



Designing and Evaluating the Extent of Application of e-Learning Module of Climate-Smart Horticulture on High-Value Horticultural Crops of Arunachal Pradesh

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ABSTRACT

e-learning is the foundation of current edutainment and civilization. e-learning is a modern tool in agriculture/ horticulture to spread specific knowledge to farmers as well as scientific information. Assuming the important aspect of e-learning, the purpose of this study was to determine the extent of e-learning module implementation on Climate-smart horticulture (CSH) on high-value horticultural crops viz., Apple, Kiwi, and Large Cardamom. The research was carried out in two districts of Arunachal Pradesh, namely West Kameng and Lower Subansiri. A total of 200 horticultural farmers were selected for the study. An e-learning module on CSH was developed using Adobe Captivate software based on the knowledge level, attitude, and information need of the respondents on the identified crops. In the study, it could be stated that there was a high extent of application of e-learning on csh on high-value horticultural crops by respondents using the e-learning module on CSH. The results of structural equation modelling (SEM) showed that user satisfaction had a positive significant influence on intention to use an e-learning module.

Keywords: Climate-smart horticulture; e-learning module; Adobe Captivate; Structural equation modeling.

Crop production is highly sensitive to climate. It is affected by long-term trends in average rainfall and temperature, interannual climate variability, shocks during specific phenological stages, and extreme weather events (IPCC, 2012). Agriculture including horticulture nevertheless is not just a prey of climate variation; it is moreover a weighty derivation of climate change. Agricultural undertakings are directly accountable for 10–12% of human-generated greenhouse gas emissions, eliminating emissions consequential from fertilizer production and fuel use. (Pye-Smith, 2011). Climate change is one of the biggest challenges to agricultural production systems. Agriculture is one of the foremost sectors contributing to global emission of greenhouse

gases (GHG) through the use of fossil fuels, renewable energy, machinery, and agro-chemicals that eventually undermined the conventional age-old production systems. Hence the emerging prerequisite is a climate-smart approach to sustainable food production (Singh and Singh, 2017). The world needs to turn into an effective, adaptable, and sustainable form of crop production in a changing environment to feed an ever-increasing population of the globe *i.e.* with the changing climate the crop production strategies do need to change. CSH is an agrarian strategy that boosts efficiency; adaptability; cuts greenhouse gases; maintains carbon sinks and climate, helps sustain balanced food and nutrition. CSH helps in tackling the undesirable impacts

of fluctuating climate. Kirwa *et al.* (2020) emphasized the significance of Climate Smart Agricultural Practices in NEH states, stating that their applicability could result in a long-term increase in agricultural productivity and cashflow while plummeting greenhouse gas emissions, thereby increasing resilience and responding to changing climatic conditions.

When executed properly, various ICT platforms are shown to substantially enhance the learning experience, dramatically improve learning outcomes, reinforce the application of learning to the digital era, and drastically motivate teaching - learning process into an enthralling, dynamic approach connected to real life (Malik and Godara, 2020). ICT in agriculture has evolved as a pertinent aspect of rural transformation, intended to improve rural livelihoods through advanced digital technologies. The apposite application ICT has the supremacy to make rural communities self-sufficient (Dhaka and Chayal, 2010). The development of easy and reliable scientific techniques that can direct farmers' decision-making on a periodic and long-term scale is vital to the preparation of climate change approaches. E-learning offers new opportunities for both educators who are agricultural scientists, subject matter experts, faculties of teaching institutes, and learners who are predominantly farmers, rural youth, *etc.* to enrich their teaching and learning experiences, through virtual environments that support not just the delivery but also the exploration and application of information and the promotion of new knowledge. The focus for any exploration of the state-of-art of e-learning is therefore no more and no less than the combination and convergence of the most advanced features of digital information and communication technologies.

Therefore, sizing the exigency of intervention of e-learning in CSH, the present study is proposed.

