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# VALIDATION OF THE COGNITIVE FLEXIBILITY SCALE (CFS) AND ITS APPLICATION IN ADOPTION OF IMPROVED CASSAVA TECHNOLOGIES AMONG CASSAVA GROWERS IN TANZANIA

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## Abstract

*This research paper discusses the validation process of the cognitive flexibility scale (CFS) as a measurement instrument for farmers' cognitive flexibility (CF). The role of CF in influencing behaviour has been established for centuries among psychologists. Thus, individual differences might be among the correlates of adoption of cassava processing technology among farmers. However, lack of an effective instrument to measure farmers' CF has been limiting the predictive and descriptive potential of farmers' CF. The instrument was validated in a two stages study with some specific objectives guiding the study namely; assess the instrument's component structure validity and reliability of CFS, examine whether CFS could categorise farmers' performance in cognitive flexibility by farmers' demographics; and whether or not could cognitive flexibility have an influence on farmers' adoption of cassava farming technologies. In the first stage the instrument was pilot tested in a survey conducted in Serengeti district in Mara region of Tanzania among 200 participants. Principle component Analysis (CPA) indicated that CFS was a three factor scale with good internal consistency (α = 0.85). The three factors found were technology acceptance (α = 0.92), open mindedness (α = 0.86), and adapting to new situations (α = 0.37). In the second stage, a total of 360 participants, of whom 181 were males and 178 were females responded to the CFS. It was found that the improved CFS was a three factor scale reaching an internal consistency of α = 0.85. The three subscales in the CFS were adapting to new farming technologies (α = 0.88), acceptance of new farming technologies (α = 0.86), and open mindedness to other people's ideas (α = 0.80). The findings further indicate low correlations among the subscales, implying discriminant validity of the scale. In addition to theoretical implications, the paper discusses the measure's effectiveness and its potential applicability in the field of rural development and with specific focus to adoption of farming technologies. The findings provide support for validity and reliability of the CFS and its multidimensional nature. It is recommended that one needs to consider contextual factors such as the level of cassava processing technology before generalizing the validity and reliability of CFS, and thus, a need for further validation studies of the instrument.*

**Key words:** Cognitive Flexibility Scale, Flexibility in cassava processing technology, Cognitive Flexibility in Farming technologies, Psychology and adoption.

## Introduction

This paper discusses the validation process of the cognitive flexibility scale (CFS) as a measurement instrument for farmers' cognitive flexibility (CF). CF refers to the dynamic activation and modification of the cognitive processes involved in response to changes in the demands of tasks (Varanda & Fernandes, 2015). Deák and Narasimham (2003) argue that CF involves the readiness of the cognitive systems to adapt and shift attentional focus so as to select information necessary to meet the demands of the context or new task and generate new plans and new activation patterns, and then provide feedback to the body system. It is one's ability to drop one cognitive strategy and adapt to the other to meet the changes demanded by the new task.

CF is usually measured by examining the behaviour that is associated with its absence, namely; perseveration, which refers to a maladaptive repetition of a particular behaviour (Varanda & Fernandes, 2015). This approach assumes that cognitive perseveration (CP) is the opposite of CF rather than abilities which can be traced in the same continuum. This paper is in the opinion that both CP and CF are the cognitive elements existing in the same continuum and their presence to certain levels are necessary to an individual for the daily decision making. Thus, treating them as the opposites might miss the point as this might communicate a connotation of absence or presence of these crucial cognitive elements to a person. Other studies use a standard test in CF through Wisconsin Card Sorting (WCST; Kaland, Smith, & Mortensen, 2008; Dawson, & Guare, 2010; Varanda & Fernandes, 2015). The instruments for measuring perseveration and the WCST, however, seem to work well with experimental studies restricted to the clinical and educational psychology studies.

According to Hamtiaux and Houssemand (2012), despite long term attempts to define CF in diverse fields of studies, the concept still lacked consensus in its definition and elements that make up the CF, and that the semantic components of the construct still needed to be identified and clarified. Other researchers have also supported a need to re-conceptualize CF to capture the technology-enhanced contexts (Barak & Ziv, 2013 & Plesch, Kaendler, Rummel, Wiedmann & Spada, 2013; Varanda & Fernandes, 2015).

In response to the call for re-conceptualizing cognitive flexibility to capture the technology-enhanced contexts (Barak & Ziv; 2013; & Plesch, *et al*, 2013), Barak and Levenberg (2016) developed a self response Flexible Thinking in Learning Questionnaire (FTL) with the purpose to measure learners' dispositional inclination to think flexibly in technology-enhanced learning. The instrument had 17 items measuring three main factors, namely technology acceptance, open mindedness and adapting to new situations. The three factors were measured from strongly agree to strongly disagree with high scores on the scale indicating high flexibility. Indeed, the Barak and Levenberg's (2016) instrument responded to the call to come up with the instrument that could measure CF in the technology-enhanced context. However, their instrument is still based on the school setting, leaving the agricultural technologies and the farmers outside the context. The review of the past studies, thus, hardly found a measurement scale specifically aimed at measuring CF among farmers in the context of agricultural technologies. This necessitated a need to come up with the CFS, which is an instrument measuring CF among farmers with a specific focus on agricultural technologies. The Barak and Levenberg's (2016) Flexible Thinking in Learning Questionnaire (FTL) from which the CFS was adopted has items which are:

