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Farmers' multidimensional beliefs in orange-fleshed sweetpotato acceptance among rural households in Uganda

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ABSTRACT

This study sought to assess the role of multi-dimensional beliefs in acceptance of orange-fleshed sweetpotato (OFSP) as an important food for fighting micronutrient deficiencies among rural households in Uganda. Cross-sectional survey data gathered from 341 randomly selected household heads drawn from two districts were analyzed using one-way ANOVA. Post hoc tests indicate that multi-dimensional beliefs (resilience in the field (MD=0.442, p<.05), dry matter content (MD=0.90, p<.05) and control over timely access to labor (MD=0.45, p<.05) significantly enhanced farmers' decisions to try OFSP cultivation. From trial to sustained cultivation, actions of peers (MD=1.57, p<.001); and control over timely access to labor, (MD=0.55, p<.05), availability of OFSP vines (MD=0.88, p<.001) and control over access to other OFSP farmers (MD=0.63, p<.001) revealed to be important variables. The results also suggest that multi-dimensional beliefs (actions of peers, (MD=1.17, p<.001), approval of peers (MD=1.00, p<.001), control over access to OFSP vines (MD=0.67, p<.001) and control over access to other OFSP farmers (MD=0.70, p<.01)), are vital in supporting farmers to maintain their decisions to cultivate OFSP. We conclude that farmers' multi-dimensional beliefs are important in the cultivation of OFSP, and farmers' advancement along each acceptance stage demands for different sets of beliefs. It is recommended that promotion efforts for OFSP and related crop enterprises pay attention to decision-makers' beliefs.

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Introduction

Micronutrient deficiency is a major public health burden in sub-Saharan Africa (FAO *et al.*, 2017). These deficiencies are primarily due to consumption of food that is low in micronutrients. For Uganda, annual losses to vitamin A, Iodine, Zinc and Iron deficiencies are estimated at US$145 million (World Bank, 2011). Vitamin A, in particular, is a vital nutrient for maternal health and child survival, and its deficiency leads to acquired blindness, compromised body immunity and increased mortality among affected groups (WHO, 2009). In 2016, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations endorsed improving micronutrient content of staple crops as a strategic approach to combating nutritional deficiencies in developing countries (Garcia-Casal *et al.*, 2017). Among the target staples is the orange-fleshed sweetpotato (OFSP) which is enriched with ß-carotene, a precursor to vitamin A (Low *et al.*, 2017). Several studies suggest that OFSP potentially

could alter vitamin A deficiency (VAD) prevalence in affected communities (Sharma *et al.,* 2016; Low *et al.,* 2017). In Uganda, numerous initiatives have been implemented to deliver OFSP in rural areas where VAD is rampant (Wirth *et al.,* 2017). Given that the target areas primarily are ones where the energy-dense white fleshed sweetpotato is a major staple, the favored promotional strategies aim to support households that already produce and consume white fleshed sweetpotato switch to OFSP (Asare-marfo *et al.,* 2013).

Several behavioral models present behavioral decision outcomes to originate from individuals' evaluation of the balance of costs and benefits nested in a new behavior, which is termed as the decisional balance (Jensen et al., 2012). Beliefs are behind the cognitive mechanisms (e.g. attitudes, norms, self-efficacy) influencing intention formation, which are behind behavioral change (Ajzen, 2015). Jensen *et al.* (2012) observe that if the decisional balance involves habitual behavior, good intentions may not be sufficiently powerful to change behavior because people tend to be unaware of decisions they make when it comes to habitual behaviors. Breaking these automatically cued behavior patterns thus needs actions that either make people more aware of their behaviors or to interrupt their beliefs that formed the habitual patterns (Mackie *et al.,* 2015). Some decisional balances may be strongly linked to affective and emotional responses. For example in the case of VAD, decision-makers' beliefs about VAD as a health risk to their children or spouse may be associated with fear, which impacts on their behavioral patterns (Jensen *et al.* 2012). Literature arguably shows smallholder's beliefs to be multidimensional; where the acceptance of a single new idea is linked to several unrelated beliefs whose contribution to decisional balance compliment, supplement or compete with each other within the farmers' decisional system (Shikuku *et al.,* 2019). Sometimes a farmer may ignore a given belief within their belief system in order to finalize a given decision outcome (Rogers, 1983).