METHODOLOGY

A quasi-experimental research method was adopted in the study to get sufficient and reliable details about the variables. The study was carried out in the two districts of Arunachal Pradesh, namely Lower Subansiri and West Kameng. Two most horticulturally relevant community and rural development (C&RD) blocks from each listed district were deliberately selected, *i.e.* C&RD blocks Dirang and Kalaktang from district of West Kameng, and C&RD blocks Ziro-I and

Ziro-II from district of Lower Subansiri. A cluster of two villages from each established C&RD block was then selected, taking into account the significance and contiguity of horticulture. Consequently, villages Rungkhung and Zimthung were reported from the Dirang C&RD block. Similarly, villages *viz.*, Shergaon and Rupa were being finalized from Kalaktang C&RD block. Furthermore, the two villages were considered for study from Ziro-I C&RD, namely Hari and Siro, and the Deed and the Yachuli villages were selected for study from Ziro-II C&RD block. By following the probability proportional to size sampling (PPS), a total of 200 horticultural farmers ($n_{a(Apple)} = 67$, $n_{k(Kiwi)} = 70$, and $n_{lc(Large Cardamom)} = 63$) were selected for the study.

In addition, the study proposed a hypothesis to better understand the relationship between user satisfaction and e-learning module use intention an e-learning module. Accordingly, hypothesis (H1): User satisfaction (US) has a positive significant effect on intention to use an e-learning module (ITU).

For developing an e-learning module on CSH, the ADDIE model developed by Food and Organization (FAO, 2011) was used. The ADDIE model consisted of five stages *viz.*, Analysis, Design, Development, Implementation and Evaluation, and the detail of the stages are described below. The software Adobe Captivate 2017 was utilized in developing the present e-learning module.

Analysis : The module started with a needs analysis to determine whether: training/knowledge of CSH was obligatory to fill any gap in knowledge and skills, and e-learning was the superlative elucidation to deliver the training/learning. Need analysis allowed the documentation of overall, elevated course goals. Another decisive step taken into consideration in the study was target audience analysis in which design and delivery of e-learning content was explicated considering the key characteristics of the learners (e.g. their prior knowledge and skills, access to technology, learning context and topographical provenience).

Design : The study kept clear and concrete activities in this stage of designing. This stage comprised of the following activities *viz.*, framing a set of learning objectives vital to attain the overall course objective; outlining the order in which the objectives should be achieved *i.e.* sequencing; and selection of instructional media, evaluation and delivery strategies. As a result, a



Fig. 1. Climate-smart plant protection practices of apple

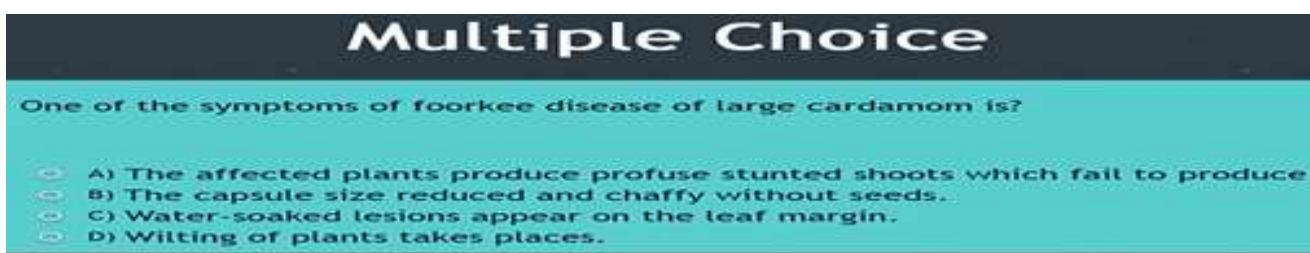


Fig. 2. Assessment on climate-smart plant protection practices of large cardamom

blueprint was developed which was used as a reference for developing a course. This blueprint exemplified the course structure (e.g. its arrangement in courses, units, lessons, activities); the learning objectives concomitant with each unit; and delivery procedures and formats (e.g. asynchronous; interactive self paced materials) to deliver each unit.

Development: During this 'Development' stage the contents for the e-learning module were developed. Depending on the existing resources the content of e-learning varied significantly. The e-learning module developed in the study was practically asynchronous. Three main steps for the development of multimedia interactive content considered in the study were: (1) Content Development: This step included writing/gathering all the vital knowledge and information on climate-smart package of practices of identified crops viz., apple, kiwi, and large cardamom; (2) Creation of the story board: incorporation of instructional methods i.e. instructional elements needed to support the learning process and media elements. It was mainly a file detailing all the components of the final interactive items, which included text, video, images, interactions, evaluation tests; and (3) Courseware Development: This step kept consideration on developing media and interactive components, producing the e-learning course in different formats for compact disc read-only memory (CD-ROM), flash drive, hypertext mark-up language (HTML) and web delivery and integrating the content elements into a

learning platform so that learners could access it.