> *"I adjust quickly to new learning technologies; I adjust easily to technological changes as software updates; I am open to updates in new technological tools that can help me learn; I use various technological tools for learning and frequently change between them; I like to experience new learning technologies; when learning, I listen to various opinions even if they contradict my opinion; Even when I am convinced that I am right, I listen to other learners' opinions; In a learning process, I am open to feedback and criticism; When learning, I tend to consider various possibilities; When learning I observe things from different perspectives; For deep learning, I tend to examine diverse viewpoints; It is important that different viewpoints will be expressed in the learning process; I adjust myself to changes in learning conditions without difficulty; I adjust easily when ways of learning change; I do not have trouble getting*

> *used to new learning situations; I adjust to different learning situations" and "I am open to changes in my ways of learning even if it requires effort and work."*

In this study, these items were adopted by changing their wordings and are now read as:

> *"I adjust quickly to new farming technologies; I adjust easily to technological changes in farming such as using new seeds varieties; I am open to updates in new farming tools that can help me improve farming; I use various farming tools for farming and frequently change between them; I like to experience new farming technologies; When learning new farming experiences I listen to various opinions even if they contradict my opinion; Even when I am convinced I am right I listen to other farmers' opinion; In practicing farming activities, I am open to feedback and criticism; In farming, I tend to consider cultivating various crops with changing seasons; When learning new farming experiences, I observe things from different perspectives; For successful farming, I tend to try diverse farming techniques; For successful farming, I tend to try diverse farming techniques; It is important that different farming techniques will be expressed in the farming practice; I adjust myself to changes in farming conditions without difficulty; I adjust easily when ways of farming change; I do not have trouble getting used to new farming techniques; I adjust to different farming situations; I am open to changes in my ways of farming even if it requires effort and work."*

In the field of rural development, it has been argued that in the process of diffusion of innovations, agricultural researchers and food technologists are usually sources of the innovations while farmers are the recipients of the innovations through the education channeled to them by extension agents (TARP II SUA, 2005). It follows then that farmers' CF is necessary for the adoption of the innovated technologies. On the other hand, rigidity in the farmers' cognition might result in rejection of the technologies invented. With regard to adoption of technologies in agriculture, Abel, Ross, Herbert, Manning, Walker and Wheeler (1998) argue that farmers have often been reluctant adopters of new practices. Specifically, Promar Consulting (2011) reports that low acceptance to adopt the improved cassava processing technology, has partly been due continued use of traditional methods in cassava processing.

The reluctance to adopt new technologies in agriculture and continued use of traditional methods (Abel, *et al.,* 1998; Promar Consulting, 2011) not only threatens the technology development in the field of agriculture but also calls for an immediate study on farmers' CF. This is because we live in the rapid changing world with a lot of new coming uncertainties such as extreme climatic events, demand for value addition of the harvests, energy crops and debates surrounding genetically modified crops. With these increasing demands, farmers have to plan ahead and be able to think flexibly so as to cope and succeed in farming (Darnhofer, Bellon, Dedieu & Milestad, 2009).

In Tanzania the problem of farmers' low acceptance to adopt the improved cassava processing technology among farmers has been observed. The technology involves production of high quality cassava flour (HQCF) for home based consumption and for bakery industry with some products such as biscuits, bread, starch, and ethanol (Hirschnitz-Garbers, 2015). The technology was introduced in the country about two decades ago by the government, by providing processing machines such as graters and press to both small holder farmers' groups for free and to Small and Medium Enterprises (SMEs) on credit (Silayo, 2003). The aim was to improve the quality of the cassava products and commercialize the cassava farming so as to improve farmers' income and livelihood (Keya and Rubaihayo, 2013). To date however, contrary to expectations, very few (about 15.9 percent) of the provided processing units are in operation, and that farmers have continued using their traditional processing methods (Match Maker Associate, 2007; Promar Consulting, 2011; Intermech Engineering, 2018). The curious question was thus, what could explain such reluctance to change and low acceptance of the technology in the country despite availed access?

The theoretical explanations by the Social Cognitive Theory (SCT; Bandura, 1977) inform that human behaviour is influenced in a reciprocal relationship by both personal and environmental variables. According to SCT; self and society, personal determinants such as cognitive, affective, and biological stimulus, behavioural patterns and environmental stimulus interactively determine each other in a bidirectional way (Bandura, 1977). One's ability to change and adapt to new demand requires presence of one's interaction with the object to be adopted through exposure and imitation. However, such imitation might be positive when the imitated object rewards rather than punishing the imitating individual. From such a theoretical line of argument, the key understanding of what constitutes CF and its development relies on understanding how one has been exposed to other people who use cassava processing technology and how that technology has been rewarding or punishing those who have been using it.

Without contradicting SCT, Barak and Levenberg (2016) put forward a model which assumes that adapting to new farming technology (AFT) is predicted by both open mindedness (OM) and acceptance of new farming technologies (TA). In their argument, they put OM as a force behind TA, which also leads to AFT. This means that when farmers' cognitions are open to receive other people's ideas, they will be likely to accept a new technology which is a result of other people's idea and, thus, adoption of new farming technologies. Adoption of the CFS was, thus, guided by both SCT theory and Barak and Levenberg's (2016) assumption behind the development of FTL. The validation was done with the general purpose being to validate the cognitive flexibility scale (CFS) and apply it in the adoption of cassava farming technologies among cassava growers. This was through specific objectives which were: Assess the component's structure, validity and reliability of CFS; examine the CFS' ability to categorise farmers' performance in cognitive flexibility by farmers' demographics; and examine whether or not could cognitive flexibility be associated with farmers' adoption of cassava farming technologies.

