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Evaluation of Training on Good Agronomic Practices for Seed Yam Production in Nigeria

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Abstract: The second phase of the Yam Improvement for Income and Food Security in West Africa (YIIFSWA II) project was implemented through a strong collaboration between research and private sector. Private seed companies were provided with a wide variety of training and development activities on good agronomic practices (GAPs). However, the effects of the training activities were yet to be evaluated. This paper evaluated the contribution of the training on high-quality seed yam production through paying particular attention to how it was tailored to the needs of various farmers, and how the knowledge gained was transferred to the field. The study employed an applied Kirkpatrick model and descriptive statistics to measure the indicators of training effectiveness. Results from a statistical population of 172 farmers using 179 demonstration fields showed that the farmers' training on GAPs was effective, based on four criteria of the Kirkpatrick training evaluation process. The satisfactory results at the beginning of the hierarchical model have implications on the satisfactory results at the end. Improving the effectiveness of a training depends on defining factors such as (i) Training based on satisfaction in meeting the needs of your trainees and the seed production business; (ii) Training based on learning objectives in improving the trainees' skills and knowledge; and (iii) Training based on learner attitude change in applying new skills and knowledge in the fields. Conclusions drawn from this study indicated that the training was a reasonable value-added mechanism of improved agricultural knowledge and practices for enhancing high-quality seed yam production in Nigeria.

Keywords: effectiveness; knowledge; seed production business; learning outcomes; Kirkpatrick's model

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1. Introduction

Yam (*Dioscorea* spp.) is considered a major food and cash crop in West Africa; more than 100 million people depend on it for their food security and livelihoods. About 95 percent of global supply was produced on 8.3 million hectares in 2020 in the region [1]. Yam has a high socio-cultural value, serving for thanksgiving, marriage and other celebrations, giving it prominence over other food crops in West Africa. The crop is very vital for the region but inopportunely limited by several constraints. The most important challenges are seed-related, which could be designedly coined as the "4As", implying: (i) quality Assurance, (ii) Availability, (iii) Accessibility and (iv) Affordability. These obstacles have been intricately linked with farmers' inability to gain higher yields and generate viable incomes [2].

To tackle "A" challenges and strengthen the yam sector as a critical step towards improving the livelihoods and food security of millions of poor farmers who grow, sell and eat yam [3], the second phase of the Yam Improvement for Income and Food Security in West Africa (YIIFSWA) project was initiated to work extensively with national partners. The 5-year YIIFSWA-II project was to develop and provide a functional commercial yam seed system in Nigeria and Ghana, in order to benefit smallholder farmers through timely and affordable access to high-quality seed yam tubers of improved varieties. Empowering smallholder yam producers with the seeds of improved varieties for increased productivity and better income, while enabling women to profitably participate in the commercial seed value chain, were key in achieving the project vision of demand–creation production systems and provision of an enabling environment for improved varieties of seed yam to flourish. To realize this vision of an economically sustainable, commercial yam seed system in Nigeria and Ghana, the project team coached and worked closely with the private seed companies to implement their business plans and organized trials to demonstrate the value of quality seed yam of improved varieties, with a specific focus on engaging women entrepreneurs. The project provided trainings to the seed companies, which in turn trained the farmers. This process became strategically important for the seed companies to benefit from the training activities, demonstrate the results achieved and thus justify the investments made [4–7]. Therefore, evaluation of training becomes critical to inform on whether the training program has been able to achieve its objectives. Unfortunately, evaluation of trainings was still not a very well-researched issue, especially in the agricultural sphere. Therefore, this paper assessed farmers' training on Good Agronomic Practices (GAPs), and analyzed the interactions between the dimensions of knowledge management practices in improving the seed yam production and seed system in Nigeria. In the remaining parts of the article, we discuss the literature review, methodology, results, and provide some discussions that can contribute to improving the effectiveness of the training evaluation process.

2. Materials and Methods

2.1. Study Area and Participants

The study was carried out in Nigeria (Figure 1), the world's largest yam-producing country, accounting for 67 percent of the world's production and 71 percent of regional yam supply [1]. The high value attributed to the quantity of yam produced annually in the country is about 20 billion dollars, which shows its crucial importance to the economy of the country.