Implementation : In this stage, the e-learning course was delivered to learners. The course ware was delivered to the respondents/farmers in the form of CD-ROM, flash drive, HTML etc.

Evaluation : In this stage, learners feedback, attainment of learning objectives, transfer of knowledge and skills related to particular domain and the impact of module were being evaluated.

RESULTS AND DISCUSSION

The study summoned a statistically valid design to examine the extent of application of e-learning by respondents on CSH on high-value horticultural crops. During the research, three knowledge tests were developed to examine 'Knowledge acquired on CSH' respecting apple, kiwi, and large cardamom. The respondents (apple farmers, kiwi farmers, and large cardamom farmers) have been exposed and administered two episodes of knowledge test in different time intervals.

Table 1. Change in the knowledge level of the respondents

Farmers	Mean		Z-value	Cohen's d (effect size)
	Before	After		
Apple farmers	14.90	18.73	8.19*	1.47
Kiwi farmers	8.97	12.21	8.83*	1.59
Large cardamom farmers	10.60	13.16	5.45*	1.47

(*Sig @ p < 0.05)

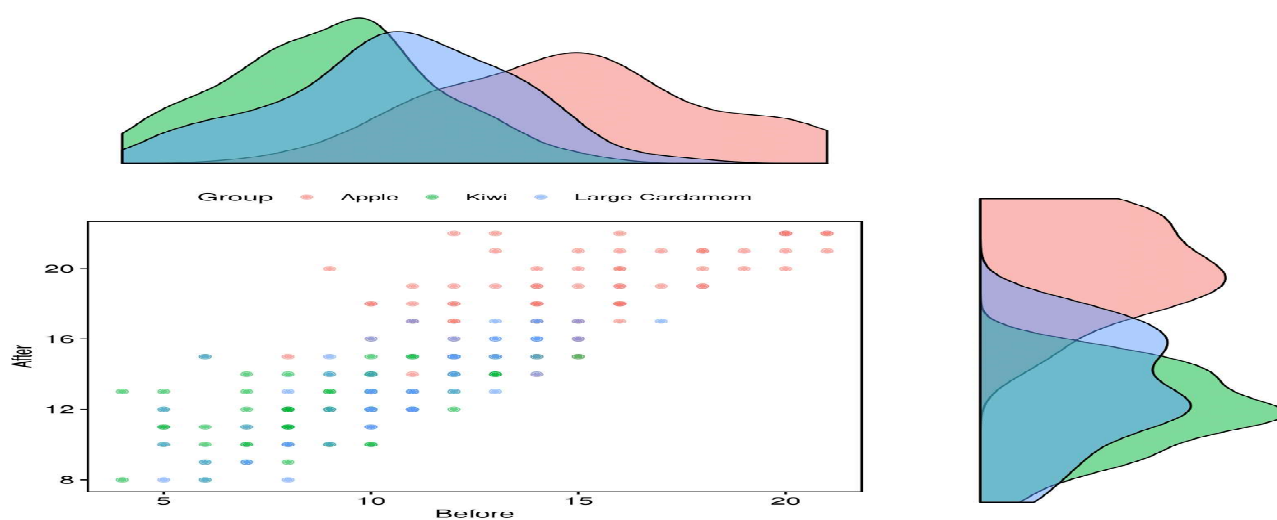


Fig.1. Marginal plot and densitograms of before and after knowledge test scores

The research was subjected to examine whether there was any significant change in knowledge of respondents on CSH concerning apple, kiwi, and large cardamom after administration of respective e-learning modules. In due course Z-test was performed owing to existence of sample size more than 30, that is $n_{a(Apple)} = 67$, $n_{k(Kiwi)} = 70$ and $n_{lc(Large Cardamom)} = 63$.

A keen perusal of Table 1, wherein the Z statistic values of 8.19, 8.83, and 5.45 concerning apple, kiwi, and large cardamom respondents could estimate that there was a significant increase in knowledge of respondents on CSH concerning apple, kiwi, and large cardamom after administration of respective e-learning modules. A visualization of 'marginal plot' and 'densitograms' on the distribution of before and after knowledge test scores achieved by apple, kiwi, and large cardamom farmers/respondents of study is depicted in Figure 1.