## Methodology

### *Study design, area and sampling*

The first stage of this cross-sectional study (pilot) was carried out among cassava farmers in Serengeti District, which is located on the Eastern part of Mara region. The second stage of the study added more participants from Sengerema District in Mwanza region, and Biharamulo District in Kagera region, both located in the Lake zone of Tanzania. The districts were selected given their cassava cultivation potential and presence of the cassava processing units in operation, which is a potential drive for adoption of the improved cassava processing technology.

This study was quantitative in approach under which a cross – sectional study design was employed. The study targeted all farmers cultivating cassava around the areas where the improved cassava processing units exist. Two categories of cassava farmers were identified. First, farmers who processed their harvested cassava in the improved processing units and second, farmers cultivating cassava but do not process using the improved but rather by traditional processing methods. The two categories were identified by assistance of village executive officers, extension officers, and the owners of the cassava processing units. Due to indefinite nature of the population, randomization methods of sampling were ruled out. Instead, in both stage one and two of the study, sampling was done through invitation whereby farmers identified were invited through their mobile phone numbers obtained from the records in the cassava processing units or from the village executive officers. Following invitation, each farmer from the two categories who consented to participate in the study was included in the sample, reaching a total of 200 participants in the first stage of the study and 360 participants in the second stage of the study.

In stage one, the participants were 200 including 101(50.5%) males and 99 (49.5%) females. Participants were of three age groups namely young age group (<= 35), who were 67 (33.5%), middle age group (36 – 45) who were 76 (38%), and old age (46+) who were 57 (28.5%). The participants were included 37 (18.5%) farmers with no formal education, 77 (38.5%) with primary level of education and 86 (43%) farmers who reported secondary education or above. In stage 2 of the study, 360 participants [181 (50.3%) males and 179 (49.7%) females] responded to the 15 CFS items of the improved CFS. The participants belonging to young age group (<= 35 years) were 174 (48.3), middle age group (36 – 44) were 84 (23.3%), and old age group (45+) were 102 (28.3%). With regard to their level of education, 70 (19.4%) had no formal education, 138 (38.3%) had primary education, and 152 (42.2%) reported to have secondary education level or above. When asked about economic activities they were engaged in, 183 (50.8%) reported only farming, 36 (10%) reported farming and business, while 141 (39.2%) reported farming and other economic activities. 'Other economic activities' reported included rearing cattle, poultry, casual labour in other farmers' farms ('*Kufanya vibarua*') driving motor cycles ('*bodaboda*'), carpentry, selling charcoal and firewood, and ox-cart dragging.

***Data collection and Analysis***

In stage one (pilot), data were collected between March and April in 2019, a CFS comprising 17 items was administered to 200 participants. Data collection for the stage two was carried out during June and July 2019, whereby a CFS comprising 15 items was administered to 360 participants. In stage one of the study, the respondents were required to respond to the 17 CFS' items measured in a five point scale, namely Strongly Disagree, Disagree, Neutral, Disagree and Strongly Agree. In stage two, they responded to selected 15 items measured in a five point scale, namely 1 = "Never", 2 = "Occasionally", 3 = "Sometimes" (about 50% of the time), 4 = "Usually", and 5 = "Always".

Data analysis employed a Principle Component Analysis (PCA) statistic technique. Pallant (2011) proposes the use of PCA when one intends to validate the existing instrument in a new context, which was the case in the present study. In principal components analysis the original variables are transformed into a smaller set of linear combinations, with all of the variance in the variables being used. It thus, reduces a set of variables into a number of items clustering together to form a factor, also known as a component or dimension and indicates the relationship existing among the reduced factors (Tabachnick & Fidell, 2007). In this study the CPA was found relevant in validating the CFS. In the first stage, the 17 items of the Cognitive Flexibility Scale (CFS) were subjected to the PCA using SPSS version 21, while in stage two of data analysis 15 items were subjected to the same procedure.

***Scoring and interpretation***

All the items in the scale were positively worded so that low score (1) means low trait and high score (5) means high trait in the Cognitive Flexibility scale. The scores were then totalized to obtain the total score for each participant in each sub – scale. The participant's total score in the CFS was obtained by totalizing the scores for each subscale. Interpretation of the CFS scores was guided by the assumption made in Barak, and Levenberg's (2016) model. The model assumes that adapting to new farming technology (AFT) is predicted by both open mindedness (OM) and acceptance of new farming technologies (TA). In that regard, therefore, there is no categorical assumption in measuring the CFS but rather a linearity assumption. This means that low, moderate, and high scores apply than assuming the oppositeness (presence or absence). Therefore, low cognitive flexibility was awarded to a participant who scored below the median and high cognitive flexibility was awarded to a participant who scored at or above the median score.

## Results

### *Stage 1 of the study*

The Kaiser Meyer-Oklin was adequate at 0.87, which exceeded the minimum acceptable value of 0.6 (Kaiser, 1970). In addition, the Bartlett's Test of Sphericity was $p < 0.001$, supporting the factorability of the correlation matrix (Barttlet, 1954). Further results from the analysis appear in Table 1.