Rogers's (1983) influential work observed that change agents must be familiar with their clients' beliefs, if programs of change are to attain desired outcomes. Several studies (e.g. Wang *et al.,* 2009; Fanou-fogny *et al.,* 2011) have found farmers' acceptance of new technologies to be affected by their beliefs. Existing studies on the topic are either descriptive or focus on predicting behavioral intention (e.g. Yanggen and Nagujja, 2006; Shikuku *et al.,* 2019) with little emphasis on how changed behavior can be maintained. Talsma *et al.* (2013) for example examined sensory and cultural acceptability antecedents for intentions to consume vitamin A rich cassava among a sample of 30 children (7–12 yr) and 30 caretakers (18–45 yr) in primary schools in eastern Kenya and concluded that consumption and health-related beliefs are strong predictors. However, little is known about the role of beliefs in OFSP acceptance decisions among smallholder farmers in Uganda. Valuable insights could be revealed by focusing on the role of smallholder farmers' multi-dimensional beliefs in OFSP cultivation decisions. Therefore, this study assesses the multi-dimensional beliefs of rural household decision-makers, in a sample of OFSP adopting households, regarding their decision to grow OFSP. In doing so, this study seeks to develop belief-based characterization of OFSP acceptance in order to guide variety delivery efforts.

Conceptual Framework

Acceptance of new technologies is probably better explored, when seen as a process, rather than as a binary outcome (where an individual is deemed to either accept or reject a new behavior). To that end, Prochaska and DiClemente's (1982) offer the stages of change (SoC) model. From a SoC perspective, acceptance behavior may be viewed as a five-stage process involving pre-contemplation, contemplation, preparation, action, and maintenance, as pseudo-stages representing a single acceptance process. Pre-contemplation and contemplation are deemed as the first stage

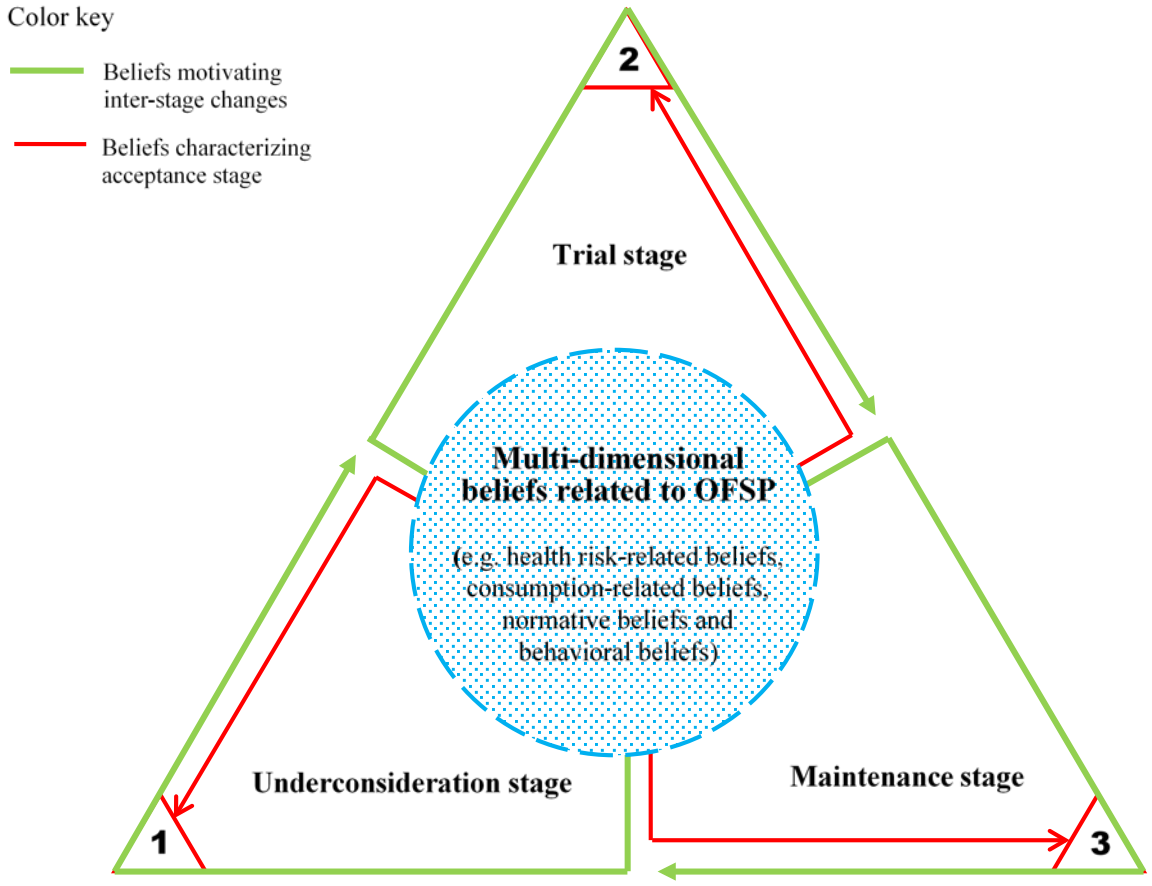

Figure 1. The study conceptual framework, three pseudo-staged acceptance process.

