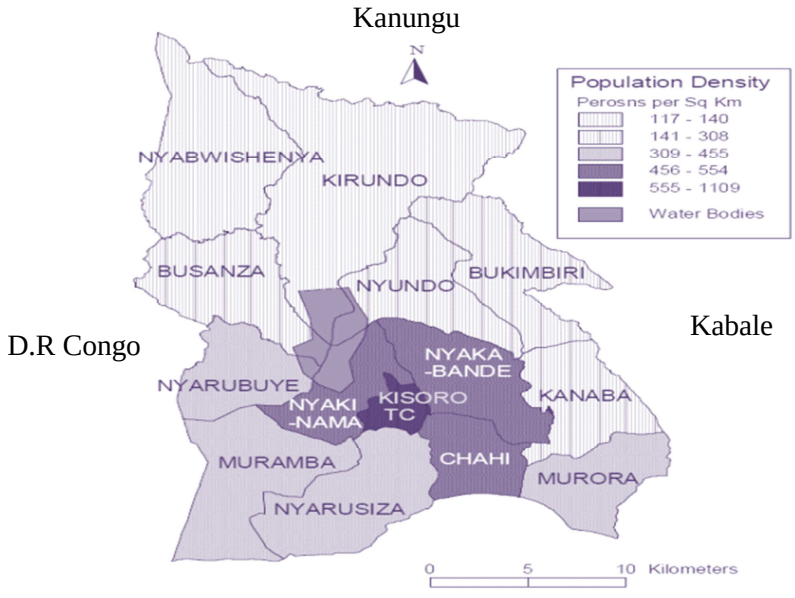
Source: Own compilation, based on Munro et al. (2007)

Figure 1. Conceptual Framework to determine the intention to adopt iodine biofortified legumes, based on Protection Motivation Theory

CHAPTER THREE: METHODOLOGY

3.1 Study area description

This study was conducted in Kisoro District in the far south-western region of Uganda and located west of the capital, Kampala. It is bordered by Kanungu District in the North, Kabale District in the East, Rwanda in the South and Democratic Republic of Congo in the West. Kisoro is one of the highly mountainous districts in Uganda and most areas are 1,980 metres above sea level which makes access to these areas difficult. Covering an area of 701.4 square kilometres, the population in Kisoro as of 2012 stood at 254,300 inhabitants characterized with a population density of 362.6 inhabitants per square kilometre. With this area, it is divided into 14 sub-counties and 49 parishes each with various respective villages. This part of the country has soils that are fertile enough to support most staple crops and so it is well-known for maize, sweet potatoes, irish potatoes, sorghum and beans production. Kisoro district has for a long time registered the highest prevalence of iodine deficiency in Uganda (WHO, 2006). Given the mountainous nature of this area that makes it prone to iodine leaching from soil as well as its remoteness and other barriers for salt iodization program, IDDs have continued to devastate the lives of many people in this region.



Source: (UBOS, 2002)

Figure 2. Map of the study area showing the area

3.2 Study design and sample

The data for the current study was collected using a cross-sectional research design among parents of primary school-aged children and school authorities of primary schools. From a list 136 primary schools, 40 were randomly selected to represent clusters, each with a school authority to be interviewed. Due to the fact that a reliable list of households with precise address details could not be obtained, together with logistical constraints, a random walk technique was used to select 9 households with primary school children from every cluster. A total of 360 households (parents) were interviewed within a predetermined radius from each school in order to get a representative sample of the study population.

3.3 Survey

3.3.1 Instrument for data collection

Two structured pre-tested questionnaires (see appendix) were administered by a trained interviewer to parents and school authorities. They contained four more or less similar sections to allow comparisons where necessary: socio-demographic profile, knowledge about iodine, an information cue preceding the PMT components and a cheap talk script followed by the WTP questions.

3.3.2 Knowledge about iodine, iodine deficiency and interventions

Regarding knowledge, five questions on micronutrients, iodine, Iodine Deficiency Disorders and possible interventions (salt iodization and biofortification) were measured in terms of familiarity (5-points scale, ranging from 1 “not at all familiar” to 5 “extremely familiar”). A follow-up question was designed to collect data on the sources from where respondents got information for each respective aspect as given above. Two additional questions (1 “not at all aware” – 5 “extremely aware”) were included to assess their knowledge about the relationship between iodine intake and mental development or school performance. Finally, respondents were asked about the link between living in mountainous and land locked areas and the risk of IDDs, and whether they are convinced that their children’s diet provided enough iodine (1 “yes” to 3 “Don’t Know”).

3.3.3 Protection Motivation Theory

PMT constructs were assessed using a five-point Likert scale.

3.3.3.1 Threat appraisal

Perceived severity was assessed with three items including: “IDDs frightens you as a very serious health problem”, “You know children who have suffered from IDDs” and “It is possible that children and/or school perform poorly because of iodine deficiency”. Also for perceived vulnerability three scaled items were used: “Do you feel children are vulnerable to suffer from IDD if they do not eat iodine rich foods”, “Children are likely to perform poorly at school due to iodine deficiency” and “In your opinion protecting children from the risk of IDDs by opting for foods rich in iodine is important” Perceived fear had two components; “Thoughts about IDDs affect your mood and school performance of children affect your mood”. The scale for measurement of all the three components ranged from “strongly disagree” (1) to “strongly agree” (5).

3.3.3.2 Coping appraisal

Except for Response cost (“I doubt the cost-effectiveness of biofortified foods”) coping appraisal components were assessed by two items: Response efficacy: “Consuming iodine rich foods will reduce the risk of IDDs” and “Iodine biofortified legumes will help improve school performance of children”; and Self-efficacy: “It is possible for your children to eat iodine biofortified legumes at school/home” and “I would agree to include iodine biofortified legumes in school/household meals”; These components were measured using a scale, ranging from “strongly disagree” (1) to “strongly agree” (5).

3.3.3.3 Behavioural intention

Behavioural intention was determined by four 5-point Likert scale items (“extremely unlikely” 1 to “extremely likely” 5) “How likely are you to accept iodine biofortified legumes as a source of iodine for your children?”, “How likely is it that you will include iodine biofortified legumes in the household/school menu for the children?”, “Are you likely to buy iodine biofortified legumes for the household/school?”, and “I will consider advocating for inclusion of iodine biofortified legumes in school meals”.

3.3.4 Willingness-To-Pay (WTP)

A payment card technique was used to assess parent’s and school authority’s willingness to pay for biofortified legumes. Specifically, a closed-ended question approach was employed;

given the ease with which questions would be answered, the time limitations, costs involved for the survey, the lack of an actual buying situation and the focus on PMT constructs which would not favour other approaches. In order to use the closed-ended question approach, participants were provided with a hypothetical market scenario and a cheap talk script assuming they were exposed to biofortified legumes. Legumes were used since consumers in the study were familiar with them as a staple food and the contingent valuation method requires that respondents have some degree of awareness about a product being investigated (Mitchell and Carson, 1989). Therefore, two sets of questions were presented to respondents with a range of amounts in Ugandan Shillings and asked to select an amount that matches the maximum amount of money they would be willing to pay more (first set) or less (second set) for biofortified legumes with a reference to the normal market price of legumes. Each set consisted of a WTP question directed towards its inclusion in school feeding programs (schools) or home meals (parents) and a question reflecting their WTP for its inclusion in school meals. The first set of questions prompted responses directed to a premium amount at school feeding program level or school meals for schools authorities and household level or school meals for parents. The second set of questions though similar in wording like the first ones were instead designed to elicit discount responses.

3.4 Data analysis

Data collected was entered using the EpiData platform (Lauritsen and Bruus, 2005). This allowed for pre-screening and cross checking all the entries from the primary questionnaires. The correct database was then exposited to StataIC version 12 (StataCorp, 2011) software for subsequent analysis. Descriptive statistics and graphing techniques were used to explain socio-demographics and knowledge variables (external factors to the PMT model). To find out if there exists differences between the two study groups, Chi-square analysis for proportions (Pearson's or Fisher's Exact test) and Mann-Whitney U test for comparison of means were used where applicable. Factor analysis was applied to obtain factor scores for both the knowledge and PMT composite variables that build upon reliability analysis using Cronbach's alpha (Rowe, 2006). Based on the research questions, three possible dependent variables were derived from the PMT model. These included threat appraisal, coping appraisal and behavioural intention and with reference to cronbach's alpha techniques, their reliabilities were determined to ascertain whether they could be used as such. The dependent variables were initially each related to external factors. On the other hand, external factors

and each individual construct of threat and coping appraisal (independent variables) were related to behavioural intention as the dependent variable.

Multiple linear regression analyses were performed to find out which independent variable(s) had a significant effect on each of the dependent variables and if so by how much. For each regression model, the first analyses conducted were to find out if the model fulfilled the Ordinary Least Squares (OLS) assumptions and also assessment of the model goodness of fit. Given that some of the assumptions were met while others were violated due to the existence of outliers, a Robust method for multiple linear regression was used as an alternative. Having checked again for possible data entry errors, the decision to use this approach was reached at because there was no convincing reason to omit outlier entries from the analysis since they seemed to be rightly observed. The data for parents was analysed with a cluster option of Robust regression because the data was collected using cluster sampling technique. This is the same as the normal Robust regression analysis and the only difference is that the former takes into consideration the cluster inter- and intra- differences while the later does not. Conversely, data for school authorities was analysed using the ordinary Robust regression analysis.