**Table 1: Total Variance Explained**

| **Component** | **Initial Eigenvalues** | | | **Extraction Sums of Squared Loadings** | | | **Rotation Sums of Squared Loadings** |
|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| CFS1 | 6.079 | 35.761 | 35.761 | 6.079 | 35.761 | 35.761 | 6.007 |
| CFS2 | 3.333 | 19.604 | 55.366 | 3.333 | 19.604 | 55.366 | 3.576 |
| CFS3 | 1.387 | 8.158 | 63.523 | 1.387 | 8.158 | 63.523 | 1.432 |
| CFS4 | .837 | 4.924 | 68.447 | | | | |
| CFS5 | .798 | 4.695 | 73.142 | | | | |
| CFS6 | .685 | 4.027 | 77.169 | | | | |
| CFS7 | .642 | 3.777 | 80.946 | | | | |
| CFS8 | .529 | 3.113 | 84.059 | | | | |
| CFS9 | .499 | 2.934 | 86.992 | | | | |
| CFS10 | .413 | 2.431 | 89.423 | | | | |
| CFS11 | .371 | 2.185 | 91.608 | | | | |
| CFS12 | .335 | 1.970 | 93.579 | | | | |
| CFS13 | .293 | 1.724 | 95.302 | | | | |
| CFS14 | .246 | 1.448 | 96.750 | | | | |
| CFS15 | .229 | 1.344 | 98.095 | | | | |
| CFS16 | .173 | 1.016 | 99.111 | | | | |
| CFS17 | .151 | .889 | 100.000 | | | | |

The results in Table 1 indicate that the initial PCA analysis found about 3 components with eigen values greater than 1. The three components accounted for 35.76%, 19.60%, and 8.16% of the total variance respectively and explained a total of 63.52% of the variance. Similar results were found in the scree plot, which indicated an elbow point at the third component (See Figure 1).

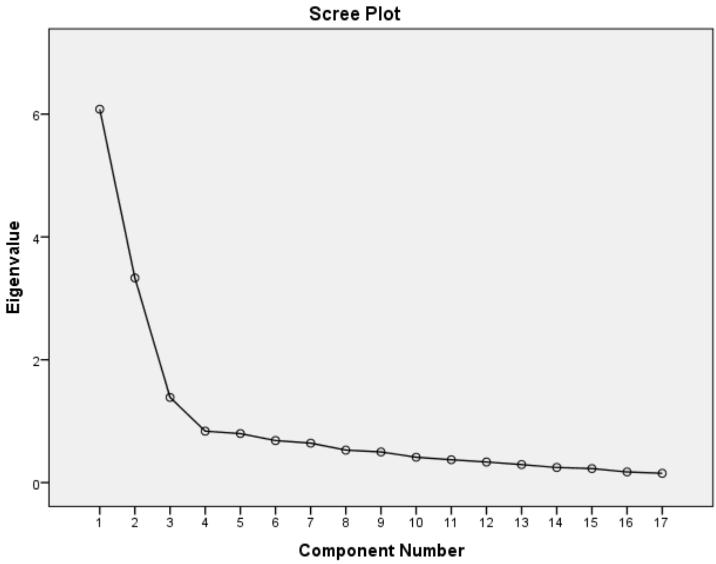


*Figure 1: The Scree Plot for the Three Factors*

The Monte Carlo PCA for Parallel analysis was further performed to screen the decision on the number of components. When systematic comparison between the actual PCA values and the criterion values from the parallel analysis was done, the same 3 components from PCA with eigenvalues exceeding the corresponding criterion values for a randomly generated data matrix of the same size (17 variables × 200 respondents), were greater than those from parallel analysis supporting the three components solution.

***Item Structure, reliability and validity of the CFS***

Analysis indicated that the CFS was a three factor scale composed of technology acceptance, which shared 35.76% of the variance, open mindedness, which shared 19.60% of the variance, and adapting to new farming technologies, which shared 8.16% of the variance. The total CFS scale indicated the shared variance of 63.52%.

The reliability for the total CFS was good with an internal consistency of α = 0.85. The internal consistency for technology acceptance subscale was α = 0.92, for open mindedness subscale it was α = 0.86, and for adapting to new farming technologies subscale it was very low (α = 0.36). Table 2 summarizes the results.

**Table 2: Pattern and Structure Matrices for CFS with Oblimin Rotation of Three Factor Solution of CFS Items**

| Item | Pattern Coefficients Components | | | Structure Coefficients Components | | | Communalities |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | |
| CFS13 | .914 | | | .895 | | | .479 |
| CFS15 | .900 | | | .889 | | | .434 |
| CFS14 | .848 | | | .845 | | | .691 |
| CFS12 | .843 | | | .831 | | | .506 |
| CFS3 | .803 | | | .818 | | | .484 |
| CFS6 | .713 | | | .699 | | | .505 |
| CFS5 | .671 | | | .670 | | | .516 |
| CFS4 | .658 | | | .658 | | | .667 |
| CFS1 | .608 | | | .630 | | | .704 |
| CFS2 | .593 | | | .616 | | | .701 |
| CFS10 | | .836 | | | .830 | | .687 |
| CFS9 | | .825 | | | .827 | | .722 |
| CFS8 | | .824 | | | .825 | | .817 |
| CFS11 | | .822 | | | .802 | | .721 |
| CFS7 | | .709 | | | .716 | | .796 |
| CFS17 | | | .797 | | | .787 | .672 |
| CFS16 | | | .685 | .301 | .379 | .704 | .696 |
| α | .918 | .863 | .369 | | | | |
| Total scale α | | .852 | | | | | |

In terms of discriminant validity, there was a weak positive correlation (r = 0.14) between technology acceptance factor and open mindedness factor; and low but negative correlation (r = -0.01) (Almost no correlation) between adapting to new farming technologies and technology acceptance. Lastly, a weak correlation (r = 0.07) (Almost no correlation) was found between adapting to new farming technologies subscale and open mindedness subscale. This was interpreted that the first two subscales measured the same trait and at the same time they could stand alone as subscales in the cognitive flexibility scale. However, the third subscale (adapting to new farming technologies) indicated no relationship to other subscales suggesting that while the items in the subscale might be measuring the same trait, they were not able to stand alone as independent factors. Further assessment of the third subscale indicated a very low reliability (α = 0.36), suggesting omission of the subscale in the CFS for the next stage of research and analysis. The third subscale was omitted in the stage 2 study, given its low reliability (internal consistency) and discriminant validity found in the PCA. Therefore, the remaining 15 items were surveyed in stage 2 of the study.

