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Underlying Structure of Job Competency Scale in Climate-Smart Agricultural Extension Service

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ABSTRACT

Climate change could reduce agricultural productivity in lower latitude communities, thereby threatening the food security and livelihoods of farm families. Climate smart agriculture (CSA) has been identified as an approach that could sustainably enhance productivity and mitigate the exacerbating effect of climate change on agriculture. For CSA technologies to be accepted, there is a need for special advisory services delivered by competent extension agents. This study assessed the structure of such competencies among 341 Malaysian extension workers selected randomly. The data obtained from a structured questionnaire was subjected to Varimax rotation of the principal component analysis. The KMO obtained was 0.847 while Bartlett's Test was significant ($p < 0.001$). Assessment of internal consistency revealed a Cronbach alpha of 0.926. Using Kaiser's criterion, seven components explaining 76.053% variance were extracted. However, parallel analysis streamlined and retained five components. This implied that CSA competency among Malaysian extension workers had a five component structure. This should be taken into consideration when designing trainings to make sure the relevant aspects are covered. It could also be beneficial in climate change adaptation and mitigation programmes.

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INTRODUCTION

Climate change has varying effects on different agricultural enterprises in different parts of the world. In the lower latitudes, where Malaysia is located, the overall impact is expected to be lower agricultural productivity (Vaghefi et al., 2016). The greatest threats of climate change are on the food security and livelihood of vulnerable societies. Developing countries may face a decline of 9 to 21% agricultural productivity which would exacerbate food and nutritional insecurity (Devendra, 2012). Climate smart agriculture (CSA) has been identified as an alternative approach that could sustainably enhance productivity and mitigate the exacerbating effect of climate change on agriculture. This calls for a site-specific approach to mitigate and adapt to the phenomenon while enhancing the resilience and livelihoods of individuals and communities. It also poses enormous challenges for extension and rural advisory services to promote relevant innovations in line with the changing demands. This is more so as one of the major issues in up-scaling CSA is information dissemination (Sala et al., 2016).

Empirically developed scales are important in measuring concepts and constructs in social science studies (Bernard, 2006; Kumar, 2011). Competency is one such construct. While there are scales for measuring core competencies in agricultural extension and advisory services (Suvedi et al., 2018; Suvedi & Kaplowitz, 2016); there is a pronounced dearth of evidence-based, empirically developed, standard scales for measuring specific competencies of extension agents (EA) that are applicable to relevant contemporary issues such as climate change in the tropics. Hence, this study identified relevant items in the construct and assessed their underlying structure.

The study is organized in five major sections. The current section introduces the work by presenting its background, significance and research questions. The next section reviews relevant literature on competency, CSA and the principal component analysis. The section on methodology describes the participants, measurement of the scale and the analytical technique. This is followed by the results section where the findings are presented. The subsequent section discusses the findings and their implications for extension practice. The final section presents the conclusion.

RESEARCH QUESTIONS

The principal components analysis (PCA) could be designed and performed to achieve several goals. This study is aimed at summarizing the patterns of correlations among the observed variable items; reducing the large number of observed variables to a smaller number of factors; and establishing construct validity for the scale of competency in CSA advisory services. These are achieved by answering the following research questions: How many reliable and interpretable factors are there in the data set of 31 CSA advisory competency items? Which factors account for the most variance in CSA advisory competence among extension personnel? How much variance in the data set is accounted for by the factors?

Significance of the Study

This study delineates the construct of competence in the context of CSA advisory service and proposes a scale for its measurement. This would be beneficial in future studies that would require the concept of competence among its variables in similar contexts. The scale would help in measuring the levels of competence among extension workers and identifying competence gaps and training needs. Such information is vital to extension organizations for capacity development efforts. It is also expected to be relevant for agricultural and environmental policy making aimed at climate change adaptation and mitigation among extension clients in developing tropical countries.