Table 1. Sample seven-point Likert scale used to assess multi-dimensional beliefs

Dimension	Sample belief	Sample statement (rank 1 to 7)
Production	Vine accessibility	It is easier to access orange-fleshed sweetpotato vines than the vines for white sweetpotato
Consumption	Preference	The colour of orange-fleshed sweetpotato is preferred by a) children and b) adults in my household than that of white sweetpotato.
Market	Marketability of surplus	It is easier to sale surplus orange sweetpotato than it is for white sweetpotato
Health beliefs	Susceptibility to VAD	How likely is: a) the first, b) second, c) third and d) fourth youngest, e) female and d) male decision-maker member in the household to contract VAD
	Severity of VAD	If the first youngest household member contracted VAD, how likely is it to affect: a) general emotional feelings of members, b) expenditure of household, c) mobility of member outside household and d) income of your household
	Health benefits	Orange-fleshed sweetpotato is more healthier than white sweetpotato
Behavioral beliefs (Attitude)	Evaluative	It is extremely valuable to grow orange-fleshed sweetpotato than the white sweetpotato
	General	It is generally a good idea to grow orange-fleshed sweetpotato than the white sweetpotato
	Affective	It is expectantly enjoyable to grow orange-fleshed sweetpotato than white sweetpotato
Normative	Other's actions	Members of my farming group grow orange-fleshed sweetpotato than the white sweetpotato
	Others' approvals	Members of my farming group approve that I grow white fleshed sweetpotato than the orange-fleshed sweetpotato
Control beliefs	Labour	I easily have access to labour needed to grow orange-fleshed sweetpotato than the white sweetpotato

(matching behavioral intentionality) because a person mentally applies a new idea to his or her present or expected future state before deciding whether or not to try it (Rogers, 1983). Preparation and action relate to trial activities, in which one experiments with the new idea before deciding to maintain it (Vet *et al.,* 2007). Therefore, this study adopted a three-staged SoC-based (acceptance) dependent variable, which starts with 'underconsideration', through 'trial' and finishes in the 'maintenance' stage (Fig. 1).

Decisions to transition and relapse between the stages can be argued to be motivated by decision-makers calculations, which are themselves intermediary to the beliefs they hold (Rogers, 1983). Besides, bio-fortified foods could potentially be affected by several multidimensional beliefs (related to health-risk and production, marketing and consumption of OFSP and farmers' normative, control-related and behavioral beliefs) due to their health and nutrition role (Shikuku *et al.,* 2019). For example, three health related beliefs affect behavior: 1) the perceived likelihood to contract a health condition (susceptibility); 2) feelings concerning the seriousness of health conditions if contracted (severity); and 3) feelings concerning the benefits or barriers associated with the proposed intervention (appropriateness of intervention) (Rosenstock, 1974). Jensen *et al.* (2012) indicate that a decision-maker who perceives a health risk to their children or spouse, are likely to make decisions based on fear. Smallholder farmers' decisions regarding the production, consumption and marketing of staple foods have been found to be inseparable (Graeub *et al.,* 2016). The appropriateness of bio-fortified crops as a VAD intervention could, thus, be affected by farmers' beliefs about the crops' ability to match production, consumption and marketing needs. At the same time, Ajzen and Sheikh (2013) suggest that behavior changes (such as changing from white fleshed sweetpotato to OFSP) can be affected by whether individuals: 1) perceive nearby peers to approve of or carry out themselves the new behavior (normative beliefs); 2) perceive to have control over required assets for them to engage in the behavior and; 3) evaluate being involved in the new behavior positively or not (behavioral beliefs). A decision-maker could believe that it is important to implement a certain intervention, but remain holding negative beliefs about the intervention; thus doubting whether the intervention actually works, on the other hand. This study assumes that multi-dimensional beliefs explain farmers' iterative changing from one stage to another (Fig. 1).

Methods

Study area and sample

Two hundred (200) main household decision-makers representing 100 randomly selected households participated in the study. The participants were selected to represent decision-makers in central and eastern Uganda covered by the "Developing and Delivering Bio-fortified Crops" (DDBC) project, which reached 409,711 rural households between 2012 and 2016. Central Uganda was at the lower end of the VAD incidence continuum while the eastern was at the high end (Uganda Bureau of Statistics, 2011).

Variable measurement and data collection

The scale for the dependent variable was adapted from the original SoC questionnaire (Prochaska and DiClemente, 1982). The three-staged acceptance process was thus assessed using a five-point scale. Point 1, *not growing OFSP right now* and point 2, *thinking about starting to grow OFSP*, were both deemed as part of *underconsideration stage.* Point 3, *making some preparation to grow OFSP* and point 4, *been growing OFSP in the last six months* were considered under *trial stage* whereas point 5, *been growing OFSP for more than six months* was considered under the *maintenance stage*, as suggested by Vet *et al.* (2007). The merger of the scale was done during data analysis, to enable an

accurate collection of information on acceptance behavior at data collection level.