**Stage 2 of the Study**

The purpose of this stage was to improve the reliability of the CFS and check for the discriminant validity of its subscales. The 15 items of the CFS from the pilot study were modified to address the weaknesses which emerged in the first instrument and the comments from the STI conference. Specific items modified were items 5, 6, and 4. Before modification the items were structured as follows:
*'I like to experience new farming technologies'*; *'When learning new farming experiences, I listen to various opinions even if they contradict my opinion'*; and *'I use various farming tools for farming and frequently change between them'*; were modified to read, ' *'I accept and enjoy experiencing new farming technologies'; 'When learning new farming experiences, I accept to*

*listen to various opinions even if they contradict my opinion'*; and '*I do accept to use various farming tools for farming and frequently change between them.*'

Other modifications were done in the instructions. For example, the instructions in the first scale were:

> In the scale provided below, read the statements about what most people do when they come across different farming situations. After reading each statement, **check under the response** (1, 2, 3, 4 or 5) to indicate your level of agreement with the statement. 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree. Please note that there are no Right or wrong answers to the statements in this task but be very sincere to yourself in responding to a statement.

The instructions were modified to read:

> In the scale provided below, read the statements about what people experience in regarding to farming technologies. After reading each statement, **put a tick (✓)** under the number column that applies to you against each statement. Please note that there is neither **right** nor **wrong** answer to the statements in this task but be very sincere to yourself in responding to a statement. The numbers mean: namely, 1 = Never, 2 = Occasionally, 3 = Sometimes (about 50% of the time), 4 = Usually, and 5 = Always.

## Results

***Item Structure, reliability and validity of the CFS***

The Principle Component Analysis (PCA) found the Kaiser Meyer-Oklin adequate at 0.84, exceeding the acceptable value of 0.6 (Kaiser, 1970). The Bartlett's Test of Sphericity was $p < 0.001$, which supported the factorability of the correlation matrix (Barttlet, 1954). Table 3 shows the details.

*Table 3: Total Variance Explained*

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | |
|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| 1 | 4.937 | 32.911 | 32.911 | 4.937 | 32.911 | 32.911 | 4.312 |
| 2 | 2.726 | 18.174 | 51.084 | 2.726 | 18.174 | 51.084 | 3.227 |
| 3 | 2.339 | 15.591 | 66.676 | 2.339 | 15.591 | 66.676 | 2.942 |
| 4 | .797 | 5.316 | 71.992 | | | | |
| 5 | .643 | 4.287 | 76.279 | | | | |
| 6 | .566 | 3.772 | 80.051 | | | | |
| 7 | .511 | 3.406 | 83.456 | | | | |
| 8 | .418 | 2.787 | 86.243 | | | | |
| 9 | .400 | 2.669 | 88.912 | | | | |
| 10 | .378 | 2.521 | 91.433 | | | | |
| 11 | .316 | 2.110 | 93.543 | | | | |
| 12 | .292 | 1.948 | 95.491 | | | | |
| 13 | .262 | 1.746 | 97.237 | | | | |
| 14 | .221 | 1.475 | 98.712 | | | | |
| 15 | .193 | 1.288 | 100.000 | | | | |

The results in Table 3 from the initial PCA analysis indicate the 3 components whose eigen values were greater than 1. The components accounted for 32.91%, 18.17%, and 15.51% of the total variance respectively, and explained a total of 66.68% of the variance. The three factors made up the three subscales of the CFS. The subscales are adapting to new farming technologies, acceptance of new farming technologies, and open mindedness to other people's ideas. Results from the scree plot supported the initial PCA analysis, since an elbow point was observed at the third component as indicated in Figure 2.

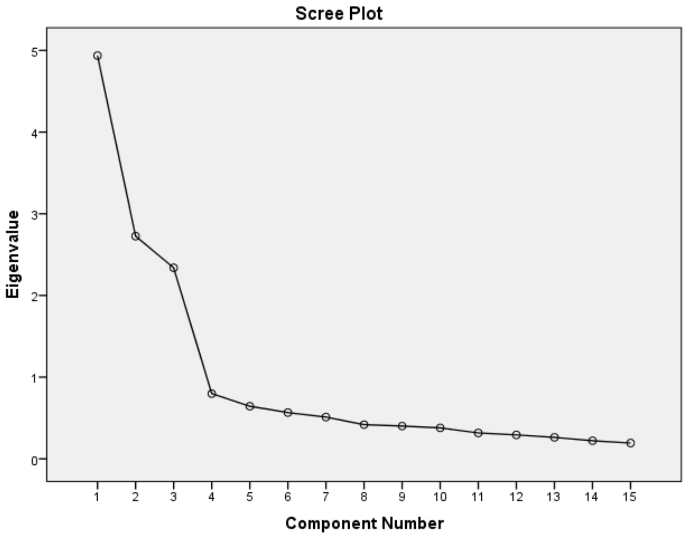


*Figure 2: Scree Plot for 3 factors structure of the CFS*

Further, the parallel analysis was conducted to screen the decision on the number of components using the Monte Carlo PCA. The systematic comparison between the actual PCA values and the criterion values from the parallel analysis found the same 3 components. This is because the three factors from PCA had their eigenvalues greater than the corresponding criterion values for a randomly generated data matrix of the same size (15 variables × 360 respondents) from parallel analysis.