LITERATURE REVIEW

Competency

The term competency was arguably popularized in the field of human resource development (HRD) by McClelland in 1973 in his seminal work titled ‘Testing for competence rather than for “intelligence”’, as an alternative to traditional intelligence testing in organizations (McClelland, 1973; Vathanophas & Thai-ngam, 2007). He conceptualized competence as a personal trait associated with high performance and “demonstration of particular talents in practice and application of knowledge required to perform a job” (McClelland, 1973). It has been defined as the adequacy of skills and knowledge that enable a person to act in various situations. Competence is the ability or capability (Boyatzis, 2008) to do something efficiently and effectively (i.e. successfully). It refers to a set of related but distinct behaviours organized around an underlying construct, called the “intent”. Earlier on, he defined the concept as an omnibus term covering abilities, traits, knowledge, skills and behaviours enabling the performance of a task within a specific function or job by an individual (Boyatzis, 1982). Recent studies have maintained the general theme of the earlier definitions of the concept as the behavioural attributes required for a person to perform a role effectively (Priyadarshini & Dave, 2012). Competency refers to the individual’s ability to apply or use knowledge, skills, behaviours and attributes to effectively perform tasks, specific functions, or operate in a specified role (Chouhan & Srivastava, 2014).

Broadly classified as core and specialized, competencies are also referred to as technical (hard) and functional (soft, process) respectively. In the field of agricultural extension and rural advisory services, core competencies are those identified by the Global Forum on Rural Advisory Services (GFRAS) Consortium as critical for extension agents throughout the world (Davis, 2015). Core competencies also refer to collective organizational skills upon which the organization bases its primary operations or services (Suvedi & Kaplowitz, 2016). Technical competencies for field extension workers vary according to the area of specialization and responsibility (Suvedi & Kaplowitz, 2016). Special contexts and/or phenomena (such as environmental changes, famine, or natural disaster) usually require specialized competencies. The current study focuses mainly on the technical competencies expected of field level extension agents delivering CSA advisory services in Malaysia.

Competence has always been linked to performance. This is because competencies are seen as behavioural factors that serve as efficient tools in measuring performance (Zaim et al., 2013). This implies that extension agents with high a level of competence tend to perform the job of advisory service more efficiently. Identifying relevant competencies and incorporating them in trainings would improve the performance of extension agents. This, in turn, would bring about improvements in the clientele through, for instance, higher resilience to climate change. Studies have shown high correlation between various competency dimensions, and job performance (Boyatzis, 2008; Mckim, 2013; Singh et al., 2016; Suvedi & Kaplowitz, 2016; Vathanophas & Thai-ngam, 2007; Xu & Ye, 2014; Zaim et al., 2013). Likewise, the performance of Malaysian EAs is determined by their level of competencies (Awang, 1992; Tiraieyari, 2009; Tiraieyari et al., 2010).

However, most of the extension agents interviewed revealed low to moderate levels of both job performance (65.7%) and CSA advisory competence (61.5%). These findings are presented in Figure 1. This corroborates not just the relationship between the concepts but also the need to deconstruct the construct of competence, as it is proven to be a precursor of performance. Studies in the area (Peninsular Malaysia) have already established a causal relationship between competency and job performance among extension agents (Tiraieyari et al., 2010; Umar et al., 2018). Therefore, understanding the structure of competence

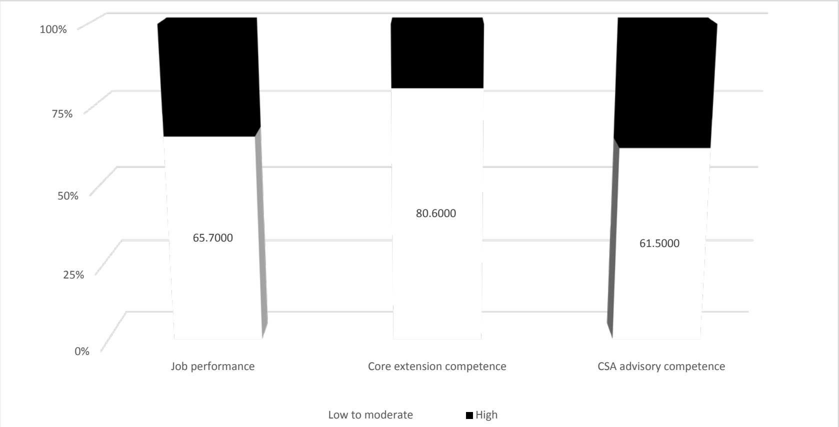

*Figure 1***.** Levels of performance and competencies among extension agents in Malaysia

as achieved in this study is vital in enhancing job performance among extension agents.