The explanatory variables of interest were farmers' multi-dimensional beliefs (related to health-risk and production, marketing and consumption of OFSP and the normative, control over production assets and behavioral beliefs of decision-makers), which were assessed using a seven-point Likert scale (of ascending level of importance). The scale ranged from 1 to 7, and farmers were asked to rate how closely each scale item described their beliefs via assigning a score between one (lowest score) and seven (highest score). The items were adapted from previous studies (Ajzen, 2013; Mackie *et al.,* 2015; Shikuku *et al.,* 2019). Under health, the beliefs assessed included: VAD susceptibility and seriousness (for the four youngest children and decision-makers). Production-related beliefs (ease of vine access, vine preservation, resilience in the field [to diseases, weeds, pests and timing of planting], yields, tuber size and maturity period), consumption-related beliefs (preference in household, piecemeal harvesting, dry matter content and fibers in cooked tubers) and marketability of surplus OFSP storage root tubers, were used to evaluate the beliefs associated with appropriateness of OFSP as a VAD interventions. Under behavioral beliefs, beliefs assessed included: evaluative, general and affective beliefs while under normative beliefs, actions and approval of nearby peers (important others) to grow OFSP were assessed. Lastly, under behavioral control, the beliefs assessed included: control over labor; control over vine access and control over access to other OFSP cultivating farmers. To avoid scale answering bias, positive and negative statements were used in the instrument. Sample scale items and the belief variables considered under each dimension are provided in Table 1.

A panel of three experts, two senior academics at Makerere University and one nutritional consultant at HarvestPlus, checked the survey instrument for content validity. Before it was used, the instrument was further pre-tested for reliability on 16 households in Nsambya village in Rakai district, one of the areas that joined DDBC project in 2012. The village was selected for its fairly physically isolated location from the study sub-counties to avoid contaminating the main sample. Pre-test interviewing and respondent answering experiences informed the minor changes that were made in question wording and sequencing to improve the clarity of the instrument. The instrument was administered by trained interviewers in native languages, because the respondents lived in areas with known high illiteracy prevalence. All the respondents were verbally informed of the study's purpose and their rights. They were further assured that the information they shared was to be treated with confidentiality throughout the process of the study.

Data analysis

The data analysis was done in three steps using the Statistical Package for Social Scientists (SPSS) version 16. First, descriptive statistics (frequencies and percentages) were generated for social demographics and acceptance stages. Second, one-way ANOVA was performed to obtain the mean scores and to test for the significance of mean score differences in farmers' beliefs for the three acceptance stages. Third, post hoc tests were done to locate the source of mean differences, revealed in one-way ANOVA as suggested by Field (2009).

Results

Table 2 presents the proportional distributions of measures of socio-demographic characteristics, and the dependent variable.

Tables 3 and 4 show the results of a one-way ANOVA that was conducted to compare the effect of multi-dimensional beliefs on acceptance of OFSP (Fig. 1).

Table 2. Numbers of cases and percentage distributions of social demographics

Variable	Number of cases	%	Variable	Number of cases	%
Dietary priority of sweetpotato			*Gender of decision-maker*		
First	266	78			
Second	23	7	Female	187	55
Third or higher	52	15	Male	154	45
Highest educational attainment of decision-makers			*Average monthly income (USD) of decision-makers*		
None	24	7	<37.3	141	41
Primary	226	66	37.3– 60	59	17
Secondary	69	21	60.1 – 90	44	13
Post-secondary	21	6	>90	97	28

Multi-dimensional beliefs in acceptance decisions

Production-related beliefs

This study hypothesized that OFSP production-related beliefs are associated with farmers' changing from one stage of the acceptance process to another. The study reveals production-related beliefs to influence farmers' acceptance of OFSP but advancement from one stage to another is associated with a different set of production-related beliefs. As shown in table 3, among the production-related beliefs, ease of access to OFSP vines (F=13.7, p<.001, d.f=2, 338), ease of vine preservation (F=6.72, p<.01, d.f=2, 338), resilience in the field (F=2.95, <.05, d.f=2, 338), tuber size (F=5.00, p<.01, d.f=2, 338) and early maturity (F=3.61, p<.05, d.f=2, 338) were positively associated with the acceptance of OFSP. However, Post hoc comparisons using the Bonferroni test indicated that the significance of the mean scores differed by inter-stage transitions (Table 4). There was a significant mean difference for OFSP resilience in the field among farmers in 'underconsideration' stage compared to these in 'trial' stage (MD=0.442, p<.05), but the difference was not significant for the transition between 'trial' and 'maintenance' as well as 'underconsideration' and 'maintenance' stages. On the other hand, vine access only significantly differed in the transition between 'trial' and 'maintenance' (MD=0.70, p<.05) and 'underconsideration' and 'maintenance' (MD=0.95, p<.05) stages. Tuber size beliefs only significantly differed in transitions between 'trial' and 'maintenance' (MD=0.50, p<.05) stages whereas vine preservation beliefs only significantly differed in transitions between 'underconsideration' and 'maintenance' (MD=0.80, p<.05) stages. Post hoc tests did not reveal early maturity belief to be significantly linked to acceptance of OFSP (as earlier revealed by ANOVA analysis Table 3).