According to Barak and Levenberg (2016), the Flexible Thinking in Learning (FTL), from which CFS has been adopted, has good internal consistency, with a Cronbach alpha coefficient of 0.91. In the present study, the Cronbach alpha coefficient for the CFS was 0.85. The internal consistency for the subscales in the FTL was reported as $\alpha = 0.84$, $\alpha = 0.90$ and $\alpha = 0.84$ for adapting to new situations, acceptance of new technologies and open mindedness to other people's ideas respectively. In the present study, the Cronbach alpha coefficients for the subscales in the CFS were $\alpha = 0.88$, $\alpha = 0.86$ and $\alpha = 0.80$ for adapting to new farming technologies, acceptance of new farming technologies and open mindedness to other people's ideas respectively. Table 4 indicates the three – factor structure for the CFS and their reliability indices.

**Table 4: Pattern and Structure Matrices for CFS with Oblimin Rotation of Three Factor Solution of CFS Items (N=360)**

| Item | Pattern Coefficients Components | | | Structure Coefficients Components | | | Communalities |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | |
| 3 | .819 | | | .821 | | | .728 |
| 13 | .812 | | | .809 | | | .671 |
| 14 | .771 | | | .796 | | | .656 |
| 15 | .729 | | | .751 | | | .628 |
| 12 | .688 | | | .722 | | | .666 |
| 2 | .688 | | | .685 | | | .766 |
| 1 | .620 | | | .630 | | | .792 |
| 5 | | .889 | | | .889 | | .693 |
| 6 | | .855 | | | .860 | | .421 |
| 4 | | .806 | | | .809 | | .518 |
| 7 | | .614 | .498 | | .652 | .534 | .766 |
| 11 | | | .822 | | | .838 | .729 |
| 9 | | | .819 | | | .834 | .557 |
| 10 | | | .816 | | | .822 | .707 |
| 8 | | | .605 | | | .613 | .704 |
| Chronbach's Alpha (α) | .88 | .86 | .80 | | | | |
| No. of items | 7 | 3 | 5 | | | | |
| Mean | 23.50 | 6.91 | 13.75 | | | | |
| Variance | 54.368 | 15.730 | 27.406 | | | | |
| Std. Deviation | 7.373 | 3.966 | 5.235 | | | | |
| Total CFS scale α | | .85 | | | | | |
| No. of Items | | 15 | | | | | |
| Mean | | 44.09 | | | | | |
| Variance | | 142.900 | | | | | |
| Std. Deviation | | 11.954 | | | | | |

Discriminant validity for the CFS was checked by running correlation among the subscales. This implies that when a scale is valid, its subscales indicate between low and moderate correlations to signify that the subscales can stand alone as a measure of the components of the scale, while at the same time measuring the same intended trait in the total scale (Pallant, 2011; Barak, & Levenberg, 2016). Low correlations were found ($r = 0.08$), ($r = -0.15$), and ($r = -0.12$) between adapting to new farming technologies and acceptance of new farming technologies, adapting to new farming technologies and open mindedness to other people's ideas, and adapting to new farming technologies and open mindedness to other people's ideas respectively. Table 5 indicates the CFS, its sub – scales and their coefficients

In the scale provided below, read the statements about what people experience in regarding to farming technologies. After reading each statement, **put a tick (✓)** under the number column that applies to you against each statement. Please note that there is neither **right** nor **wrong** answer to the statements in this task but be very sincere to yourself in responding to a statement. The numbers mean: namely, 1 = “Never, 2 = “Occasionally”, 3 = “Sometimes” (about 50% of the time), 4 = “Usually”, and 5 = “Always”.

**Table 5: The items in the CFS and its sub – scales of the**

| Item | Coefficient |
|---|---|
| *Adapting to New Farming Technologies (AFT)* | |
| I am open to updates in new farming tools that can help me improve farming | .819 |
| I adjust myself to changes in farming conditions without difficulty | .812 |
| I adjust easily when ways of farming change | .771 |
| I do not have trouble getting used to new farming techniques | .729 |
| It is important that different farming techniques will be expressed in the farming practice | .688 |
| I adjust easily to technological changes in farming such as using new seeds varieties | .688 |
| I adjust quickly to new farming technologies | .620 |
| *Acceptance of New Farming Technology (TA)* | |
| I accept to experience new farming technologies | .889 |
| When learning new farming experiences I accept to listen to various opinions even if they contradict my opinion | .855 |
| I do accept to use various farming tools for farming and frequently change between them | .806 |
| *Open Mindedness to Other People's Ideas (OM)* | |
| Even when I am convinced I am right I listen to other farmers' opinion | .498 |
| For successful farming, I tend to try diverse farming techniques | .822 |
| In farming, I tend to consider cultivating various crops with changing seasons | .819 |
| When learning new farming experiences , I observe things from different perspectives | .816 |
| In practicing farming activities, I am open to feedback and criticism | .605 |

***Performance in the CFS across Farmers' Demographics***

The population of farmers in Tanzania is composed of both youth and elderly. FinScope Tanzania (2017), categorizes the age groups of these farmers as between 18 and 24 years (26% of all farmers); between 25 and 44 years (45%) and 21% are in 45+ years within productive age (18 – 64). According to the same report, farming is carried out by both educated and non-educated who are also in the categories of no formal education (15%), primary education (65%), secondary education (18%) and tertiary education (3). In addition, the report further informs that both males and females practice a combination of other economic activities that might contribute to the economic status of the farming population. In this study, these demographics were considered relevant in assessing the effectiveness of the CFS. Table 6 presents performance distribution in the three sub – scales of the CFS by farmers' demographics.