WTP for biofortified foods was analysed using Ordered probit regression analysis (maximum likelihood estimation) (Blaine et al., 2005). The rationale behind this was that the dependent variable (WTP) was ordinal in nature having been collected using a given range of prices and the ability of this approach to account for this during analysis, hence the ordering of WTP was divided into three levels ranging from low, medium and high either at a premium or discount level. The assumption underlying this statistical analysis known as the proportional odds which assumes equality of coefficients across categories of the ordered dependent variable was checked using the Omodel-test command in stata (Wolfe and Gould, 1998). The analysis involved regressing WTP as a function of external factors and PMT components grouped at either a premium or discount level, looking at WTP for biofortified foods in the school feeding program, school meal or household meal contexts. While using the low level of discount or premium WTP as a reference, marginal effects that give the probabilities were predicted and reported which facilitated proper interpretation of the regression results. From all the models, predictors ranged from 8 to 15 and were carefully included to avoid over fitting as much as possible.

3.5 Ethical consideration

Ethical clearance to carry out the study was obtained and officially documented from the Chief Administrative Officer and the District Educational Officer of Kisoro District. Informed written or verbal consent was obtained from each respondent before any interview was conducted which involved the clear explanation of the purpose of the study and confidentiality was highly guaranteed.

CHAPTER FOUR: RESULTS

Table 1 provides an overview of the key characteristics of both samples. Male respondents are more present both in the school authority (75%) and parent (52.8%) samples, but significantly more in the former ($p=0.007$). The mean age of school authorities (36.9 ±10.35 years) and parents (34.9 ±8.48 years) are similar ($p>0.05$). School authorities (100%), however, were twice as likely ($p<0.001$) to have at least a secondary education than parents (48.1%). Whereas all school authorities were either employed by the government or privately, only 20.8% of parents had this kind of employment. A good number (52.8%) of parents were self-employed, 3.1% were casual labourers and 23.3% were totally unemployed. The difference in occupation status was significant at $p<0.001$. The results also demonstrate that the average parental income amounted 174,400 Uganda Shillings (70 USD). While the majority of school authorities rated the academic performance as good (62.5%), close to half of the parents rated it as poor (41.9%) and only 20.8% perceived it as good, a significant difference between both samples ($p<0.001$). The proportions of academic performance satisfaction between school authorities and parents differed significantly ($p<0.001$) with, respectively, 7.5% vs 31.0% (very to extremely satisfied), 55% vs 8.9% (moderately satisfied), 37% vs 51.1% (slightly to not satisfied).

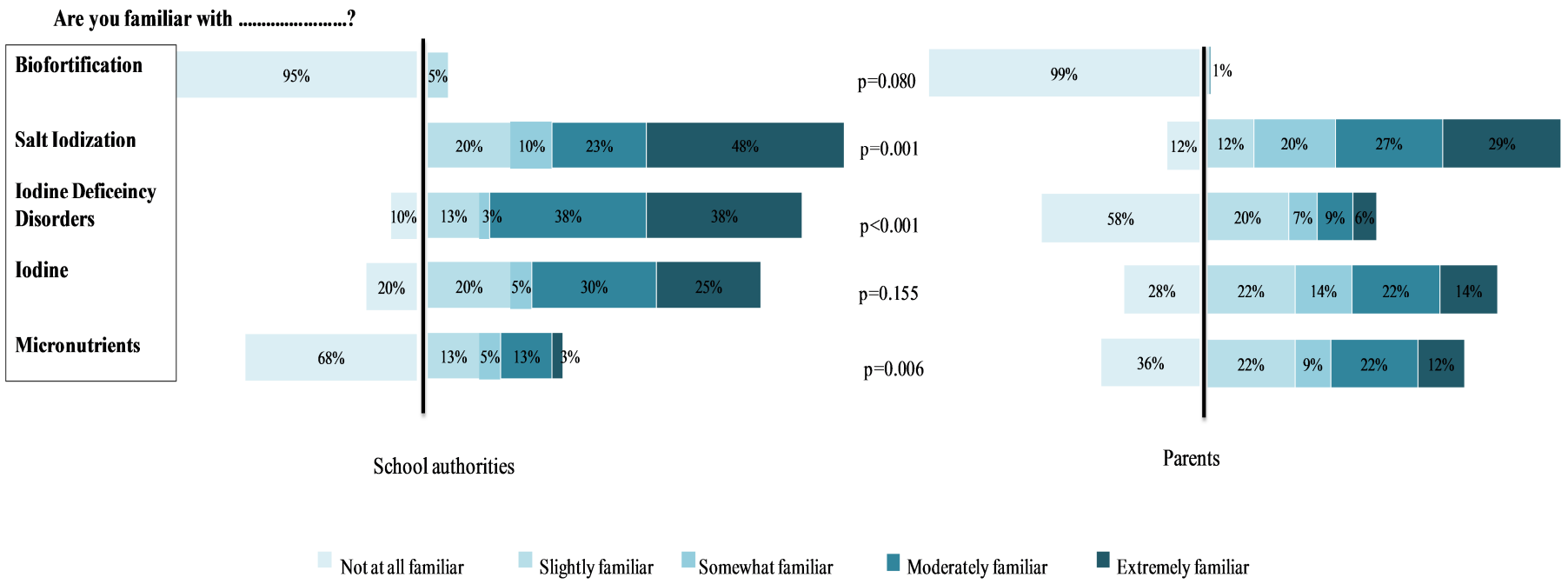
Even though the majority of schools (60%) currently ran a school feeding program, still 40% do not. A substantial proportion (95.8%) of these programs were supported by parents, while the government provided limited help to a selected few (4.2%). Most schools (87.5%) receive foods from their own farms while the market and donation only provided limited supplies, respectively 8.3% and 4.2%. Over half of the parents (59.7%) obtained food from their own farms, 37.2% relied on markets and 3.1% on donations. A significant difference in the source of food was observed between schools and households ($p<0.001$). Almost all schools (95%) used industrial iodized salt while preparing school meals. At home, 67.5% of parents reported to use iodized salt while preparing meals for children while about one out of seven parents only buys traditional salt (14.7%) and 17.8% used both. There was a significant difference in response proportions ($p<0.001$) between schools and households with respect to the type of salt used. The mean consumption of iodized salt by children at school (reported by school authorities) and at home (reported by parents) was similar ($p>0.05$), with about 6 days.

Table 1. Characteristics of school authorities and parents in Kisoro, Uganda

Characteristic	Respondents		*p-value*
	School authorities (n=40)	**Parents (n=360)**	
Gender			
Male	30 (75%)	190 (52.8%)	0.007**
Female	10 (25%)	170 (47.2%)	
Age (mean ±SD)	36.9 ±10.35	34.9 ±8.48	0.347
Education level			
No formal education		73 (20.3%)	
Primary education		114 (31.7%)	
Secondary education		83 (23.1%)	<0.001**
Tertiary	40 (100%)	82 (22.8%)	
University		8 (2.2%)	
Occupation			
Unemployed		84 (23.3%)	
Casual worker		11 (3.1%)	<0.001**
Self-employed		190 (52.8%)	
Government/private worker	40 (100%)	75 (20.8%)	
Income (mean ±SD)		174400 ±148850	
Size (mean ±SD)	644.43 ±323.29	2.37 ±0.998	
Academic performance			
Poor		151 (41.9%)	
Fair	7 (17.5%)	52 (14.4%)	
Good	25 (62.5%)	75 (20.8%)	<0.001**
Very good	6 (15%)	41 (11.4%)	
Excellent	2 (5%)	41 (11.4%)	
Academic performance satisfaction			
Not at all satisfied	6 (15%)	123 (34.2%)	
Slightly satisfied	9 (22%)	61 (16.9%)	<0.001**
Moderately satisfied	22 (55%)	32 (8.9%)	
Very satisfied	3 (7.5%)	109 (30.3%)	
Extremely satisfied		35 (9.7%)	
School feeding program			
Yes	24 (60%)		
No	16 (40%)		
Support source (n=24)†			
Parents	23 (95.8%)		
Government	1 (4.2%)		
Source of food			
Own farm	2 (8.3%)	215 (59.7%)	
Market	21 (87.5%)	134 (37.2%)	<0.001**
Donation	1 (4.2%)	11 (3.1%)	
Type of salt used			
Traditional	2 (5%)	53 (14.7%)	
Industrial iodized	38 (95%)	243 (67.5%)	<0.001**
Both		64 (17.8%)	
Freq of iodized salt intake (mean ±SD)	5.79 ±1.64	5.66 ±2.22	0.494

Proportions and means were compared using Chi-square tests and Mann-Whitney U test respectively.
Means and standard deviations are in brackets, unless indicated.
†Applicable number of respondents for that particular question
** Significant at p<0.05.