Climate-smart Agriculture

Climate smart agriculture refers to the practices that address in an integrated approach the interlinked challenges of food security and climate change. It consists of three main objectives: sustainably increasing food security by increasing agricultural productivity and incomes; building resilience and adapting to climate change; and developing opportunities to reduce the emissions of greenhouse gases as a by-product of agriculture. Extension and rural advisory services could help in achieving these objectives among farming households by facilitating increased access to climate-resilient practices, knowledge information and technologies; as well as enhancing cooperation and income diversification (Sala et al., 2016). CSA practices will also contribute to the achievement of national food security and development goals (Food and Agriculture Organization [FAO0, 2010, 2013; Sala et al., 2016).

Technologies and practices compatible with CSA are plentiful and diverse depending on factors such as location and enterprise. Hence, any innovation that supports one or more of the three features of CSA (productivity, resilience and mitigation) is considered a CSA technology (Khatri-Chhetri et al., 2016). Some of the CSA technologies used effectively in the Rajasthan State of India are categorized as: water-smart (including rainwater harvesting, drip irrigation, drainage management, laser land levelling and cover cropping); energy-smart (including zero/minimum tillage); nutrient-smart (including site specific integrated nutrient management, green manuring, leaf colour chart and intercropping with legumes); carbon-smart (including agro-forestry, fodder management, concentrate feeding and integrated pest management); weather-smart (such as climate smart housing for livestock, weather based crop agro-advisory and crop insurance); and knowledge-smart (including contingent crop planning, improved crop varieties and seed and fodder banks).

According to the Food and Agricultural Organization of the United Nations (FAO, 2010) CSA technologies include: soil and nutrient management (composting manure and crop residues, more precise matching of nutrients with plant needs, controlled release and deep placement technologies or using legumes for natural nitrogen fixation); water harvesting and use (pools, dams, pits, retaining ridges) and water-use efficiency (irrigation and drainage systems); pest and disease control; and resilient ecosystems (control of pests and disease, regulation of microclimate, decomposition of wastes, regulating nutrient cycles and crop pollination).

Enabling and enhancing the provision of such services can be achieved through the adoption of different natural resource management and production practices. It is important to note here that, there is no one solution that fits all situations and remedies all climate change effects in all societies. CSA technologies vary with location due to differences in agro-ecology, farm enterprises, technological advancement and socio-cultural disparities. Malaysia and, especially, its agricultural practitioners, being located in the lower tropics are prone to the adverse effects of climate change (Vaghefi et al, 2016). The present study is therefore, a significant step in locating the competence levels of extension workers in the priority (Khatri-Chhetri et al., 2016; Notenbaert et al., 2016; Shikuku et al., 2016) CSA technologies in Malaysia. In doing so it also uncovers the underlying structure of a potential scale of measuring such competencies.

Although core extension competencies have been categorized into a model of four major sub-components (Suvedi & Kaplowitz, 2016), the study reports that specific technical competencies vary with location and context. There is no theory yet explaining the structure of competencies of CSA advisory services in Malaysia, nor in other locations. Therefore, the expected outcomes of this study also include the exploration of core and specific competencies of EAs in developing countries and their implications.

Principal Component Analysis

The latent structure of a set of items could be empirically determined using principal components analysis (PCA). The items in the scale are grouped into a smaller number of super-variables (Tabachnick & Fidell, 2007). Although, some researchers/academics appreciate the similarity between PCA and factor analysis (Field, 2009; Pallant, 2011) with some asserting that PCA is a form of factor analysis, Tabachnik and Fidell (2007) maintained that while the former was an empirical analysis, the latter was theoretical. Another disparity is in the variance that is analysed in either analysis. Factor analysis (FA), only analyses shared variance and excludes other forms of variance resulting from error and individual variable. Meanwhile, in the PCA, all variance is analysed. Additionally, PCA is adjudged to be a psychometrically sound analytical technique that is less conceptually complex than factor analysis (Field, 2009).