**Table 6: Performance in the CFS by Farmers' Demographics (n = 360)**

**Performance by Sex**

| | Responses | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Males | | | | Females | | | |
| Sub scale | Low | | High | | Low | | High | |
| | F | % | F | % | F | % | F | % |
| AFT | 96 | 53.0 | 85 | 47.0 | 93 | 52.0 | 86 | 48.0 |
| TA | 91 | 50.3 | 90 | 49.7 | 99 | 55.3 | 80 | 44.7 |
| OM | 108 | 59.7 | 73 | 40.3 | 112 | 62.6 | 67 | 37.4 |

**Performance by Age Groups**

| | Young age group (<=35) | | | | Middle age group (36-44) | | | | Old age group (45+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | | High | | Low | | High | | Low | | High | |
| | F | % | F | % | F | % | F | % | F | % | F | % |
| AFT | 91 | 52.3 | 83 | 47.7 | 7 | 58.3 | 5 | 41.7 | 91 | 52.3 | 83 | 47.7 |
| TA | 95 | 54.6 | 79 | 45.4 | 6 | 50.0 | 6 | 50.0 | 89 | 51.1 | 85 | 48.9 |
| OM | 107 | 61.5 | 67 | 38.5 | 9 | 75.0 | 3 | 25.0 | 104 | 59.8 | 70 | 40.2 |

**Performance by Education Level**

| | No formal Education | | | | Primary education | | | | Secondary and above | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | | High | | Low | | High | | Low | | High | |
| | F | % | F | % | F | % | F | % | F | % | F | % |
| AFT | 30 | 42.9 | 40 | 57.1 | 72 | 52.2 | 66 | 47.8 | 87 | 57.2 | 65 | 42.8 |
| TA | 36 | 51.4 | 34 | 48.6 | 70 | 50.7 | 68 | 49.3 | 84 | 55.3 | 68 | 44.7 |
| OM | 36 | 51.4 | 34 | 48.6 | 82 | 59.4 | 56 | 40.6 | 102 | 67.1 | 50 | 32.9 |

Performance in the three sub – scales of cognitive flexibility was almost equally distributed across gender. In terms of age, open mindedness was higher among old age group (40.2%) followed by young age group (38.5%) and the middle age group was the last (25.0%). Although it was found that technology acceptance tendencies was higher among the middle age group (50.0%), adaptation to new farming technologies among middle age group farmers was relatively lower (41.7%) than the rest of farmers from the rest of age groups. Further, the performance in cognitive flexibility seems to decrease with an increase in level of education. In the three sub – scales of cognitive flexibility performance was a bit higher among respondents with no formal education, while it was also higher among respondents with primary education relative to their counterpart respondents with secondary education and above.

***The Association between Farmers' Cognitive Flexibility on Some Selected Cassava Farming Practices***

Chi – square analysis was used to analyse farmers' cognitive flexibility and some selected cassava farming practices. The farming practices were decision to plant either local or improved cassava varieties and attending to trainings on cassava processing technology. Table 7 presents results.

**Table 7: The Association between Farmers' Perceived Self-efficacy and some Selected Cassava Farming Practices (n = 360)**

| Cognitive flexibility | Level | Farming Practices: What kind of cassava variety have you planted in your cassava farms? Local F | Local % | Improved F | Improved % | Chi - Square $X^2$ | df | p | phi |
|---|---|---|---|---|---|---|---|---|---|
| AFT | High | 59 | 34.5 | 112 | 65.5 | .01 | 1 | .93 | .004 |
| | Low | 66 | 34.9 | 123 | 65.1 | | | | |
| TA | High | 57 | 33.5 | 113 | 66.5 | .20 | 1 | .653 | .024 |
| | Low | 68 | 35.8 | 122 | 64.2 | | | | |
| OM | High | 57 | 40.7 | 83 | 59.3 | 3.63 | 1 | .057 | -.10 |
| | Low | 68 | 30.9 | 152 | 69.1 | | | | |
| | | **Have you ever attended any training on cassava processing using modern methods?** No | | Yes | | | | | |
| | | **F** | **%** | **F** | **%** | **$X^2$** | **df** | **p** | **phi** |
| AFT | High | 147 | 86.0 | 24 | 14.0 | .99 | 1 | .32 | .05 |
| | Low | 169 | 89.4 | 20 | 10.6 | | | | |
| TA | High | 150 | 88.2 | 20 | 11.8 | .06 | 1 | .80 | -.01 |
| | Low | 166 | 87.4 | 24 | 12.6 | | | | |
| OM | High | 118 | 84.3 | 22 | 15.7 | 2.60 | 1 | .10 | .09 |
| | Low | 198 | 90.0 | 22 | 10.0 | | | | |

Data in Table 7 show a slight significant difference in open mindedness to other people's ideas (OM) though at a small magnitude of association, [$\chi 2$ (8, n = 360) = 11.29, p < 0.057, phi = -0.10] between farmers who reported planting local cassava varieties and their counterpart farmers who reported planting improved cassava varieties in their cassava farms. A negative phi - value (-0.10) means that more farmers who reported low open mindedness (69.1%) than their counterpart famers who reported high open mindedness (59.3%) reported planting improved cassava varieties. No significant differences were found in adaptation to new farming technologies (AFT) and technology acceptance (TA) with cassava varieties planted. Similarly, no significant differences were found in the three components of cognitive flexibility and attendance to training on cassava processing technology.