Figure 3 shows responses to the questions assessing stakeholders' knowledge towards specified aspects on a scale of 1 (not at all familiar) – 5 (Extremely familiar). The results indicate that for both samples, there is a relatively similar trend in the responses ranging from micronutrients to biofortification. A greatest majority of 68% and 36% respectively ranked their knowledge of micronutrients as 1 relating to "not at all familiar". The successive school authorities' vs parents' response proportions with regard to complete unfamiliarity henceforth tend to reduce systematically as one moves upwards to other related items (20% vs 28%, for iodine, 10% vs 58%, for IDDs, and 0% vs 12%, for salt iodization). Striking is the extent to which at least all school authorities have a certain degree of familiarity as far as salt iodization is concerned unlike parents. However, parents exhibit a peculiar divergence from the general trend in line with IDDs where unlike others, proportion of complete unfamiliarity responses instead greatly increases to 58%. Looking on the furthest side of the scale, a comparable trend is observed but inclined in the opposite direction. Hence the proportion of responses of school authorities vs parents related to extreme familiarity increase upwards with the items; 3% vs 12% for micronutrients, 25% vs 14% for iodine, 38% vs 6% for Iodine Deficiency Disorders and 48% vs 29% for salt iodization. Again an atypical variation from the trend is seen among parents with regard to IDDs with an almost two-fold decrease from the previous adjacent proportion. Familiarity with biofortification for both school authorities (95%) and parents (99%) is equally the same with majority of responses tending to total unfamiliarity. There were statistically significant differences between respondent's familiarity with regard to micronutrients ($p=0.006$), IDDs ($p<0.001$) and salt iodization ($p=0.001$).



** Significant at p<0.05.

Figure 3. Familiarity with iodine, its deficiency and interventions, per subsample

Table 2 shows the sources from where participants got information about the different knowledge items. Among school authorities who had reported familiarity about the five knowledge aspects, majority; 84.6% (micronutrients), 84.4% (iodine), 77.8% (IDDs), 65% (salt iodization) and 100% (biofortification) got information from professionals. Market as a source of information was more common for salt iodization and iodine at 25% and 3.1% respectively while media was generally least used (15.4% for micronutrients, 12.5% for iodine, 5.6% for IDDs and 7.5% for salt iodization).

Table 2. Sources of information reported by school authorities and parents in Kisoro, Uganda

Variable	**School authorities**	**Parents**	***p-value***
Micronutrients	n=13	n=231	
Media	2 (15.4%)	63 (27.3%)	
Market		7 (3%)	<0.001**
Relatives		30 (13%)	
Professionals	11 (84.6%)	55 (23.8%)	
Other		76 32.9%)	
Iodine	n=32	n=261	
Media	4 (12.5%)	64 (24.5%)	
Market	1 (3.1%)	5 (1.9%)	<0.001**
Relatives		38 (14.6%)	
Professionals	27 (84.4%)	77 (29.5%)	
Other		77 (29.5%)	
Iodine Deficiency Disorders	n=36	n=152	
Media	2 (5.6%)	34 (22.4%)	
Market		2 (1.3%)	<0.001**
Relatives	6 (16.7%)	41 (27%)	
Professionals	28 (77.8%)	54 (35.5%)	
Other		21 (13.8%)	
Salt iodization	n=40	n=318	
Media	3 (7.5%)	47 (14.8%)	
Market	10 (25%)	46 (14.5%)	<0.001**
Relatives	1 (2.5%)	29 (9.1%)	
Professionals	26 (65%)	64 (20.1%)	
Other		132 (41.5%)	
Biofortification	n=2	n=3	
Professionals	2 (100%)	3 (100%)	

Proportions were compared using Chi-square or Fisher's Exact Chi-square test.
n indicates the applicable number of respondents for that particular question.
** Significant at p<0.05.

Parents had a relatively balanced distribution of sources of information across all items with the exception of biofortification where professionals were the only source (100%). For micronutrients, 27.3% got Information from the media, 23.8% from professionals, 13% from relatives, 3% from the market and 32.9% from other sources. Among the parents who were familiar with iodine, 29.5% heard it from professionals, 24.5% from media, 14.6% from relatives, 1.9% from market and 29.5% from other sources. As for IDDs, the highest

proportion of parents reported professionals (35.5%), followed by relatives (27%), media (22.4%), others (13.8%) and market (1.3%). The information about salt iodization was obtained by parents in proportions of 20.1% professionals, 14.8% media, 14.5% market, 9.1% relatives and 41.5% others. The results show that the proportion of all sources of information between school authorities and parents differed significantly (P<0.001).

Results in **Table 3** indicate that school authorities on average perceived a higher threat appraisal of 4.37 ±0.46 than parents (4.35 ±0.46) but this difference was not statistically significant (p>0.05). Among threat appraisal constructs, only perceived vulnerability was marginally statistically different (p=0.05) between respondent samples while perceived severity and fear were both insignificant (p>0.05). The mean for coping appraisal score among school authorities was 4.36 (SD=0.44) significantly lower (p=0.025) than that of parents of 4.50 ±0.47. Self-efficacy gave the only highly significant difference between school authorities (4.40 ±0.47) and parents (4.70 ±0.55) with a p<0.001. Response efficacy was not statistically different between school authorities (4.31 ±0.55) and parents (4.30 ±0.54) in addition to response cost (school authorities, 2.48 ±1.26 vs parents, 2.18 ±0.92) both at p>0.05. School authorities had a mean behavioural intention score of 4.24 (SD=0.48) lower than that of parents of 4.41 (SD=0.49) characterized by a statistically significant difference with a p=0.005. For school authorities, Cronbach's alpha for the composite threat appraisal (8 items), coping appraisal (5 items) and behavioural intention (4 items) was, respectively, 0.71, 0.74 and 0.68. In the parents' survey, Cronbach's alpha was 0.78 for threat appraisal (8 items), 0.62 for coping appraisal (5 items) and 0.69 for behavioural intention (4 items).

Table 3. Protection Motivation constructs and the intention to adopt biofortified legumes among school authorities and parents in Kisoro, Uganda

PMT constructs (Scale range; 1-5)	**School authorities (n=40)**		**Parents (n=360)**		
	α	**mean±SD**	**α**	**mean±SD**	***p-value***
Threat appraisal	0.71	4.37 ±0.46	0.78	4.35 ±0.46	0.610
Perceived severity		4.12 ±0.68		4.08 ±0.62	0.574
Perceived vulnerability		4.53 ±0.46		4.37 ±0.57	0.050**
Perceived fear		4.63 ±0.49		4.74 ±0.54	0.075
Coping appraisal	0.74	4.36 ±0.44	0.62	4.50 ±0.47	0.025**
Response efficacy		4.31 ±0.55		4.30 ±0.54	0.863
Self-efficacy		4.40 ±0.47		4.70 ±0.55	<0.001**
Response cost		2.48 ±1.26		2.18 ±0.92	0.246
Behavioural intention	0.68	4.24 ±0.48	0.69	4.41 ±0.49	0.005**

Means were compared using Mann-Whitney U test.
α Cronbach's alpha
** Significant at p<0.05.

The results of the multiple regression analysis for the PMT dependent variables (threat appraisal, coping appraisal and behavioural intention) are presented in **Table 4**. While no external factor was found to be significant among school authorities in relation to threat appraisal, occupation (p=0.001), household size (p=0.028), age (p=0.047) and income (p=0.002) significantly affect threat appraisal among parents (10.4% of the explained variance). The effect of age and occupation were negative and so for a given unit increase in these predictors, threat appraisal reduced by 0.016 and 0.628 standardized units respectively, while income and household size had a positive influence hence for each unit increase in these predictors, an increase in the standardized units of threat appraisal by 0.004 and 0.084 was observed respectively.

Among school authorities, gender had a positive significant effect (p=0.045), explaining 8.7% of the total variance in coping appraisal with male school authorities having a 0.491 higher standardized units than females. For parents, occupation, education and age negatively affected coping appraisal. Knowledge about iodine and IDDs as well as household size were positive predictors of coping appraisal, together accounting for 13.3% of the explained variance of the coping appraisal model. Therefore for every unit increase in these factors, there was a corresponding decrease in the standardized units of coping appraisal by 0.611 units (occupation), 0.291 units (education) and 0.023 units (age). Conversely, as predictors increased by one unit, coping appraisal increased by 0.193 units (knowledge) and 0.098 units (household size).

With regard to intention to adopt biofortified foods, no predictor produced significant results for school authorities. For parents, occupation (p=0.006) and knowledge (p=0.017) were significant predictors (9% explained variance). However, for every unit increase in occupation and knowledge, behavioural intention was lowered by 0.571 standardized units and increased by 0.160 standardized units respectively.

Table 4. Robust regression of external predictors of threat appraisal, coping appraisal and intention to adopt iodine biofortified legumes among school authorities and parents in Kisoro, Uganda

Predictors	School authorities						Parents[c]					
	Threat appraisal R^2 = 0.140		Coping appraisal R^2 =0.087		Behavioural Intention R^2 = 0.132		Threat appraisal R^2 = 0.104		Coping appraisal R^2 = 0.133		Behavioural Intention R^2 = 0.090	
	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value
Gender	0.131	0.660	0.491	0.045**	0.268	0.431	-0.073	0.493	-0.004	0.961	0.026	0.762
Age	-0.006	0.637	0.008	0.674	-0.016	0.148	-0.016	0.047**	-0.023	0.006**	-0.004	0.574
Education							-0.127	0.315	-0.291	0.019**	-0.254	0.126
Occupation							-0.628	0.001**	-0.611	0.002**	-0.571	0.006**
Income							0.004	0.002**	0.003	0.072	0.001	0.204
School/household size	0.001	0.128	0.0001	0.903	0.0003	0.460	0.084	0.028**	0.098	0.005**	-0.007	0.865
Knowledge of Iodine & IDDs	0.277	0.063	0.086	0.607	0.255	0.107	0.096	0.148	0.193	0.016**	0.160	0.017**
Academic performance satisfaction	-0.040	0.766	-0.007	0.966	0.086	0.569	0.001	0.987	-0.012	0.808	0.062	0.225

Note: except for age and income, all variables were recoded into dummy variables.
[c] Cluster option included
** Significant at p<0.05

Table 5 shows the effects of both external factors and PMT components on intention to adopt biofortified legumes. In both samples, the models accounted for a relatively large variation of the behavioural intention (42% to 45%). Response cost had a significant negative effect in the sample of school authorities. It followed that for every standardized unit increase in response cost, behavioural intention reduced by 0.217 standardized units. Among parents, self-efficacy was the only significant predictor, positively affecting intention to adopt biofortified foods. Hence for ever unit increase in the standardized values of self-efficacy, behavioural intention also increased by 0.476 standardized units.