Consumption-market-related beliefs

This study hypothesized that OFSP consumption and market-related beliefs are associated with farmers' changing from one stage of the acceptance process to another. The study reveals consumption and market-related beliefs associated with OFSP acceptance, although changing from one stage to another require a different set of beliefs. OFSP preference in a household (F=4.03, p<.05, d.f=2, 338) and dry matter content (F=6.45, p<.01, d.f=2, 338) were positively and significantly associated with OFSP acceptance. However, Post hoc comparisons indicated that significance of the mean scores differed by inter-stage transitions (Table 4). The mean score of OFSP preference were only significantly different in the transitions between 'underconsideration' and 'maintenance' stages (MD=0.33, p<.05). For dry matter content, significant means were observed with transition between 'underconsideration' and 'trial' stages (MD=0.90, p<.05) as well as between 'underconsideration' and 'maintenance' stages

Table 3. Mean differences for the effect of multi-dimensional beliefs on acceptance of OFSP

Multi-dimensional beliefs		**Mean score**						
Dimension	**Beliefs**	**Stage 1 (N=40)**	**SD**	**Stage 2 (N=63)**	**SD**	**Stage 3 (N=238)**	**SD**	**F-vlaue**
Production	Ease vine access	1.75	0.95	2.00	0.82	2.70	1.45	**13.7*** **
	Vine preservation	2.69	1.47	2.98	1.30	3.49	1.53	**6.72** **
	Resilience in field	2.56	0.97	3.00	0.97	2.84	0.87	**2.95***
	Yield size	3.42	1.14	3.56	0.83	3.69	0.84	1.93
	Tuber size	4.73	1.55	4.98	1.00	5.23	0.89	**5.00** **
	Early maturity	5.01	1.32	5.00	0.85	5.29	0.84	**3.61***
Consumption	Piecemeal duration	3.88	1.79	4.06	1.34	4.19	1.46	0.775
	OFSP preference	2.85	0.60	3.11	0.69	3.18	0.69	**4.03***
	Dry matter content	2.85	1.64	3.75	1.55	3.71	1.38	**6.45** **
	Health benefits	5.36	0.92	5.44	0.94	5.40	0.85	0.115
	Fiber content	4.15	1.56	4.48	1.25	4.05	1.42	2.28
Market	Marketability	3.17	0.95	3.28	0.76	3.48	0.82	**3.18***
VAD risk	Susceptible (decision-makers)	3.01	1.69	2.70	1.45	2.76	1.58	0.54
	Susceptible (children)	4.21	0.98	4.60	1.16	4.07	1.39	**4.16***
	Serious (decision-maker)	5.85	0.89	5.96	0.92	5.95	0.82	0.25
	Serious (children)	4.64	0.93	4.09	1.18	3.97	1.18	**5.75** **
Attitude	General	4.55	1.45	4.56	1.23	4.95	0.97	**4.80** **
	Affective	4.90	1.28	4.90	1.08	5.11	0.83	1.82
	Evaluative	5.30	1.07	4.99	1.17	5.19	0.82	1.64
Social	Others' action	1.55	0.81	1.94	1.04	3.12	1.36	**41.37*** **
	Other approval	2.98	1.66	3.57	1.68	3.57	1.45	**7.53** **
Control	Timely labor	2.46	1.57	2.90	1.28	3.01	1.16	**3.38***
	Access vines	1.45	0.83	1.58	0.93	2.24	1.30	**13.19*** **
	Access other farmers	1.45	0.78	1.52	0.67	2.15	1.25	**12.73*** **

* P < 0.05, ** P < 0.01 and *** P < 0.001

(MD=0.86, p<.05) but not between 'trial' and maintenance stages. The post hoc test, however, did not reveal marketability of surplus tubers as an important belief in OFSP acceptance (Table 3).

Risk-related beliefs

This study hypothesized that VAD risk-related beliefs are associated with farmers' changing from one stage of the acceptance process to another.

Table 4. Mean differences for the effect of multi-dimensional beliefs on acceptance of OFSP

Multi-dimensional beliefs		Inter-stage Mean difference and significance		
Dimension	Beliefs	Stage1—>2	Stage2—>3	Stage1—>3
Production	Ease vine access	0.25	**0.70***	**0.95***
	Vine preservation	0.30	0.50	**0.80***
	Resilience in field	**0.442***	-0.166	0.276
	Tuber size	0.26	**0.50***	0.24
	Early maturity	-0.01	0.29	0.28
Consumption	OFSP preference	0.26	0.07	**0.33***
	Dry matter content	**0.90***	-0.04	**0.86***
Market	Marketability of excess	0.12	0.19	0.30
VAD risk	Susceptible (decision-makers)			
	Susceptible (children)	0.40	**-0.54***	-0.14
	Serious (decision-maker)			
	Serious (children)	-0.55	**-0.67****	-0.12
Attitude	General	0.01	**0.39***	0.40
Social	Others' action	0.39	**1.57*****	**1.17*****
	Other approval	0.60	0.36	**1.00****
Control	Timely labor	**0.45***	**0.55***	0.10
	Access vines	0.13	**0.80*****	**0.67*****
	Access other farmers	0.07	**0.63*****	**0.70****