In this study the PCA was used to determine items (or variables, according to Tabachnik & Fidell (2007)) which grouped together to form factors that were independent of one another. This could provide an evidence-based measure of competence in CSA advisory and explain how the scale is latently structured among extension personnel. From a review of studies, over 60 question items were extracted to form a scale of competence in CSA advisory. In collaboration with experts in the academia and practice, these were narrowed down to 31 items that were considered valid and relevant in the study area. This study subjected these 31 items to PCA in order to understand how they are structured and assess their correlation.

METHODOLOGY

Participants

The population studied was made up of all public extension personnel in Peninsular Malaysia, consisting of supervisory cadre and field level extension agents in general.

The sample frame was obtained after compiling lists of personnel from the following agencies: MADA, KADA, IADA, RISDA, DOA, DOF and DVS. According to the Global Forum for Rural Advisory Services (GFRAS) there are a total of 1355 extension workers in Malaysia as of 2012 (Swanson & Davis, 2014). Computation using Raosoft® Sample Size Calculator set at confidence level of 95% and acceptable margin of error of 5% indicated that a sample size of 300 was appropriate. The sample selection was conducted using Random Number Generator. The principle of sampling implores the use of as large a sample size as possible considering available resources. As Kumar (2011) puts it “the greater the sample size, the more accurate the estimate …”. Therefore, a higher number of respondents (350) was selected. This was also meant to off-set non-response and unusable questionnaires, as 300 is the minimum acceptable sample size for PCA (Tabachnick & Fidell, 2007). After retrieval and cleaning of the instrument a total of 341 forms were considered to have enough information and were retained.

In concurrence with the findings of Tiraieyari (2009), the socio-demographic profile of respondents indicated that the majority (87%) of extension personnel in the study area were men. Similar studies in other regions also indicate that agricultural extension is a male-dominated profession (Diehl et al., 2015; Kwaw-mensah, 2008). The findings of the socio-demographic profile also indicated that 61% of the respondents were 40 years of age and below, and perhaps willing to experiment and learn new phenomena such as CSA advisory in their line of work. Most (77%) of the respondents occupied the job position of agricultural assistants while the remaining 23% were agricultural officers. In terms of educational attainment, 35% indicated having SPM (equivalent to high school) certificate while only 12% reported having a university degree. A 2014 study in Malaysia revealed a similar trend when it found that 46.7% of extension agents held SPM while 10% held bachelor degrees (Tiraieyari et al., 2014). This relatively low educational attainment calls for enhanced training and capacity-building of personnel.

Measure

To measure the competency of extension workers in delivering CSA advisory services to farmers, a scale of 31 items was put together based on literature from World Meteorological Organization (WMO)’s climate services competencies, Food and Agricultural Organization of the United Nations (FAO), Global Alliance for Climate Smart Agriculture (GACSA) and the United Kingdom Department for International Development (DFID)’s climate and environment advisers competency framework among others (DFID, 2011; FAO, 2010, 2013; Sala et al., 2016; Khatri-Chhetri et al., 2016; WMO, 2016). The instrument was assessed for face and content validity by experts in Faculties of Agriculture and Educational Studies in Universiti Putra Malaysia, and officials of the Department of Agriculture (DOA), Malaysia and was found to be a valid measure of training needs on climate change competencies in Malaysia. Moreover, it was pretested among 30 extension personnel that were not part of the study sample and it was found to have attained an acceptable level of reliability.