Table 5. Robust regression of external factors, PMT constructs of Threat and Coping appraisal as predictors of intention to adopt biofortified legumes as a dependent variable among school authorities and parents in Kisoro, Uganda

Predictors	**School authorities (R^2 =0.424)**		**Parents[c] (R^2 = 0.457)**	
	β	***p*-value**	**β**	***p*-value**
Gender	0.068	0.828	0.046	0.513
Age	-0.016	0.168	0.007	0.283
Education			-0.083	0.563
Occupation			-0.184	0.144
Income			-0.001	0.435
School/household size	0.0002	0.639	-0.061	0.069
Knowledge of Iodine & IDD	0.265	0.113	0.056	0.167
Academic performance	0.116	0.462	0.063	0.181
Perceived severity	0.162	0.517	0.206	0.089
Perceived vulnerability	0.049	0.842	0.007	0.910
Perceived fear	-0.077	0.638	0.025	0.575
Response efficacy	0.137	0.532	0.141	0.120
Self-efficacy	0.172	0.416	0.475	<0.001**
Response cost	-0.217	0.041**	0.022	0.548

[c] Cluster option included
** Significant at p<0.05.

Finally, an ordered probit regression analysis was conducted to identify significant determinants of WTP (**Table 6**) when biofortified foods are offered at a premium (PR) or discount (DC) each at a school feeding program (SFP) level, household meal (HM) level and as an independent school meal (SM). Both subsamples are on average prepared to pay a higher price premium for iodine biofortified legumes in school meals (60% – 70%) and home meals (26%) than in school feeding program (23.3%). Conversely, they require relatively similar discount prices, respectively 33 – 39% and 38% for school/home meals and school feeding program, when it could be offered at a discount.

Regarding the inclusion of biofortified legumes in the school feeding program, the marginal effects based on probabilities show that school size has a negative effect on premium for biofortified foods in the school authority sample. When others are held constant, a one pupil

increase in school size decreased the chance of reporting lower levels of premium WTP by 0.002% (p=0.015). On the other hand, perceived vulnerability had a positive marginal effect in case there would be a discount. As perceived vulnerability increased by one standardized unit, percentage points for WTP at low levels of discount increased by 0.470 (p=0.010). For parents, no predictor was found to affect WTP for biofortified foods at a premium price in home meals; however, at a discount price, education and response efficacy had positive marginal effects on WTP. Hence educated parents were 0.066% more likely to report low level of WTP than uneducated parents (p=0.009) and every one standardized unit increase in response efficacy increased the chances to report low levels of WTP by 0.057%.

When offered as independent school meals, age had positive and school size negative marginal effects related to premiums for biofortified legumes in the school authorities sample. A one year increase in age significantly (p=0.039) increased the chance of giving low WTP by 0.023% and with every one increase in the number of pupils, WTP at low levels of premium significantly (p=0.014) decreased by 0.001%. In the discount scenario, knowledge and response efficacy positively affected WTP whereas self-efficacy and behavioural intention generate negative effects. Each standardized unit increase in knowledge (p=0.029) and response efficacy (p=0.017) increased the chance of reporting low levels of WTP for biofortified foods by 0.189% and 0.292% respectively. Conversely, when self-efficacy (p=0.015) and behavioural intention (p=0.031) increased by one standardized unit, the probability of reporting a low level of WTP at a discount reduced by 0.228% and 0.192% respectively.

Parents' premium WTP for school meals was in a similar way positively affected by age and response efficacy, and negatively by household size. Each one year increase in age (p=0.018) and one standardized unit increase in response efficacy (p=0.010) resulted into 0.004% and 0.055% increase in the probability to report low WTP values respectively. Also, as household size became bigger by one addition member, the chance to report low levels of WTP for biofortified school meals decreased by 0.019%. When looking at the discount values, gender and behavioural intention had negative marginal effects while age and response efficacy were positive determinants. Hence, women were 0.045% more likely to report WTP at low levels than men (p=0.026) and as behavioural intention increased by one standardized unit, reporting WTP at low levels reduced by 0.031% (p=0.026). On the other hand, as parent's age (p<0.001) increased by one year and response efficacy (p<0.001) increased by one standardized unit, the chance of reporting low WTP values increased by 0.005% and 0.083% respectively.

Table 6. Ordered Probit regression of external factors, all PMT constructs Willingness to Pay for biofortified legumes as a dependent variable at premium and discount among school authorities and parents in Kisoro, Uganda

Predictors	Level/pseudo R^2	School authorities				Parents			
		PR-SFP/0.182	PR-SM/0.216	DC-SFP/0.244	DC-SM/0.400	PR-HM/0.047	PR-SM/0.042	DC-HM/0.039	DC-SM/0.202
	Mean WTP ±SD (in $)	**1.85 ±0.16**	**1.60 ±0.16**	**0.93 ±0.21**	**0.61 ±0.10**	**1.89 ±0.16**	**1.70 ±0.17**	**1.00 ±0.17**	**0.63 ±0.10**
Gender	mfx	-0.115	-0.195	-0.164	0.013	-0.054	-0.018	-0.023	-0.050
	p-value	*0.554*	*0.380*	*0.313*	*0.911*	*0.198*	*0.404*	*0.338*	*0.026***
Age	mfx	-0.017	0.023	0.005	0.014	0.004	0.004	0.0004	0.005
	p-value	*0.074*	0.039**	*0.499*	*0.061*	*0.216*	*0.020***	*0.831*	*<0.001***
Education	mfx					0.063	0.042	0.066	0.008
	p-value					*0.278*	*0.113*	*0.009***	*0.756*
Occupation	mfx					0.086	-0.062	-0.031	-0.020
	p-value					*0.131*	*0.150*	*0.448*	*0.590*
Income	mfx					0.0004	0.0004	-0.0002	0.0001
	p-value					*0.302*	*0.061*	*0.369*	*0.471*
School/household size	mfx	-0.001	-0.001	-0.0003	-0.00003	-0.022	-0.019	-0.005	-0.012
	p-value	*0.015***	*0.014***	*0.246*	*0.866*	*0.131*	*0.015***	*0.576*	*0.068*
Knowledge of Iodine &	mfx	0.136	-0.128	-0.125	0.189	-0.040	-0.018	-0.009	0.009
IDDs	*p-value*	*0.197*	*0.237*	*0.090*	*0.029***	*0.108*	*0.167*	*0.538*	*0.439*
Academic performance	mfx	0.063	-0.135	-0.104	-0.039	-0.045	-0.011	-0.002	-0.007
satisfaction	*p-value*	*0.446*	*0.167*	*0.119*	*0.457*	*0.060*	*0.377*	*0.883*	*0.540*
Perceived severity	mfx	-0.217	-0.463	-0.278	-0.094	-0.062	-0.015	-0.024	-0.013
	p-value	*0.232*	0.060	*0.071*	*0.435*	*0.071*	*0.375*	*0.196*	*0.383*
Perceived vulnerability	mfx	0.151	0.229	0.470	0.038	0.016	-0.008	0.024	0.009
	p-value	*0.465*	0.333	*0.010***	*0.762*	*0.619*	*0.624*	*0.204*	*0.565*
Perceived fear	mfx	0.014	-0.103	0.010	0.047	-0.048	0.008	-0.008	0.004
	p-value	*0.883*	*0.342*	*0.884*	*0.401*	*0.135*	*0.617*	*0.641*	*0.756*
Response efficacy	mfx	-0.063	-0.123	0.041	0.292	-0.005	0.055	0.057	0.083
	p-value	*0.641*	*0.405*	*0.686*	*0.017***	*0.901*	*0.013***	*0.014***	*<0.001***
Self-efficacy	mfx	0.266	0.221	-0.072	-0.228	0.036	-0.026	-0.032	-0.025
	p-value	*0.057*	*0.121*	*0.476*	*0.029***	*0.326*	*0.165*	*0.118*	*0.122*
Response cost	mfx	-0.030	0.103	0.067	-0.053	-0.009	0.011	-0.010	-0.009
	p-value	*0.762*	*0.343*	*0.343*	*0.406*	*0.631*	*0.290*	*0.341*	*0.324*
Behavioural intention	mfx	0.006	0.093	-0.012	-0.192	-0.065	-0.008	-0.020	-0.031
	p-value	*0.960*	*0.501*	*0.887*	*0.041***	*0.054*	*0.610*	*0.256*	*0.026***

PR, premium, DC, discount, SFP, school feeding program, SM, school meals, HM, household meal; mfx, marginal effect coefficient; Regular prices, 1.5$ (SFP/HM) -1.0$ (SM); ** Significant at p<0.05.