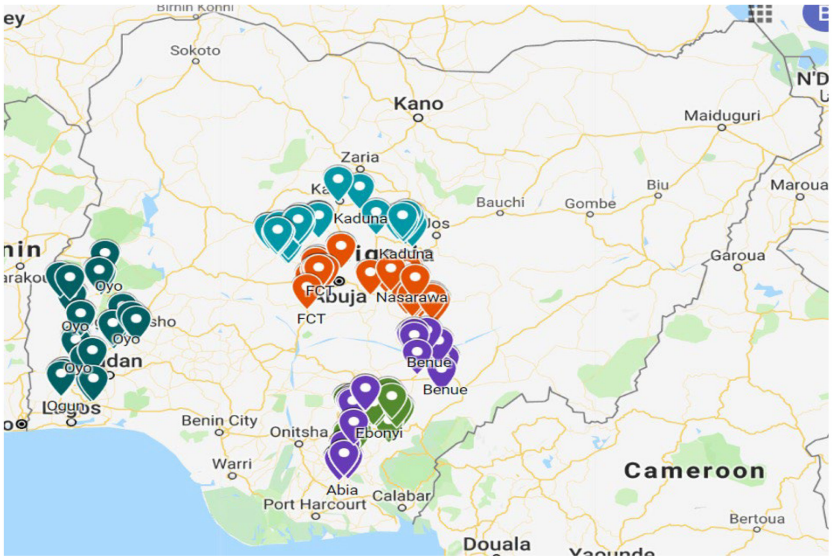

Figure 1. Study area depicting the locations of demonstration fields.

An important task to fulfill the project's goal was to establish a functional, scalable, and sustainable foundation and certified seed system, driven by the private sector. Thus, five seed companies: Nwabudo Agro Seeds and Inputs Company Limited (NASICL), Strategic Seeds Nigeria Limited (SSNL), Da-Allgreen Seeds Limited (DAGS), Biocrops Biotechnology Nigeria Limited (Biocrops or BIO for a simplified form), and PS Nutraceutical International Limited (PS Nutrac) partnered with the project to achieve the goal. With an intention to produce foundation seed yam in the formal system, at least two staff from each of the seed companies were trained from 27–30 March 2019 at IITA Station, Abuja in Nigeria, to maintain high standards in their crop to avoid waste of resources that would result from the rejection of seed tubers during the process of certification. The aim was for the participants, who would later be trainers of the trainees of seed companies, to appreciate the effect of using GAPs with certified seed for ware yam production.

The training was made up of presentations, discussions and hands-on learning. Participants learned improved agronomic practices including land preparation, which encouraged the use of ridging for seedbed, instead of the usual mounds, plant spacing to achieve optimum plant population, seed cutting and treatment before planting, fertilizer application and general field management. Investments made to train seed companies were in turn to train farmers from 11 to 24 April 2019 in establishing their own demonstration fields. A total of 172 farmers were trained by the seed companies.

In total, 179 demonstration fields were established with farmers by the above-mentioned five private seed companies in 10 states across the country. These states were purposely selected to host both the training on GAPs and the demonstration fields based mainly on close follow-up objective, depending on their strategic positions in relation to the headquarter locations and operational areas of various seed companies. The demonstrations were set in the Abia, Benue, Ebonyi, Enugu, Kaduna, Nasarawa, Ogun and Oyo states, as well as the Federal Capital Territory (FCT). The demonstration fields were established using three improved yam varieties that were promoted by the project, in addition to the locally preferred variety, considered as a control, as an opportunity to promote greater yield increase. The improved varieties included: two white yams (TDr 89/02665 and TDr 95/19177, named Asiedu and Kpamyo, respectively) and one water yam (TDa 98/01176, called Swaswa) variety, to compare with the most important local variety of each location assumed to hold down productivity in targeted areas.

The establishment of the seed production demonstration plots was intended for educating certified seed entrepreneurs and seed producers, preferably out-growers committed to the seed companies, on an improved seed yam production technique, the superior performance of improved varieties over the best local yam landraces, as well as GAPs required for quality seed yam production. Integration of women in the implementation of demonstration sites was strongly encouraged to make informed decisions on how to decrease constraints and increase benefits to recipients, regardless of gender. As part of the design and planning process for setting up the demonstration plots, foundation seed companies were advised to assess the preferences of women for the demonstrations. Women were targeted, not just for participation, but also to be empowered to identify priorities, since the roles and power relations between men and women can affect activity implementation. It should be noted that, traditionally, males dominate ware yam production, which is assumed to be tedious for women. However, seed production is less cumbersome, hence the targeting of women.