The e-learning module on CSH with respect to apple, kiwi and large cardamom provided learning capsules in a systematic order. During the study, it was reflected that visuals & graphics associated in the e-learning module with different stages on the package of practices of crops vitalized and made instructions/teaching intervention more realistic and concrete. The cognitive ideas acquired/learned through the e-learning module were able to be reflected and implemented in CSH farming practices in near real-time by the respondents. This led to impress ideas more indelibly on the mind of users. The respondents could picture experiences outside one's own traditional/conventional environment of farming. The e-learning module could

overcome the language (scientific jargon) barrier, comprehension, and understanding, thereby combating verbalism or unnecessary or meaningless form of words. It made the farmers/respondents learn faster, more, and remember longer. The scientific findings in the study could evidence that e-learning module could make respondents attracted and hold attention, aroused and sustained interest, changed attitude or point of view, stimulated creative thinking and motivated action on CSH.

To determine the extent of application of e-learning on CSH on high-value horticultural crops by respondents through the application of e-learning module concerning apple, kiwi, and large cardamom, the effect size of 'after' and 'before' the application of e-learning module was examined by using 'Cohen's d' as depicted in Table 1. With the respective Cohen's d values of 1.47, 1.59, and 1.47 for knowledge on climate-smart cultivation of apple, kiwi, and large cardamom, it could be reported that there was a high extent of application (*Sawilowsky, 2009*) of e-learning on CSH on high-value horticultural crops by respondents through the application of e-learning module. Besides they expressed that the text attached with audio as well animation used was suitable for the users who could not read and write. *Chong et al. (2005)* emphasized the significance of animations in the e-learning module towards increasing the pensiveness of motivational factors amongst the participants. The study could proclaimed that the above critical observations were the most astounding causes for getting a significant increase on knowledge acquired

Table 2. Results of reliability and validity of the scale

Constructs	No. of items	Indicators	Factor loadings	AVE	CR	Cronbach's alpha
US	4	us1	0.77	0.77	0.93	0.94
		us2	0.85			
		us3	0.92			
		us4	0.96			
ITU	7	itu1	0.67	0.59	0.88	0.88
		itu2	0.67			
		itu3	0.81			
		itu4	0.85			
		itu5	0.64			
		itu6	0.68			
		itu7	0.62			

by respondents apropos of CSH on high-value horticultural crops after application/administration of e-learning module to the respondents. The results supported the findings of *Rani et al. (2017)*, *Mahalakshmi et al. (2016)*, *Som (2015)*, *Rani and Rao (2014)*, *Bhaurao (2013)*, *Yadav (2013)* and *Anandaraja et al. (2006)*.

The approach of SEM was employed to see how well a given conceptual model fits the data and to find structural relationships amongst latent constructs. It was employed and see if there was any link between user satisfaction and the intention to use an e-learning module. Maximum Likelihood Estimation (MLE) was used to conduct the SEM. When multivariate normality is applied, it is one of the most used approaches. Figure 4 shows the research's final model. The curving two-way arrow indicates the covariance or correlation between the stated set of measurement errors for the associated items owing to recurrence (Figure 4). As a result, the

corresponding errors were established as “free parameter estimates” utilising the double-headed arrow (*Bryne, 2016*).

To examine the convergent validity of scales, the researchers used the Average Variance Extracted (AVE) approach. Table 2 shows that the scales US and ITU have AVEs of 0.77 and 0.59, respectively. The findings stated that all of the AVE values were higher than the widely accepted cutoff of 0.50 (*Fornell and Larcker, 1981*). Furthermore, by referring to the SEM as displayed in Figure 4, it can be reported that the item statements in the scales notably US and ITU have factor loading in the range of ‘0.77 – 0.96’ and ‘0.62 – 0.85’, respectively. The study's constructs were internally valid, based on the specified range of factor loadings (*Hair et al., 2010*).