## Discussion of the findings

The CFS was developed for the purpose of measuring farmers' cognitive flexibility with focus to farming practices. The instrument is potential for application as both a research instrument for researchers and a self-assessment instrument among farmers. It can be useful in assessing individual differences in technology acceptance, open mindedness, and adapting to new farming technologies among farmers. Farmers can utilize it as a reflective tool to raise awareness on several aspects related to changes in farming and agricultural technologies. Comparison of the reliability indices indicates that while the Barak and Levernberg's (2016) Flexible Thinking in Learning (FTL) Questionnaire had found three reliable subscales (Technology Acceptance, $\alpha$ = 0.90; Open mindedness, $\alpha$ = 0.84; and Adapting to new situations, $\alpha$ = 0.90), the findings in the pilot study among 200 participants found two subscales with reliability indices high and acceptable ($\alpha$ = 0.92 for technology and acceptance and adapting to new farming technologies and $\alpha$ = 0.86 for open mindedness subscale). However, in the subsequent study, after the modifications described in the methodology section of this paper, the scale indicated stability with acceptable Alpha indices. Although the reliability for total CFS reached an acceptable index, it was a bit lower than that reported by Barak and Levernberg's (2016). These differences might be accounted for by different contexts, samples, nature of the technologies assessed, and the levels at which participants have been exposed to a variety of the technologies.

Despite its validity and reliability, generalizability of the CFS instrument to other contexts needs awareness of some limitations it might be facing. The most foreseen limitation is the fact that the instrument has been developed and tested among farmers in Tanzania, where the level of farming technology is very low. For example, most cassava processing units in Tanzania still use graters, press machines, and drying racks (sun drying). These technologies still need manual peeling and washing of cassava before grating and pressing. This might partly explain the differences in the reliability indices found in the present adopted CFS relative to the FTL. It is natural that, for one to report the way one adapts to new technologies, one might need to have been exposed to the technologies, experience them and recall their experiences in adapting to the technologies (Bandura, 2001). As long as farmers might not have undergone such an exposure, the questions regarding their adaptation to new technologies or situations are likely to remain invalid since the best they could do to the scale is to honestly report the neutral position on the scale.

Barak and Levenberg's (2016) assume that adapting to new farming technology (AFT) is predicted by both open mindedness (OM) and acceptance of new farming technologies (TA). One could thus, expect a positive association between OM and adoption of improved cassava varieties. On contrary, these results found a negative association between these variables. Neither could OM predict TA nor AFT. For example, it was found that although technology acceptance tendencies was higher among farmers in the middle age group (50.0%), adaptation to new farming technologies among middle age group farmers was a bit lower (41.7%) relative to the rest of farmers from the rest of age groups. This implies that open mindedness must not necessarily predict acceptance and acceptance mist not necessarily predict adaptation to new farming technology; but rather, it involves conscious assessment of what other people propose to the farmer, and then the farmer either accepts or rejects the proposal depending on how the proposal matches or mismatches the farmer's interests and preferences. This argument is in line with the argument by the social cognitive theory (SCT, Bandura, 1997) that cognitive skills, preconceptions, and value preferences of the observers determine what a person is more likely to adopt. Further, the theory is supported in its argument that exposure to the role model and the way the role model is either rewarded or punished determines the flexibility to adoption of a given behaviour. The term determination implies that farmers may or may not adopt depending on their cognitive skills gained as a result of imitating the role model.

## Conclusions and Recommendations

This paper intended to validate the cognitive flexibility scale (CFS) and apply it in the adoption of cassava farming technologies among cassava growers. This was done by assessing its component's structure, validity and reliability, examine its ability to categorise farmers' performance in cognitive flexibility by farmers' demographics; and whether or not could cognitive flexibility have an influence on farmers' adoption of cassava farming technologies. Based on the findings of the study, four conclusions are hereby drawn. First, cognitive flexibility scale (CFS) is a three factor, five point scale from 'never' to 'always' measuring adapting to new farming technologies, acceptance of new farming technologies and open mindedness to other people's ideas. Second, CFS is both valid and reliable instrument for measuring farmers' cognitive flexibility. Third, CFS is able to categorise farmers' performance in cognitive flexibility by their demographics such as sex, age groups and levels of formal education. Fourth, cognitive flexibility as measured by CFS is potentially associated with farmers' adoption of cassava farming practices and technologies. Therefore, CFS is an effective instrument for measuring farmers' cognitive flexibility and potential instrument for farmer's self assessment regarding farmers' technology acceptance, adapting to new farming technologies and open-mindedness regarding farming technologies. It is, however, recommended that for effective performance, one might need to cautiously generalize the validity and reliability of the CFS by considering contextual factors such as the level of cassava processing technology assessed, and thus, a need for further validation of the instrument. It is also recommended that future research can think of improving CFS through validation studies by testing its effectiveness to measure adoption of other crops and technologies in agriculture.

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