* P < 0.05, ** P < 0.01 and *** P < 0.001

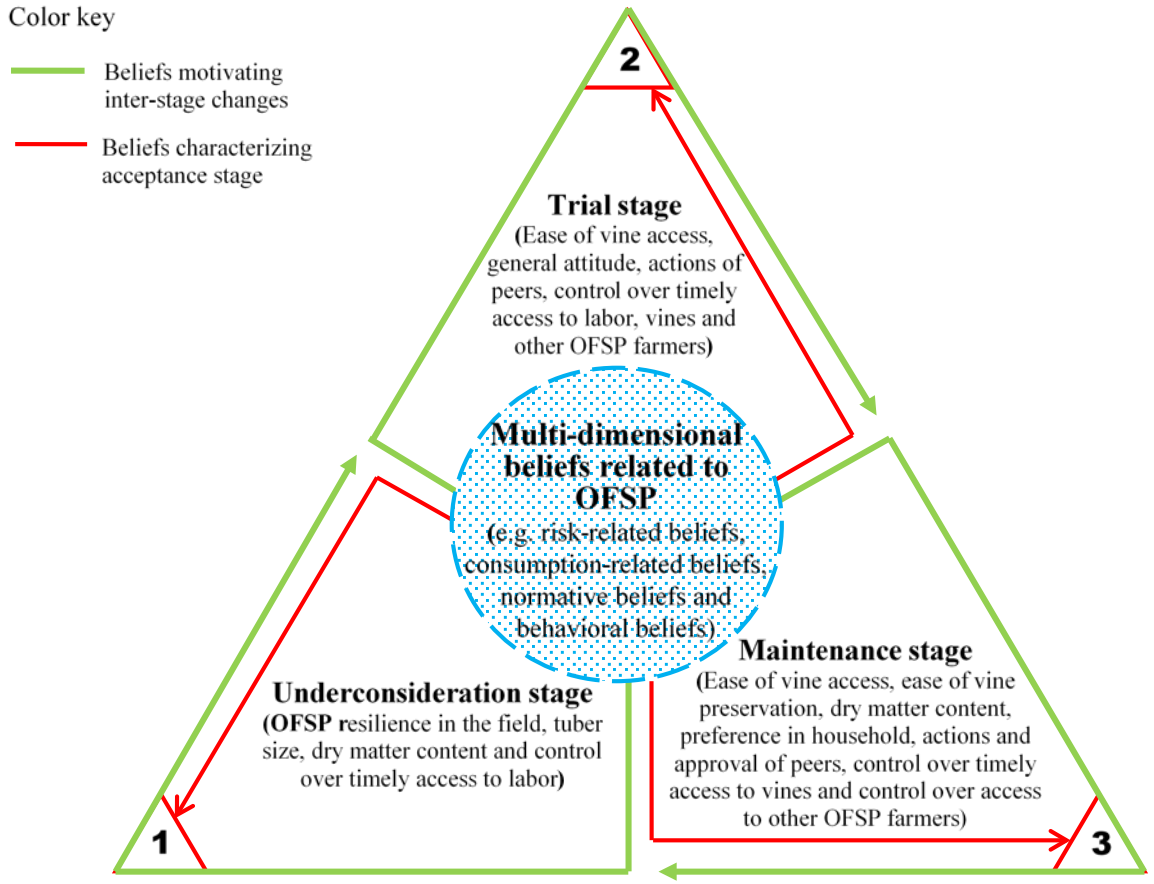

Figure 2. The study empirical association between multidimensional beliefs and acceptance

The study reveals risk-related beliefs (susceptibility to VAD: F=4.16, p<.05, d.f=2, 338 and seriousness of VAD: F=5.75, p<.01, d.f=2, 338 among children within the household) to be negatively and significantly related with OFSP acceptance. Post hoc comparisons, however, indicated the mean score difference for both of these beliefs, that is, susceptibility (MD=-0.54, p<.05) and seriousness (MD=-0.67, p<.01), to only significantly differ with transitions from 'trial' to maintenance stage and not any other transition.

Behavioral related beliefs

This study hypothesized that behavioral-related beliefs are associated with farmers' changing from one stage of the acceptance process to another, which this study confirms. However, among the behavioral beliefs, it was the mean score of general attitudinal belief that was found to be significantly and positively associated with OFSP acceptance (F=4.80, p<.01, d.f=2, 338). The mean scores of general attitude, significantly differed on transition from 'trial' to 'maintenance' (MD=0.39, p<.05) and not any other transition.