Cronbach's alpha was used to assess the internal consistency and item reliability of scales. Composite Reliability (CR), on the other hand, has been used to assess

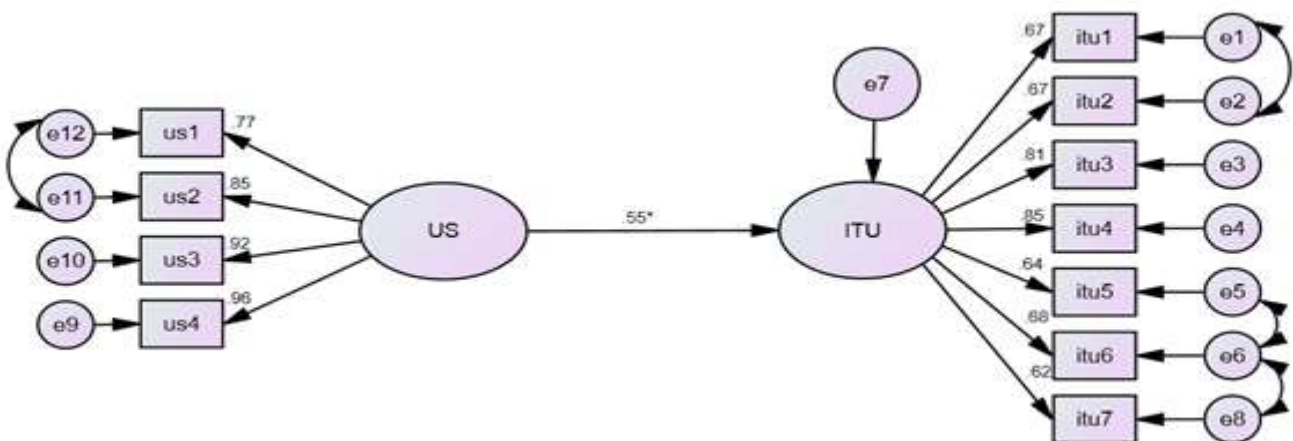
**Fig. 4. SEM showing relationship between user satisfaction and intention to use an e-learning module**

Table 3. The overall model's fitness indices

Fitness indices	Criteria	Results
χ^2/df	< 3.00 (Kline, 2005)	1.67
CFI	≥ 0.90 (Klem, 2000; McDonald and Ho, 2002)	0.98
TLI	≥ 0.90 (Klem, 2000; McDonald and Ho, 2002)	0.98
SRMR	≤ 0.08 (Hu and Bentler, 1999)	0.53
RMSEA	< 0.07 (Steiger, 2007)	0.06

scales' overall reliability. The Cronbach's α and CR of the US and ITU scales, respectively, have exceeded the standard value of 0.70, as can be shown (Table 2).

The model fit indices were examined using AMOS 20 as shown in Table 3. The model fit index (U^2/df) was 1.67, which was less than 3.00, and so met the requirement of acceptable model fit. Both the Comparative fit index (CFI) and the Tucker-Lewis index (TLI) have been estimated to have a value of 0.98, confirming a satisfactory model fit as the acceptance criterion were >0.90 . Standardized Root Mean Square Residual (SRMR) was reported to be 0.53, indicating a strong model fit as the acceptance limit was 0.08. Likewise, the model's Root Mean Square Error Approximation (RMSEA) indicated that the measured value of 0.06 was well within the realm of satisfactory model fit, as the acceptance cutoff was 0.07. Table 3

indicated that the generated model met all of the requisite criteria. As a result, the analysis was used to evaluate the relationships between the constructs that had been hypothesised.

Hypothesis : The findings revealed that US had a positive significant influence on ITU ($\beta = 0.36$ at $p < 0.001$). As a result, H1 ($p < 0.001$) was supported and accepted.

CONCLUSION

High extent of application of e-learning on CSH on high-value horticultural crops by respondents through application of e-learning module inferred evolved intellect of the farmers and their approval of innovative extension education methodologies. User satisfaction was found to have a positive significant influence on intention to use an e-learning module. Thus the study concluded that farmers were enthusiastic to exploit innovative instructional tools, thereby encouraging further investigation and interpolations in the field of extension education. The e-learning module designed in the study could also be efficiently used by extension functionaries and varied institutions for training their target clients about CSH on high-value horticultural crops. It could also benefit numerous scholars and various program developers to concoct a persuasive approach to generate cognizance about CSH through e-learning modules in the future.

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