CHAPTER FIVE: DISCUSSION

5.1 Knowledge about iodine, its deficiencies and intervention strategies

Even though parents got more acquainted with micronutrients, familiarity with vitamins and minerals is relatively low in both samples. Despite the fact that 3 out of 5 schools have a school food program, nearly 70% is not familiar with micronutrients. Knowledge on iodine and salt iodization is high in both groups, most likely due to the regular use of iodized salt. Consumers who use iodized salt regularly would easily respond to prompts related to iodine than non-users. Although, it is difficult to ascertain the consistency of intake, 95% of school authorities and 85.3% of parents use iodized salt to prepare meals for children. This may explain why a good number of respondents showed considerable knowledge with respect to iodine and iodized salt. This is a positive finding, that, if consumers are aware of the importance of iodine, may lead to satisfactory intake levels of iodized salt, as shown in previous studies (Buxton and Baguune, 2012; Mohapatra et al., 2001). Nutrition awareness as according to van Dillen et al. (2008) initially directs the health behaviour of someone but the study at hand contrary demonstrates a possibility that continued use of fortified foods enhances and maintains someone's knowledge towards that particular food. This is not entirely contradictory to what literature currently explains but merely presents a different explanation of how the advent of iodized salt intervention has to a given extent boosted public knowledge towards iodine.

Unfortunately, study participants are not that familiar with IDDs, especially in the group of parents, calling for communication efforts when marketing foods rich in iodine. Although some parents could not identify a single deficiency disorder related to iodine, it does not mean that parents are unaware of the existence of goitre or poor school performance of their children, but they can not associate iodine to these disorders. High level of illiteracy as seen in this study can be a reason why these parents are ignorant about IDDs especially goitre and poor academic performance in such a manner as compared to school authorities. This has also been shown in other studies where people do not know the causes of IDDs and, in extreme cases, sometimes associate it to traditional practices especially witchcraft (Mallik et al., 1998; Jooste et al., 2005). As expected, only few people have heard of biofortification. It is not a surprise that knowledge about biofortification is very low in the study area. Although biofortified orange sweet potatoes were introduced in the same area in 2007, few people participated in this intervention (Hotz et al., 2012). It is clear that additional efforts are needed to increase awareness.

Professionals are an important source of information for study respondents. This shows that majority of people have trust in expert advise than from any other source of information regarding nutrition which view is shared by van Dillen et al. (2004) and Hiddink et al. (1997) who reported positive perceptions among respondents towards health care professionals as dissemination avenues of nutrition information. Given the mountainous terrain of the study area, access to professionals would be limited and hence media is expected to play a major role but to the contrary it does not. As compared to health professionals, consumers tend to have less trust in media information as it falls short of facts and is often contradictory in nature (Ward et al., 2012). The use of other forms of cheap and effective communication strategies with messages tailored to the needs of the recipients is needed. An intervention study that used mobile phone text messaging to participants was effective in not only improving the knowledge and attitudes of people towards iodine and IDDs but also helped to enhance the consumption of iodized salt (Mehran et al., 2012).

5.2 Consumer reactions towards biofortified foods based on protection motivation theory

5.2.1 How do threat appraisal, coping appraisal and behavioural intentions differ among school authorities and parents?

School authorities and parents demonstrate a high average threat appraisal, coping appraisal and behavioural intention, however, there exists some difference in reactions among the two groups either at the main component level or at the individual items that make up the PMT components. There is a general observation in both groups of respondents having the same level of threat appraisal but on specific note, school authorities are more likely to perceive a higher degree of vulnerability than parents, a finding that might relate to school authorities' more negative perception of academic performance.

All coping appraisal items obtain a high score, except for the relatively low response cost. The higher coping appraisal of parents solely characterized by self-efficacy concurs with a study that showed that although children's food preferences are affected by environmental influences or may be innate, parents of children with healthy food choices felt that they had more control over them, with a view that unhealthy preferences were only short-term and modifiable (Russell and Worsley, 2013). This may have an implication to the success of health promotion interventions for example based on consumption of biofortified foods by children which requires parents to be as efficient as possible in expressing confidence while positively

influencing their children's food preferences. The expression of a lower intention to adopt iodine biofortified foods by school authorities than parents can be explained by the fact that school feeding schemes still require external assistance and hence the possible reservations expressed in their responses (Bundy et al., 2011). It can be seen in the present study that all the schools that have an existing school feeding program either get support from parents or the government but they are not self-reliant.

5.2.2 Which external factors influence the main PMT components and the relative importance of determinants on intention to adopt iodine biofortified foods?

Since no study had yet shown a direct relationship with potential external factors; threat and coping appraisal in addition to behavioural intention were made response variables aimed at generating new knowledge to literature. Among school authorities, only the coping appraisal model produced significant results with gender the only main predictor and therefore male school authorities have a higher level of coping appraisal than females. The higher level of coping appraisal among male school authorities contradicts previous studies about healthy eating behaviours who reported, respectively no (Renner et al., 2008; Cox and Bastiaans, 2007) or an opposite effect of gender (Lowenstein et al., 2013). These differences are not a surprise because these studies concentrated on one but not the combined effect on all coping appraisal components as in the current study.

When looking at the three models at household level (parents), occupation negatively affects all main PMT components, while age and household size have a negative and positive influence on both types of appraisal respectively. The current study shows that parents who are employed have a lower threat appraisal, coping appraisal and behavioural intention than unemployed parents. Similarly, younger parents have a higher threat appraisal and coping appraisal than older parents. This contradicts evidence on individual PMT components that found a positive relationship between perceived severity of health problems, age and occupation status (Avila-Burgos et al., 2005). In the present study, however, older and employed parents may have limited experience with iodine deficiency and do not perceive it to be a serious problem that requires prompt attention.

Knowledge is an important predictor of both coping appraisal and behavioural intention. As knowledge of parents increases, their coping appraisal and intention to adopt biofortified foods also rises. This is not in line with previous studies that have reported lower behavioural intentions with increasing knowledge about particular healthy foods in question (Henson et al.,

2010b; Verbeke, 2005). Unlike these studies where the unexpected negative association was attributed to what constituted the knowledge, how it was disseminated and a possibility that consumers utilized other means to deal with the apparent health problem, evidence provided in the current study is backed up by the high level of knowledge about iodine in the study sample and the limited availability of coping strategies to address the problem of iodine deficiency. A comparable study about biofortified pro-vitamin A cassava in Kenya found out that the high awareness by childrens' caretakers about vitamin A and its deficiencies significantly increased their intention to use biofortified cassava (Talsma et al., 2013). Therefore, promotion of iodine biofortified foods should be accompanied with an awareness campaign. Furthermore, income and education relatively significantly determined, respectively, the threat and coping appraisal models. Contrary to what previous studies have shown, i.e. education enhances knowledge acquisition (Molster et al., 2009; Bornkessel et al., 2014), the present study suggests that educated parents have a lower coping appraisal. Given that increased knowledge enhances coping appraisal, from a marketing point of view, improving iodine deficiency related knowledge seems to be more effective in increasing coping appraisal than having a high education level. This positive knowledge effect may be, in turn, related to parents' previous experiences of using iodized salt which validates the point made earlier that experience also plays an important role in boosting knowledge. Still, it is important to note that knowledge is most likely a prerequisite but not the only condition to ensure a sustainable behavioural change in favour of iodine rich foods.

The current study provides more evidence that PMT theory can be used to predict the behavioural intention towards biofortified foods. Response cost had a significant negative effect in the sample of school authorities. The higher the perceived costs, the lower the intention to change behaviour in future by consuming biofortified legumes. This underlines that the dependence on external assistance is a barrier to adoption among schools. Jensen et al. (2013) for example, cited similar barriers associated with launching a school feeding program and considered the costs, consumer's willingness-to-pay and the requirement of external support as most important. Among parents, self-efficacy was the only significant predictor, positively affecting the intention to adopt biofortified foods. This suggests that parents' acceptance is mainly based on their confidence to undertake the proposed dietary intervention, a finding that is shared by other studies which applied a similar model of consumer's reaction to nutritious foods (Cox and Bastiaans, 2007; Cox et al., 2004; Henson et al., 2008; Henson et

al., 2010b). Hence, a suitable measure to take would be to build on the existing self-efficacy among beneficiaries of such food based interventions.

5.2.3 What determines consumer willingness-to-pay for iodine biofortified foods?

Consumers in the current study are willing to pay for biofortified foods at an average premium as high as 70% and at an average discount as high as 39% of the normal market price of legumes depending on the context considered. Other studies in developing regions have reported values in a more or less similar range: premium prices of 13.8% (Kimenju and De Groote, 2008) and 33.7% (De Steur et al., 2012b) versus discount prices of 37% (De Groote and Kimenju, 2008). Still, the range of WTP can be higher, up to 64% (Gonzalez et al., 2009) or as low as 3.8% (Loureiro and Bugbee, 2005).

The current study further shows that young individuals heading schools with many pupils are more willing to pay a premium for biofortified foods. While those who do not perceive high risk to IDDs, are young, have low knowledge and response efficacy but have some self-efficacy and behavioural intention are more likely to pay for biofortified foods when given at a discount. For parents to pay at a premium, they are more likely to be in a young age category, living with big families and have low response efficacy. On the other hand, female parents, young in age with low level of education, low response efficacy but with some behavioural intention will ordinarily pay for biofortified foods at a discount price. Since female parents have the main responsibility to take care of children at home with regards to child feeding, their positive influence on WTP is needed. This is supported with a study by Gonzalez et al. (2009) who showed that women were more willing to pay higher for biofortified cassava than males and showed how this was important to the nutrition care of children. De Steur et al. (2012b) also illustrated women's higher interest in and WTP for GM biofortified rice. They further found out that knowledge of perceived benefits tends to increase the willingness-to-pay and because response efficacy is synonymous with perceived benefits or effectiveness of an advocated food, low knowledge of biofortified foods and response efficacy in the current study possibly results into a higher preference mainly at a discount level. Although there is no education effect in the 'premium' model, its positive effect on willingness-to-pay a discount corresponds with a Kenyan study on fortified maize (De Groote and Kimenju, 2008).