Statistical Analysis

In this study, IBM® SPSS® version 23 was used in performing the analyses. Varimax form of orthogonal rotation was employed as there is no underlying theory about which variables should be compiled into which component and the association is basically empirical. Therefore, any label or name attached to a resultant component is just a reflection of the variables associated with it (the component). This is the case in CSA advisory as an item of competency can fit into different components depending on the area of the study and farming system practices. For instance, ability to disseminate weather forecast information can be seen as a strategy in facilitating adaptation. At the same time, it can also lead to increased productivity if the information is applied appropriately by the client. Therefore, such items can be interpreted based on components they are assigned in relation to other items. A step-wise approach to the statistical procedure is presented herewith:

Selecting and Measuring a Set of Variables. As explained earlier, the variable items in this study were derived from literature. In collaboration with professionals, the items were screened and the best-fit were selected for inclusion in this study. These were measured using a 5-point Likert-type scale in a structured questionnaire. The reliability of the scale was established.

Assessing the Appropriateness of the Data. One of the important requirements of PCA is adequate sample size. This is because large sample sizes tend to produce more reliable correlation coefficients (Tabachnick & Fidell, 2007). This study used 341 cases which is safely an acceptable sample size. Another requirement for factor analysis is the level of inter-correlations among the items (Pallant, 2011). This could be assessed from the SPSS output through the Bartlett's test of sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO). Meanwhile, Bartlett's Test tests the hypothesis that the population correlation matrix is an identity matrix. An identity matrix has all the correlation coefficients as zero, and is not suitable for factor analysis. Therefore, the Bartlett's Test is expected to be significant ($p < 0.05$). Likewise, the reliability of the scale was established. These were tested and the data was found to be appropriate for PCA.

Extracting a Set of Factors. PCA aims to extract maximum variance in the data set with few components thereby summarizing large data set into a smaller number of components for interpretation and comprehension (and further analysis). The researchers have to decide on the number of components that explain the variance. It is an issue of judgement while trying to balance the need to have a simple solution with the least possible number of factors; and the need for a solution that explains as much of the variance as possible. There are a few techniques found to be handy in deciding the number of factors to extract. They include: Scree plot, Kaiser's criterion and parallel analysis (Pallant, 2011). To prove the superiority of parallel analysis, all the techniques were conducted for this study.

The scree plot is a visual method of determining the number of components to extract. It is basically a graph of eigenvalues on the Y-axis against the factors on the X-axis. It displays relative importance of each factor with few factors on the sharp descent and the remaining more or less on the horizontal. SPSS uses the Kaiser's criterion to retain factors by default, depending on the settings. However, the Kaiser's criterion is widely criticized as being unreliable and for overestimating (Field, 2009).

To counter these shortcomings, Horn's parallel analysis was conducted. It generated eigenvalues from many random hypothetical sets of data with similar characteristics as the data being analysed. All factors with eigenvalues greater than those from the randomly generated data were retained (Dinno, 2009; O'Connor, 2000) taking into consideration the argument by Field (2009) that it is always better to retain too few than too many factors.

Rotation. The factors extracted were relatively complex to interpret. To simplify the output and enhance its scientific usability, the factors were rotated to maximize loading of each item on one of the extracted factors while suppressing it on the other factors (Tabachnick & Fidell, 2007). The orthogonal rotation is suitable for analyses when their underlying factors are independent and correlated (Tabachnick & Fidell, 2007) and when variables are not theory-driven (Field, 2009). It is assumed to be clearer for interpretation. In this study, Varimax type of the orthogonal rotation was considered most appropriate and, therefore, conducted.

RESULTS

After subjecting the 31 items to PCA, the KMO value obtained was 0.847. This is considered acceptable as it is greater than 0.7, and the data set is appropriate for factor analysis. Bartlett's Test indicated that the correlation matrix is significantly different from correlation matrix ($p < 0.001$). Reliability was measured in the form of internal consistency and the Cronbach's alpha was 0.926. Other assumptions such as factorability, linearity and absence of outliers were fulfilled as prescribed by Pallant (2011). The commonalities, which refer to the amount of variance an item variable shares with all the other variables in the analysis, were found to be ranging between 0.599 and 0.871 with a mean of 0.761. By default, SPSS uses the Kaiser's criterion and extracts all factors with eigenvalues of 1 and above. Using this criterion, seven factors were extracted. These factors explained 76.053% of the total variance. To ensure the retention of all the seven factors, a parallel analysis was carried out and the findings were discussed subsequently. The scree plot is known to be subjective. In this instance, shown in Figure 2, there are three inflection points that could be considered to retain 3, 4 or 7 factors respectively.