Normative related beliefs

This study had hypothesized normative-related beliefs to be associated with farmers' changing from one stage of OFSP acceptance to another, which is confirmed to be true. Beliefs about actions and approval of peers (F=41.37, p<.001, d.f=2, 338; F=7.53, p<.001, d.f=2, 338 respectively) regarding OFSP cultivation were significantly and positively associated with OFSP acceptance. The mean scores of beliefs about the action of nearby peers, significantly differed on transition from 'trial' to 'maintenance' (MD=1.57, p<.001) and from 'underconsideration' to 'maintenance' stages (MD=1.17, p<.001) but not between 'underconsideration' and 'trial' stages. Similarly, mean scores of beliefs about approval of important others significantly differed only for transition from 'underconsideration' to 'maintenance' stages (MD=1.00, p<.001), but not any other transitions.

Control-related beliefs

Lastly, it was hypothesized in this study that control-related beliefs are associated with farmers' changing from one stage of OFSP acceptance to another, which the results reveal to be true. However, advancement from one stage to another is found to be associated with a different set of control-related beliefs. Specifically, belief about control over timely access to labor (F=3.38, p<.05, d.f=2, 338), access to OFSP vines (F=13.19, p<.001, d.f=2, 338) and access to other OFSP farmers (F=12.73, p<.001, d.f=2, 338) were linked to OFSP acceptance. However, Post hoc comparisons indicated that significance of the mean scores differed by inter-stage transitions (Table 4). Control over timely access to labor, only significantly related with transition from 'underconsideration' and 'trial' (MD=0.45, p<.05) and 'trial' to 'maintenance' stages (MD=0.55, p<.05). Control belief over access to OFSP vines was associated with transition from 'trial' to 'maintenance' (MD=0.88, p<.001) and 'underconsideration' to 'maintenance' stages (MD=0.67, p<.001). Similarly, control belief over access to other OFSP farmers was associated with transition from 'trial' to 'maintenance' (MD=0.63, p<.001) and 'underconsideration' to 'maintenance' stages (MD=0.70, p<.01).

Discussion

This study was designed to assess whether any multi-dimensional beliefs characterize OFSP acceptance in Uganda. The study presents a case of bio-fortified orange sweetpotato to protect rural households from vitamin A deficiency related health challenges. Although, attempts have been made to understand the probable factors that would promote the delivery of bio-fortified crops such as OFSP among VAD affected communities in developing countries, very few studies have demonstrated the

link and significance of beliefs in the acceptance of these new varieties. This study aimed to fill this knowledge gap. An assessment of the association between a set of multidimensional beliefs (in the domain of production, consumption, marketing, risk, behavioral, normative and control over production assets) and acceptance of OFSP reveals beliefs to be vital in the acceptance of OFSP (Fig. 2). Unlike previous studies that conceptualized acceptance in terms of likelihood to grow (e.g. Shikuku *et al.,* 2019) and willing-to-pay for the new varieties (e.g. Mogendi *et al.,* 2016), the present study examined acceptance in terms of pseudo-stages that start from underconsideration through trial to maintaining decisions to grow OFSP beyond six months.

The findings of the present study reveal farmers' changing from underconsideration to trial stage to be associated with their beliefs about resilience in the fields, storage tuber size and dry matter content as well as control over timely access to labor. These findings are consistent with several previous studies (e.g. de Brauw *et al.,* 2015; Shikuku *et al.,* 2019) that suggest that production-related beliefs influence the acceptance of bio-fortified varieties. Shikuku *et al.* also established that yielding ability, sweetness, disease-resistance, storability and early maturity were linked to farmers' likelihood to cultivation of OFSP varieties. Contrary to the findings from an exploratory descriptive study conducted in Uganda by Yanggen and Nagujja (2006), beliefs about marketability of surplus roots were not found to be associated to farmers' decision to grow OFSP. UBOS and MAAIF (2010) observe that farmers in Uganda grow sweetpotato to primarily fulfill household food demands, which probably explains why market-related beliefs had insignificant linkages to acceptance of OFSP among Ugandan farmers. Similarly, early maturity was not found to be a vital belief for OFSP acceptance in this study as earlier observed in Shikuku *et al*. (2019). Shikuku *et al.*'s study, however, examined acceptance in terms of farmers' likelihood to cultivate OFSP vines and it was conducted among sweetpotato farming households in Tanzania's Lake Victoria region.