5.3 Significance of the study results

The outcomes of the current consumer study provide important information needed by various stakeholders potentially involved in the implementation of biofortification. It initially depicts PMT as a viable model that researchers involved in development of biofortified foods can use during market test studies to extensively understand consumer motivational drives towards acceptance of such nutritious foods. To policy makers, the study provides relevant information they can base on to make decisions with regards to adoption and implementation of effective biofortification programs that are tailored and targeted to the specific needs of beneficiaries. In an economic perspective, a marketer requires reliable information about target consumers and the current study offers much of that. This would ensure that appropriate marketing mix programs are designed with a clear idea of the buying behaviour of target consumers especially centred on their individual characteristics. Farmers in addition need to know which foods consumers prefer and to ensure that their production activities are demand driven. Hence the study can be used by farmers to approximate the demand of biofortified foods by consumers.

5.4 Limitations to the study

The current study did not produce significant results in the main model for the components of threat appraisal possibly due to a two-directional relationship that makes interpretation difficult (Milne et al., 2000). Future results can be improved if longitudinal studies are conducted with more emphasis on perceived vulnerability measured before and after the behaviour change occurs (Wurtele and Maddux, 1987). Studies have shown that the sensory attributes of foods children eat determine acceptance (De Moura, 2007), however, this was not part of the current study. Further studies using PMT should integrated sensory aspects to find out whether what literature suggests can also be explained using the model. The small sample of school respondents compared to parents was inevitable because a higher number was unachievable at the time of data collection given the unfriendly terrain of the study area in addition to the war that was going on in the eastern parts of D.R Congo which hindered movements during data collection. This limited some comparisons between the two study groups, however, an effort was made to use techniques that allow comparisons even in presence of different sample sizes. The effect of the information provided to respondents as part of the PMT could not be assessed because the current study did not include a control group. It is of high interest that future studies can use a design with two groups of participants; those availed with information and

others without or to assess the same group of respondents two times; first without information and second time with information.

5.5 Conclusion and recommendations

A Protection Motivation Theory based framework is used to model parents' and school authorities' reactions towards biofortified foods. By applying this framework to the case of iodine rich legumes, the effect of both external as well as internal PMT components on behavioural intention and/or its two types of appraisal (threat and coping) is analysed. In general, both stakeholder groups intended to adopt iodine biofortified foods. Regarding the main PMT constructs, this study lend support for the important role knowledge about nutritious foods and the health problem plays. Once again, self-efficacy turned out to be a strong determinant of behavioural intention among parents. Furthermore, response cost, a component that has been rarely included in PMT studies makes a significant contribution to the literature in terms of a clear negative effect on behavioural intention among school authorities. Besides, socio-demographic variables like age and gender influence the likelihood to adopt a behavioural change towards biofortified food consumption.

When looking at WTP estimates, participants were more responsive at a discount as compared to the premium offer prices, regardless of context in which biofortified foods would be used, i.e. as a part of school feeding programs or as a school/home meal. The factors that explained WTP at a discount price included gender, age, education, knowledge, perceived vulnerability, response efficacy, self-efficacy, behavioural intention with the highest required average discount of 39% while at a premium level only school/household size, age and response efficacy have a significant influence with 70% as the highest payable average premium. In this respect, a school feeding intervention based on iodine biofortified foods should strive to increase awareness of iodine, its association to deficiency disorders and self-efficacy among beneficiaries, while at the same time ensuring that the cost to be incurred by schools are not considered as a barrier for implementation. Although several factors have shown a considerable effect on the intention to adopt biofortified foods, further supporting the use of PMT models to evaluate reactions towards nutritious foods, it is crucial to further evaluate its external validity and the appropriateness of each of its items.

REFERENCES

Acham H, Kikafunda JK, Malde MK, et al. (2012) Breakfast, midday meals and academic achievement in rural primary schools in Uganda: implications for education and school health policy. *Food and Nutrition Research* 56.

Adesina AA and Zinnah MM. (1993) Technology characteristics, farmers perceptions and adoption decisions - A Tobit-model application in Sierra-Leone. *Agricultural Economics* 9: 297-311.

Ahmed AU. (2004) The Impact of Feeding Children in School: Evidence from Bangladesh. International Food Policy Research Institute, Washington, DC.

Allen LH. (2003) Interventions for micronutrient deficiency control in developing countries: Past, present and future. *Journal of Nutrition* 133: 3875S-3878S.

Andersson M, Karumbunathan V and Zimmermann MB. (2012) Global iodine status in 2011 and trends over the past decade. *Journal of Nutrition* 142: 744-750.

Avila-Burgos L, Ramirez-Valverde G, Martinez-Damian MA, et al. (2005) Socioeconomic determinants of inequality and self-reported morbidity among adolescents in a developing country. *Saudi Medical Journal* 26: 1617-1623.

Baban A and Craciun C. (2007) Changing health-risk behaviors: A review of theory and evidence-based interventions in health psychology. *Journal of Cognitive and Behavioral Psychotherapies* 7: 45-66.

Balistreri E, McClelland G, Poe G, et al. (2001) Can hypothetical questions reveal true values? A laboratory comparison of dichotomous choice and open-ended contingent values with auction values. *Environmental & Resource Economics* 18: 275-292.

Bimenya GS, Olico O, Kaviri D, et al. (2002) Monitoring the severity of iodine deficiency disorders in Uganda. *African Health Sciences* 2: 63-68.

Bishop RC and Heberlein TA. (1979) Measuring values of extra-market goods - are indirect measures biased. *American Journal of Agricultural Economics* 61: 926-930.

Blaine TW, Lichtkoppler FR, Jones KR, et al. (2005) An assessment of household willingness to pay for curbside recycling: A comparison of payment card and referendum approaches. *Journal of Environmental Management* 76: 15-22.

Bornkessel S, Broring S, Omta SWF, et al. (2014) What determines ingredient awareness of consumers? A study on ten functional food ingredients. *Food Quality and Preference* 32: 330-339.

Bouis HE. (2003) Micronutrient fortification of plants through plant breeding: can it improve nutrition in man at low cost? *Proceedings of the Nutrition Society* 62: 403-411.

Bouis HE, Hotz C, McClafferty B, et al. (2011) Biofortification: A new tool to reduce micronutrient malnutrition. *Food and Nutrition Bulletin* 32: S31-S40.

Braun R. (2002) People's concerns about biotechnology: some problems and some solutions. *Journal of Biotechnology* 98: 3-8.

Briefel RR, Wilson A and Gleason PM. (2009) Consumption of Low-Nutrient, Energy-Dense Foods and Beverages at School, Home, and Other Locations among School Lunch Participants and Nonparticipants. *Journal of the American Dietetic Association* 109: S79-S90.

Bundy D, Burbano C, Gelli A, et al. (2011) On the transition to sustainability: An analysis of the costs of school feeding compared with the costs of primary education. *Food and Nutrition Bulletin* 32: 201-205.

Bundy D, Burbano C, Grosh M, et al. (2009) What is school feeding? Rethinking School Feeding: Social Safety Nets, Child Development, and the Education Sector. The World Bank, Washington, DC.

Burgess-Champoux T, Marquart L, Vickers Z, et al. (2006) Perceptions of children, parents, and teachers regarding whole-grain foods, and implications for a school-based intervention. *Journal of Nutrition Education and Behavior* 38: 230-237.

Buxton C and Baguune B. (2012) Knowledge and practices of people in Bia District, Ghana, with regard to iodine deficiency disorders and intake of iodized salt. *Archives of Public Health* 70: 5.

Cameron KA. (2009) A practitioner's guide to persuasion: An overview of 15 selected persuasion theories, models and frameworks. *Patient Education and Counseling* 74: 309-317.

Cameron KA and DeJoy DM. (2006) The persuasive functions of warnings: theory and models. In: MS W (ed) *Handbook of warnings*. Mahwah, NJ: Lawrence Erlbaum Associates, 301-312.

Ch'ng JW and Glendon AI. (2013) Predicting sun protection behaviors using protection motivation variables. *Journal of Behavioural Medicine* 37: 245-56.

Cooke R and Sheeran P. (2004) Moderation of cognition-intention and cognition-behaviour relations: A meta-analysis of properties of variables from the theory of planned behaviour. *British Journal of Social Psychology* 43: 159-186.

Costa-Font M, Gil JM and Traill WB. (2008) Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. *Food Policy* 33: 99-111.

Cox DN and Bastiaans K. (2007) Understanding Australian consumers' perceptions of selenium and motivations to consume selenium enriched foods. *Food Quality and Preference* 18: 66-76.

Cox DN, Evans G and Lease HJ. (2008) Predictors of Australian consumers' intentions to consume conventional and novel sources of long-chain omega-3 fatty acids. *Public Health Nutrition* 11: 8-16.

Cox DN, Koster A and Russell CG. (2004) Predicting intentions to consume functional foods and supplements to offset memory loss using an adaptation of protection motivation theory. *Appetite* 43: 55-64.