A parallel analysis was conducted in which the PCA for 100 sets of randomly generated data with similar specifications (341 cases and 31 variables each) as the data in this sample were obtained. The outcome as shown in Table 1 indicates that only the first five components have parallel analysis eigenvalues greater than actual eigenvalues. Therefore, there are five statistically significant components in the actual data set and that the Kaiser's criterion overestimated these to seven.

The next step was to conduct another PCA restricting the factors to be extracted to five. This differed from the initial PCA where the decision was left to SPSS which initially extracted seven items based on their having eigenvalues greater than 1. The rotated component matrix is reproduced in Appendix 2. This had 68.7% of the total

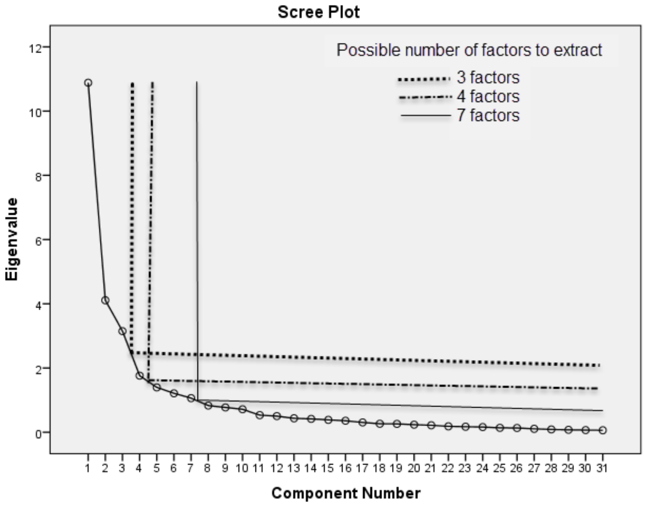

Figure 2. Scree plot

Table 1

Eigenvalues from PCA and parallel analysis

Component number	Actual eigenvalue from PCA	Criterion eigenvalue from Parallel Analysis	Decision
1	10.883034	1.685717	Accept
2	4.109788	1.593598	Accept
3	3.147663	1.518111	Accept
4	1.762700	1.454542	Accept

Table 1 *(Continued)*

Component number	Actual eigenvalue from PCA	Criterion eigenvalue from Parallel Analysis	Decision
5	1.397422	1.396918	Accept
6	1.213051	1.354558	Reject
7	1.062780	1.306277	Reject

Table 2

Total variance explained by the factors extracted

Component	**Number of items**	**Initial**			**Rotation**		
		Total variance	Percentage variance	Cumulative percentage	Total variance	Percentage variance	Cumulative percentage
1	12	10.883	35.107	35.107	7.883	25.428	25.428
2	8	4.110	13.257	48.364	5.326	17.181	42.609
3	4	3.148	10.154	58.518	3.360	10.840	53.449
4	4	1.763	5.686	64.204	3.195	10.306	63.756
5	3	1.397	4.508	68.712	1.536	4.956	68.712

variance in the construct explained by the five factors extracted. The breakdown of the factor loadings and variance explained by each factor are shown in Table 2.

DISCUSSION

Overall, five major components explained 68.7% of the total variance in the CSA advisory competence scale. Having been subjected to parallel analysis, these are considered more statistically reliable than the initial seven factors suggested using Kaiser's criterion. The components were subsequently interpreted. The first component is composed of 12 items such as competence in 'demonstrating site-specific nutrient management practices', 'cultivation of improved (climate-smart) varieties' and 'agricultural marketing strategies'. These explained 35% variance before rotation and 25% after rotation. Their initial eigenvalue was 10.88 which became 7.88 after rotation. The component corresponded closely to the first pillar of CSA and, hence named *Productivity and food security enhancement competencies*. The second component was made up of 8 items including ability to 'facilitate climate change resilience via participatory approach' and 'promote index based insurance' and was named

Resilience and adaptation competencies as it coincided with the second pillar of CSA. The component was responsible for about 13% of the variance which improved to about 17% after rotation. The eigenvalue also improved from 4.11 to about 5.33 after rotation.