In order for farmers to change from trial cultivation of OFSP to maintaining their decisions, control over production assets (i.e. timely access to: vines, labor and other OFSP farmers) were revealed to be important beliefs. The results corroborate previous studies (e..g. Surmann *et al.,* 2017; Wallston, 2015) that indicate that for an individual to accept a new idea, he or she, among other things, must have a belief that the tasks associated with acceptance are manageable. Similarly, Hummel et al. (2018) revealed that social pressure and the feelings decision makers have about the behavior to be the best predictors of caretakers' behavior to prepare OFSP for their child in a study conduct in central and southern Malawi among 270 adults and 60 children. This study, similarly finds beliefs about actions of peers and general attitude beliefs to be associated with changing from trial to maintenance stage. This implies that farmers who have a positive general attitude about OFSP and also believe that nearby peers are also growing OFSPs will most likely advance from trail stage to maintenance stage. The results echo the conclusion of several studies (e.g. Rogers, 1983; Wani and Ali, 2015) which suggest that the individual's attitudes about a new idea tell us whether he or she would accept the innovation. In other words, consideration of a new idea does not go beyond the knowledge function if someone does not define the information as relevant to his or her situation. However, in this study general feelings about OFSP was neither linked with changing from underconsideration to trial nor from underconsideration to maintenance, which is in line with Rogers's observation that attitude has no influence on technology acceptance in early stages of the new idea acceptance process. Consistent with Yanggen and Nagujja (2006) who described the acceptance of OFSP to be linked to vine access, this study found farmers' beliefs about the ease of access to vines to be associated with changing from trial cultivation of OFSP to maintaining their behavior. The change from underconsideration to trial stages

was not associated with vine access, probably because this stage has been largely accompanied with vine push policy from change agents. Yanggen and Nagujja also conceptualized acceptance differently (in terms of proportion of mound of the total sweetpotato garden).

Unexpectedly, results from the present study suggest that farmers' decisions to change from trial to sustained OFSP cultivation is also associated with negative beliefs about susceptibility to, as well as seriousness of VAD in children. This implies that farmers who think that VAD is a serious condition to which their children are likely to suffer are the ones not likely to cultivate OFSP (which offers a remedy to VAD itself). This finding corroborate other studies (e.g. Sun *et al.*, 2006) that observed a negative relationship of risk related beliefs with rural women's willingness-to-pay for iron fortified soy-sauce in China that they did not observe in the urban counterparts. Other studies (e.g. Jensen *et al.*, 2012), however, observe that risk-related beliefs arouse fear which positive affect decisional balance. Thus, there seem to be a dissonance between risk-related beliefs and OFSP acceptance behavior (Rogers, 1983), which could probably limit the use of risk-related beliefs in understanding bio-fortified crop acceptance behaviors. This negative linkage of risk-related beliefs with acceptance of OFSP could probably be caused by the hidden nature of malnutrition deficiencies, where if one adapts an intervention, he or she acquires trust in the intervention and gradually ceases to mentally see the challenge as a threat to his/her own situation. This could be the reason this belief is particularly found to be associated with the changing from trial to maintenance stage.

Lastly, this study reveals that it is possible to support a farmer to maintain his or her decision to cultivate OFSP, if such a farmer is supported to believe that it is easy to access OFSP planting materials as well as to preserve the vines between seasons and if the bio-fortified varieties are preferred in his or her household. In addition, a farmer should believe OFSP to have desirable dry matter content. Similarly this study finds farmers' beliefs about whether nearby peers grow and approve the growing of OFSP to support the maintenance of the decisions to grow OFSP, which is line with Hummel *et al.* (2018), discussed earlier. Jolanda *et al.* (2002) and Mackie *et al.* (2015) also suggest that when accepting new ideas, individuals seek for approval from the social groups they ascribe to so that they do not contradict what is socially deemed right by their peers.

Conclusions and recommendations

Generally, the results point to a causal role, for multi-dimensional beliefs and processes that enhance farmers' beliefs, in the acceptance of bio-fortified crops such as OFSP. The results reveal farmers' beliefs about the resilience of OFSP in the field, the new variety's dry matter content and the similarity of labor needs of OFSP and white fleshed sweetpotato, are associated with farmers' trial cultivation of OFSP. If these beliefs are enhanced, for example through information delivery, variety endorsements and social campaigns using a number of targeted media; farmers could be inspired to try out the cultivation of OFSP on their plots. Further, the results suggest that farmers would likely move from trial to sustained cultivation of OFSP varieties if their belief about the ease of obtaining planting materials, yield quality and involvement of peers in the cultivation of OFSP are enhanced. It is also vital to enhance farmers' feelings that access to planting materials, labor and other OFSP farmers is within their ability. Lastly, these results also suggest that once farmers' have reached the maintenance level of cultivating bio-fortified crops, it could be possible to support their decision via enhancing their belief system so that they do not relapse into the underconsideration stage. For example, the results reveal that through supporting farmers to believe that nearby peers are growing and approve of them to grow OFSP and that it is easy to access and preserve OFSP planting materials; farmers are likely to continue with their decisions to cultivate OFSP to

fight VAD. This study offers support for multi-dimensional interventions that target the sweetpotato seed system, household decision-makers' belief systems, and farmers' social networks as mechanisms for effective bio-fortified crop delivery among end-users. The study specifically calls for change agents' focus on investing in the belief system of targeted household decision-makers. One of the limitations of this study is that the data used was collected from subjects selected from households that were targeted by the OFSP promotional program, which therefore limits generalization of the results. Future studies could use a longitudinal design with an embedded control group.

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