Crawley H. (2005) *Eating Well at School – Nutritional and Practical Guidelines*, London: Caroline Walker Trust.

Cummings RJ and Taylor LO. (1999) Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method. *The American Economic Review* 89: 649-665.

De Groote H and Kimenju SC. (2008) Comparing consumer preferences for color and nutritional quality in maize: Application of a semi-double-bound logistic model on urban consumers in Kenya. *Food Policy* 33: 362-370.

De Moura SL. (2007) Determinants of food rejection amongst school children. *Appetite* 49: 716-719.

De Steur H, Gellynck X, Blancquaert D, et al. (2012a) Potential impact and cost-effectiveness of multi-biofortified rice in China. *New Biotechnology* 29: 432-442.

De Steur H, Gellynck X, Feng S, et al. (2012b) Determinants of willingness-to-pay for GM rice with health benefits in a high-risk region: Evidence from experimental auctions for folate biofortified rice in China. *Food Quality and Preference* 25: 87-94.

De Steur H, Gellynck X, Storozhenko S, et al. (2010) Health impact in China of folate-biofortified rice. *Nature Biotechnology* 28: 554-556.

Demont M, Rutsaert P, Ndour M, et al. (2013) Experimental auctions, collective induction and choice shift: willingness-to-pay for rice quality in Senegal. *European Review of Agricultural Economics* 40: 261-286.

Essuman A and Bosumtwi-Sam C. (2013) School feeding and educational access in rural Ghana: Is poor targeting and delivery limiting impact? *International Journal of Educational Development* 33: 253-262.

Farre G, Twyman RM, Zhu CF, et al. (2011) Nutritionally enhanced crops and food security: scientific achievements versus political expediency. *Current Opinion in Biotechnology* 22: 245-251.

Floyd DL, Prentice-Dunn S and Rogers RW. (2000) A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology* 30: 407-429.

Gelli A, Meir U and Espejo F. (2007) Does provision of food in school increase girls' enrollment? Evidence from schools in sub-Saharan Africa. *Food and Nutrition Bulletin* 28: 149-155.

Gomez-Galera S, Rojas E, Sudhakar D, et al. (2010) Critical evaluation of strategies for mineral fortification of staple food crops. *Transgenic Research* 19: 165-180.

Gonzalez C, Johnson N and Qaim M. (2009) Consumer Acceptance of Second-Generation GM Foods: The Case of Biofortified Cassava in the North-east of Brazil. *Journal of Agricultural Economics* 60: 604-624.

Greenhalgh T, Kristjansson E and Robinson V. (2007) Realist review to understand the efficacy of school feeding programmes. *British Medical Journal* 335: 858-861.

Gu C, Chan CWH, Twinn S, et al. (2012) The influence of knowledge and perception of the risk of cervical cancer on screening behavior in mainland Chinese women. *Psycho-Oncology* 21: 1299-1308.

Hansen J, Holm L, Frewer L, et al. (2003) Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. *Appetite* 41: 111-121.

Helmes AW. (2002) Application of the protection motivation theory to genetic testing for breast cancer risk. *Preventive Medicine* 35: 453-462.

Henson S, Blandon J, Cranfield J, et al. (2010a) Understanding the propensity of consumers to comply with dietary guidelines directed at heart health. *Appetite* 54: 52-61.

Henson S, Cranfield J and Herath D. (2010b) Understanding consumer receptivity towards foods and non-prescription pills containing phytosterols as a means to offset the risk of cardiovascular disease: an application of protection motivation theory. *International Journal of Consumer Studies* 34: 28-37.

Henson S, Masakure O and Cranfield J. (2008) The propensity for consumers to offset health risks through the use of functional foods and nutraceuticals: The case of lycopene. *Food Quality and Preference* 19: 395-406.

Hiddink GJ, Hautvast JG, Van Woerkum CM, et al. (1997) Consumers' expectations about nutrition guidance: the importance of primary care physicians. *Am J Clin Nutr* 65: 1974S-1979S.

Hirschi KD. (2009) Nutrient Biofortification of Food Crops. *Annual Review of Nutrition.* Palo Alto: Annual Reviews, 401-421.

Hodgkins S and Orbell S. (1998) Can protection motivation theory predict behaviour? A longitudinal test exploring the role of previous behaviour. *Psychology & Health* 13: 237-250.

Hotz C, Loechl C, Lubowa A, et al. (2012) Introduction of beta-carotene-rich orange sweet potato in rural Uganda resulted in increased vitamin A intakes among children and women and improved vitamin A status among children. *Journal of Nutrition* 142: 1871-1880.

Hu WY, Zhong FN and Ding YL. (2006) Actual media reports on GM foods and Chinese consumers' willingness to pay for GM soybean oil. *Journal of Agricultural and Resource Economics* 31: 376-390.

Huotilainen A, Pirttila-backman AM and Tuorila H. (2006) How innovativeness relates to social representation of new foods and to the willingness to try and use such foods. *Food Quality and Preference* 17: 353-361.

Jensen JD, Smed S, Morkbak MR, et al. (2013) Economic viability of new launched school lunch programmes. *British Food Journal* 115: 1038-1053.

Jomaa LH, McDonnell E and Probart C. (2011) School feeding programs in developing countries: impacts on children's health and educational outcomes. *Nutrition Reviews* 69: 83-98.

Jooste PL, Upson N and Charlton KE. (2005) Knowledge of iodine nutrition in the South African adult population. *Public Health Nutrition* 8: 382-386.

Khush G, Lee S, Cho JI, et al. (2012) Biofortification of crops for reducing malnutrition. *Plant Biotechnology Reports* 6: 195-202.

Kimenju SC and De Groote H. (2008) Consumer willingness to pay for genetically modified food in Kenya. *Agricultural Economics* 38: 35-46.

Kristjansson EA, Robinson V, Petticrew M, et al. (2007) School feeding for improving the physical and psychosocial health of disadvantaged elementary school children. *Cochrane Database Systematic Reviews*: CD004676.

Lauritsen JM and Bruus M. (2005) EpiData: A comprehensive tool for validated entry and documentation of data. 3.1 ed. The EpiData Association. Odense, Denmark.

Loureiro ML and Bugbee M. (2005) Enhanced GM foods: Are consumers ready to pay for the potential benefits of biotechnology? *Journal of Consumer Affairs* 39: 52-70.

Lowenstein LM, Perrin EM, Campbell MK, et al. (2013) Primary care providers' self-efficacy and outcome expectations for childhood obesity counseling. *Childhood Obesity* 9: 208-215.

Lyons GH, Stangoulis JCR and Graham RD. (2004) Exploiting micronutrient interaction to optimize biofortification programs: The case for inclusion of selenium and iodine in the HarvestPlus program. *Nutrition Reviews* 62: 247-252.

Mabaya E, Jordaan D, Malope P, et al. (2010) Attribute preferences and willingness to pay for fortified cereal foods in Botswana. *Agrekon* 49: 459-483.

Macharia-Mutie CW, Moreno-Londono AM, Brouwer ID, et al. (2009) Factors predicting the intention to consume grain amaranth enriched porridge in Makuyu division, Kenya. *Annals of Nutrition and Metabolism* 55: 433-433.

Maddux JE and Rogers RW. (1983) Protection motivation and self-efficacy - a revised theory of fear appeals and attitude-change. *Journal of Experimental Social Psychology* 19: 469-479.

Mai R and Hoffmann S. (2012) Taste lovers versus nutrition fact seekers: How health consciousness and self-efficacy determine the way consumers choose food products. *Journal of Consumer Behaviour* 11: 316-328.

Mallik AK, Anand K, Pandav CS, et al. (1998) Knowledge beliefs and practices regarding iodine deficiency disorders among the tribals in Car Nicobar. *Indian J Pediatr* 65: 115-120.

Mayer JE, Pfeiffer WH and Beyer P. (2008) Biofortified crops to alleviate micronutrient malnutrition. *Current Opinion in Plant Biology* 11: 166-170.

McEwan PJ. (2013) The impact of Chile's school feeding program on education outcomes. *Economics of Education Review* 32: 122-139.

McGuire S. (2013) WHO, World Food Programme, and International Fund for Agricultural Development. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO. *Advances in Nutrition* 4: 126-127.

McMackin E, Dean M, Woodside JV, et al. (2013) Whole grains and health: attitudes to whole grains against a prevailing background of increased marketing and promotion. *Public Health Nutrition* 16: 743-751.

Meenakshi JV, Banerji A, Manyong V, et al. (2012) Using a discrete choice experiment to elicit the demand for a nutritious food: Willingness-to-pay for orange maize in rural Zambia. *Journal of Health Economics* 31: 62-71.

Meenakshi JV, Johnson NL, Manyong VM, et al. (2010) How Cost-Effective is Biofortification in Combating Micronutrient Malnutrition? An Ex ante Assessment. *World Development* 38: 64-75.

Mehran L, Nazeri P, Delshad H, et al. (2012) Does a text messaging intervention improve knowledge, attitudes and practice regarding iodine deficiency and iodized salt consumption? *Public Health Nutrition* 15: 2320-2325.

Micronutrient-Initiative. (2009) Scaling Up Micronutrient Initiatives: What Works and What Needs More Work? The Innocenti Process. Washington DC: MI.

Milne S, Sheeran P and Orbell S. (2000) Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology* 30: 106-143.

Mina A, Favaloro EJ and Koutts J. (2011) Iodine Deficiency: Current Aspects and Future Prospects. *Labmedicine* 42: 744-746.