Four variables combined to form the third factor which had initial and rotated eigenvalues of about 3.15 and 3.36 respectively. The variance explained was 10.15% and 10.84% before and after rotation respectively. Because it was made up of items including 'ability to communicate climate information through effective ICTs' and 'translate CSA information into local vernacular' it was named *Information management & facilitation competencies*. The fourth component was made up of four items including knowledge of environmental protection practices and ability to 'demonstrate zero/minimum tillage'. It was thence named *Mitigation and greenhouse gas (GHG) reduction competencies* in line with the third pillar and was responsible for 5.7% and 10.3% of the variance before and after rotation respectively. Its eigenvalue of 1.76 improved to about 3.2 after rotation. Finally, the fifth component was made up of 3 *Knowledge* items that had to do with understanding weather forecast, extreme weather events and enhancing adaptive capacity among vulnerable groups. Its eigenvalues were about 1.8 and 3.2 before and after rotation respectively. These correspond with a variance of 4.5% and 5% respectively. The complete list of constituent items is shown in Appendix 1.

It should be noted that after having components coinciding with the three pillars of CSA (Sala et al., 2016), this study has found an additional component that could aid in disseminating information and facilitating adoption of CSA technologies. This component is equally important as successful advisory services rely heavily on the competence of agents in soft skills such as communication and facilitation skills (Suvedi & Kaplowitz, 2016; Umar et al., 2017).

The factor that explained the highest proportion of variance in the CSA competence scale in Malaysia is the productivity and food security component. This has also been at the forefront of international climate change adaptation efforts and policies (FAO, 2010, 2013; Sala et al., 2016). This confirmed that in Malaysia, as in other climes, there is a defined need for EAs to have high capacity and proficiency in delivering advisory services on technologies that enhance farmers' productivity and promote food security in the society.

This was followed by resilience and adaptation component. This is also critical as farmers' resilience is vital to not just their agricultural enterprises but also ensures sustainable livelihood of the farm families (Devendra, 2012; Sala et al., 2016). Therefore, EAs should be competent in transmitting innovations that enhance climate change adaptation and resilience to the clientele. The next important component had to do with information management and facilitation. The relevance of skills in communication and information technologies as well as information management among EAs in Malaysia and around the world has already been established (Suvedi & Kaplowitz, 2016; Umar et al., 2017). Communication skills are core extension competencies required in all field advisory services. Such soft skills should be mandatory in extension trainings and capacity development sessions.

Agricultural activities also contribute to GHG emissions, exacerbating global climate change in the process (FAO, 2013; Khatri-Chhetri et al., 2016; Sala et al., 2016). Hence, it is vital for the advisory services providers to be competent in delivering technologies capable of enhancing the mitigation of climate change and reducing environmentally harmful practices. Therefore, Mitigation and GHG reduction component is another important sub-construct of CSA advisory competencies in Malaysia.

IMPLICATIONS

The findings imply that CSA advisory competency among Malaysian extension workers has a five component structure. This should be taken into consideration when designing trainings and capacity development initiatives to make sure all aspects are covered in enhancing the competencies of extension workers in delivering CSA technologies and practices among the clientele. The findings of the study could also be beneficial in climate change adaptation and mitigation programmes and contemporary food security and agricultural development policies. This study should be replicated, by testing the scale in other locations and contexts. To aid theory development in this field, future studies should also look at the predictors and outcomes of competency in extension work performance, thereby situating the competency construct in a theoretical framework.

CONCLUSION

CSA practices are vital in climate change-prone farming communities. For effective adoption and utilization of such practices, the extension workers have an important role to play which requires them to be competent. After parallel analysis, the competency scale has been shown to be made up of five major components. Hence, the PCA is effective in reducing the dimensions of the CSA competency scale from 31 items to five components. Likewise, the parallel analysis has been proven to be the best extraction criterion in the PCA of CSA competencies among extension agents in Peninsular Malaysia.