Mitchell RC and Carson RT. (1989) *Using surveys to value public goods: the contingent valuation method,* Washington, DC: Resources for the Future.

Mohapatra SSS, Bulliyya G, Kerketta AS, et al. (2001) Elimination of iodine deficiency disorders by 2000 and its bearing on the people in a district of Orissa, India: a knowledge-attitude-practices study. *Asia Pacific Journal of Clinical Nutrition* 10: 58-62.

Molster C, Samanek A, Bower C, et al. (2009) A survey of folate knowledge and consumer behaviours in Western Australia prior to the introduction of mandatory food fortification. *Australian and New Zealand Journal of Public Health* 33: 577-582.

Munro S, Lewin S, Swart T, et al. (2007) A review of health behaviour theories: how useful are these for developing interventions to promote long-term medication adherence for TB and HIV/AIDS? *Bmc Public Health* 7: 104.

Murphy SP, Gewa C, Grillenberger M, et al. (2007) Designing snacks to address micronutrient deficiencies in rural Kenyan schoolchildren. *Journal of Nutrition* 137: 1093-1096.

Neervoort F, von Rosenstiel I, Bongers K, et al. (2012) Effect of a School Feeding Programme on Nutritional Status and Anaemia in an Urban Slum: A Preliminary Evaluation in Kenya. *Journal of Tropical Pediatrics* 59:165-74.

Neumann CG. (2007) Symposium: food-based approaches to combating micronutrient deficiencies in children of developing countries. Background. *Journal of Nutrition* 137: 1091-1092.

Neumann CG, Murphy SP, Gewa C, et al. (2007) Meat supplementation improves growth, cognitive, and behavioral outcomes in Kenyan children. *Journal of Nutrition* 137: 1119-1123.

Neuwirth K, Dunwoody S and Griffin RJ. (2000) Protection motivation and risk communication. *Risk Analysis* 20: 721-734.

Nutrition CRSP. (1992) Feasibility and planning activity. Office of Nutrition Agency for International Development, Arlington, VA.

Omwami EM, Neumann C and Bwibo NO. (2011) Effects of a school feeding intervention on school attendance rates among elementary schoolchildren in rural Kenya. *Nutrition* 27: 188-193.

Pearce EN, Andersson M and Zimmermann MB. (2013) Global iodine nutrition: Where do we stand in 2013? *Thyroid* 23: 523-528.

Perez-Massot E, Banakar R, Gomez-Galera S, et al. (2013) The contribution of transgenic plants to better health through improved nutrition: opportunities and constraints. *Genes and Nutrition* 8: 29-41.

Pineda-Lucatero A, Avila-Jimenez L, Ramos-Hernandez RI, et al. (2008) Iodine deficiency and its association with intelligence quotient in schoolchildren from Colima, Mexico. *Public Health Nutrition* 11: 690-698.

Pounis GD, Makri S, Gougias L, et al. (2011) Consumer perception and use of iron fortified foods is associated with their knowledge and understanding of nutritional issues. *Food Quality and Preference* 22: 683-688.

Qian M, Wang D, Watkins WE, et al. (2005) The effects of iodine on intelligence in children: a meta-analysis of studies conducted in China. *Asia Pacific Journal of Clinical Nutrition* 14: 32-42.

Renner B, Kwon S, Yang BH, et al. (2008) Social-cognitive predictors of dietary behaviors in South Korean men and women. *International Journal of Behavioural Medicine* 15: 4-13.

Rodriguez E, Lacaze V and Lupin B. (2007) Willingness to pay for organic food in Argentina: Evidence from a consumer survey. In: Canavari M, Regazzi D and Spadoni R (eds) *International marketing and international trade of quality food products. 105th seminar of the European Association of Agricultural Economists.* Bologna, Italy., 187–213.

Rogers RW. (1975) Protection Motivation Theory of fear appeals and attitude-change. *Journal of Psychology* 91: 93-114.

Rogers RW and Prentice-Dunn S. (1997) Protection motivation theory In: Gochman DS (ed) *Handbook of Health Behavior Research.* New York: Plenum, 113–132.

Rowe KJ. (2006) The measurement of composite variables from multiple indicators: Applications in Quality Assurance and Accreditation Systems (Child Care). *Background paper for the National Childcare Accreditation Council.* VIC: Australian Council for Educational Research.

Russell CG and Worsley A. (2013) Why don't they like that? And can I do anything about it? The nature and correlates of parents' attributions and self-efficacy beliefs about preschool children's food preferences. *Appetite* 66: 34-43.

Scarpa R and Thiene M. (2011) Organic food choices and Protection Motivation Theory: Addressing the psychological sources of heterogeneity. *Food Quality and Preference* 22: 532-541.

Sondergaard HA and Edelenbos M. (2007) What parents prefer and children like - Investigating choice of vegetable-based food for children. *Food Quality and Preference* 18: 949-962.

StataCorp. (2011) Stata Statistical Software. 12 ed. StataCorp LP. College Station, TX.

Stein AJ, Meenakshi JV, Qaim M, et al. (2008) Potential impacts of iron biofortification in India. *Social Science & Medicine* 66: 1797-1808.

Stewart CP, Dewey KG and Ashorn P. (2010) The undernutrition epidemic: an urgent health priority. *Lancet* 375: 282.

Talsma EF, Melse-Boonstra A, de Kok BPH, et al. (2013) Biofortified Cassava with Pro-Vitamin A Is Sensory and Culturally Acceptable for Consumption by Primary School Children in Kenya. *Plos One* 8.

UBOS. (2002) Uganda population and housing census - Kisoro district. In: Uganda Bureau of Statistics (ed). Kampala.

UN. (2000) Declaration of Millenium Development Goals: United Nations Resolution. United Nations.

Van Dillen SM, Hiddink GJ, Koelen MA, et al. (2004) Perceived relevance and information needs regarding food topics and preferred information sources among Dutch adults: results of a quantitative consumer study. *European Journal of Clinical Nutrition* 58: 1306-1313.

Van Dillen SME, Hiddink GJ, Koelen MA, et al. (2008) Exploration of possible correlates of nutrition awareness and the relationship with nutrition-related behaviours: results of a consumer study. *Public Health Nutrition* 11: 478-485.

Van Jaarsveld PJ, Faber M, Tanumihardjo SA, et al. (2005) beta-Carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *American Journal of Clinical Nutrition* 81: 1080-1087.

Van Stuijvenberg ME, Kvalsvig JD, Faber M, et al. (1999) Effect of iron-, iodine-, and beta-carotene-fortified biscuits on the micronutrient status of primary school children: a randomized controlled trial. *American Journal of Clinical Nutrition* 69: 497-503.

Van Tra P, Moritaka M and Fukuda S. (2011) Factors Affecting Consumers' Willingness to Pay for Functional Foods in Vietnam. *Journal of the Faculty of Agriculture Kyushu University* 56: 425-429.

Verbeke W. (2005) Consumer acceptance of functional foods: socio-demographic, cognitive and attitudinal determinants. *Food Quality and Preference* 16: 45-57.

Verbeke W. (2010) Consumer reactions to foods with nutrition and health claims. *Agro Food Industry Hi-Tech* 21: 5-8.

Verbeke W, Scholderer J and Lahteenmaki L. (2009) Consumer appeal of nutrition and health claims in three existing product concepts. *Appetite* 52: 684-692.

Ward PR, Henderson J, Coveney J, et al. (2012) How do South Australian consumers negotiate and respond to information in the media about food and nutrition? The importance of risk, trust and uncertainty. *Journal of Sociology* 48: 23-41.

Whaley SE, Sigman M, Neumann C, et al. (2003) The impact of dietary intervention on the cognitive development of Kenyan school children. *Journal of Nutrition* 133: 3965S-3971S.

WHO. (2006) WHO Global Database on Iodine Deficiency. World Health Organization, Geneva.

Wolfe R and Gould W. (1998) An approximate likelihood-ratio test for ordinal response models. *Stata Technical Bulletin* 42: 24-27.

Wurtele SK and Maddux JE. (1987) Relative contributions of Protection Motivation Theory components in predicting exercise intentions and behavior. *Health Psychology* 6: 453-466.

Yadav S, Gupta SK, Godbole MM, et al. (2010) Persistence of severe iodine-deficiency disorders despite universal salt iodization in an iodine-deficient area in northern India. *Public Health Nutrition* 13: 424-429.

Yuan DW, Bassie L, Sabalza M, et al. (2011) The potential impact of plant biotechnology on the Millennium Development Goals. *Plant Cell Reports* 30: 249-265.

Zhao FJ and Shewry PR. (2011) Recent developments in modifying crops and agronomic practice to improve human health. *Food Policy* 36: S94-S101.

Zhu C, Naqvi S, Gomez-Galera S, et al. (2007) Transgenic strategies for the nutritional enhancement of plants. *Trends in Plant Science* 12: 548-555.

Zimmermann MB and Andersson M. (2012) Update on iodine status worldwide. *Current Opinion in Endocrinology Diabetes and Obesity* 19: 382-387.

Zimmermann MB, Connolly K, Bozo M, et al. (2006) Iodine supplementation improves cognition in iodine-deficient schoolchildren in Albania: a randomized, controlled, double-blind study. *American Journal of Clinical Nutrition* 83: 108-114.

Zimmermann MB, Jooste PL and Pandav CS. (2008) Iodine-deficiency disorders. *Lancet* 372: 1251-1262.