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APPENDICES/ SUPPLEMENTARY DATA

Appendix 1: List of items in the scale

1. I can teach cover cropping technique
2. I can demonstrate site-specific nutrient management
3. I can demonstrate ISFM practices
4. I can advise on cultivation of improved (climate smart) crop varieties
5. I can demonstrate mixed cropping techniques (any of crop rotation, intercropping etc.)
6. I can demonstrate mixed farming techniques (any of agro-forestry, crop-livestock)
7. I can promote IPM practices for CSA
8. I can train on alternate wetting and drying (AWD)
9. I know how to disseminate eco-friendly agronomic practices
10. I can facilitate agricultural marketing strategies
11. I can disseminate rainwater harvesting technique
12. I can facilitate diversification of enterprises
13. I can facilitate climate smart rural development activities
14. I can facilitate climate change resilience via participatory approach
15. I can coordinate vulnerability risk assessments
16. I can promote index based insurance
17. I can evaluate adaptation options
18. I understand resilience to climate change
19. I can mobilize resources for adaptation
20. I understand basic agro-meteorological parameters
21. I am able to build linkages between CSA stakeholders
22. I can translate CSA information into practical guidance
23. I am able to communicate climate information through effective ICTs
24. I can translate CSA information into local vernacular
25. I know environmental protection practices
26. I can demonstrate zero/minimum tillage
27. I understand the impact of climate change on livelihoods
28. I know pro-poor options for low carbon development
29. I know how to enhance the adaptive capacity among vulnerable groups
30. I can report extreme weather events
31. I understand weather forecast

Appendix 2: Rotated component matrix of CSA competencies

	Component*				
	1	2	3	4	5
ACP22	**0.844**	0.208	0.021	0.172	0.045
ACP18_R	**0.833**	0.172	0.158	0.152	-0.005
ACP16	**0.807**	0.187	0.094	0.056	-0.053
ACP17	**0.788**	0.109	0.006	-0.047	0.279
ACP24	**0.784**	0.140	0.019	0.316	-0.053
ACP21	**0.776**	0.100	0.035	0.033	0.228
ACP19	**0.775**	0.047	0.046	0.321	-0.032
ACP23	**0.752**	0.143	0.009	0.330	-0.014
ACP20	**0.743**	0.086	0.054	0.179	0.099
ACP14	**0.730**	0.243	0.100	0.193	-0.204
ACP15_R	**0.681**	0.052	-0.016	0.265	-0.033
ACP25	**0.613**	0.348	0.064	-0.032	0.210
ACP8	0.171	**0.904**	0.043	-0.092	0.034
ACP7	0.113	**0.845**	0.204	-0.170	-0.078
ACP9	0.296	**0.796**	-0.164	0.072	0.016
ACP11	0.060	**0.792**	-0.095	0.293	0.144
ACP6	0.202	**0.784**	0.240	-0.188	0.001
ACP10_R	0.123	**0.752**	-0.162	0.373	0.075
ACP12	0.204	**0.675**	-0.186	0.430	0.026
ACP13	0.220	**0.639**	0.109	0.265	-0.234
ACP4	0.017	0.089	**0.865**	0.105	-0.008

Appendix 2 *(Continued)*

	Component*				
	1	2	3	4	5
ACP3_R	0.089	0.007	**0.843**	0.051	0.016
ACP5	0.073	0.055	**0.758**	0.084	0.159
ACP2	0.029	-0.105	**0.714**	0.303	0.032
ACP27	0.437	-0.010	0.163	**0.727**	0.111
ACP26	0.411	0.070	0.280	**0.721**	0.027
ACP28	0.364	0.136	0.227	**0.700**	0.013
ACP29	0.301	0.232	0.299	**0.660**	0.040
ACP1	0.015	-0.114	0.431	0.178	**0.687**
ACP31	0.141	-0.037	0.227	0.065	**0.677**
ACP30_R	0.031	0.120	-0.260	-0.055	**0.490**

*Component: 1 = Productivity and food security enhancement; 2 = Resilience and adaptation; 3 = Information management & facilitation; 4 = Mitigation and greenhouse gas (GHG) reduction; and 5 = Knowledge transfer