2.2. Survey Instruments

The statistical population consisted of 172 farmers, established with at least one demonstration field per farmer. The field established was composed of 4 plots, including three improved varieties provided by the project, and the fourth being a farmer's most-preferred landrace used in the target area.

A quantitative research design was adopted for this study and data was collected on farmers' fields, using a well-structured questionnaire as the research instrument, containing

both closed and open-ended questions. The questionnaire was designed based on the Likert item scales, capturing farmer's details, field information, GAP training performance, field assessment before, during and after planting, seed security, farmer's general assessment on the yam varieties planted and a general appreciation from the project team.

Observations, a GPS receiver and measuring tape for field data collection were used during the monitoring of all fields surveyed.

2.3. Training Performance and Knowledge Management Process

Training is viewed as an essential human resource development function to improve individual and organizational performance [8,9]. It builds and sustains an organization's competitive advantage through knowledge and skills enhancement. According to Huang [10], training evaluation often focused only on the quantity of training provided and not the quality of training. However, the training of farmers requires an evaluation to ascertain its effectiveness [11,12]. To increase practical experiences regarding the GAP, a series of monitoring contacts and visits were conducted by seed companies and project management.

Measurements on farmers' training consisted of data collected on the fields on how the farmers reacted to the trainings. The training for the process development skills to achieve optimum plant population and yield included: cutting of minisetts, preparation of chemicals and treatment of minisetts, field layout, site selection and land preparation, planting of demonstration plots, fertilizer application and field maintenance. The knowledge management process was measured using a graduated scale system, composed of four levels of scores for each indicator, ranging from 0 to 3. All performance indicators that have grades 1 and below indicate priority areas of work. The indicators with grades above 1 and 2.4 indicate areas for strengthening. Indicators with ratings of 2.5 and above indicate areas that require good performance sustainability.

2.4. Analytical Framework for Training Evaluation

Goldstein [13] defined training as a systematic acquisition of skills, rules, concepts or attitudes that result in improved performance. This definition also applies to the agricultural domain, where trainings are critical for learning new farming skills and improving farmers' current skills to enable them to achieve positive outcomes. For the farmers or farming workforce to cope with agricultural transformation, it is imperative to invest in their training, and in converting their skills and abilities. Training is hypothesized to enable farmers to enhance their skills and knowledge in GAPs, with a guarantee of making them more efficient and productive. From literature, the authors developed a comprehensive framework to measure the effectiveness of the GAP training (Figure 2). The training was designed following a problem diagnostic process with inputs from the project stakeholders.

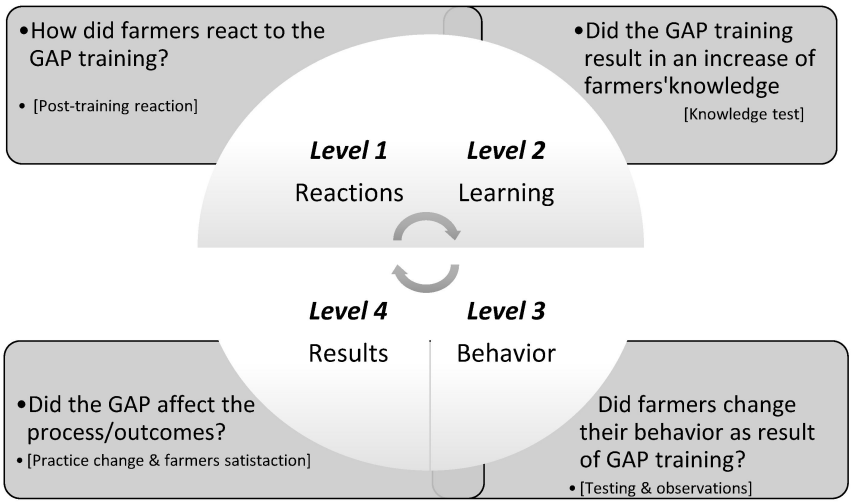

Figure 2. Hierarchical Kirkpatrick model.

Several methods for training evaluation exist, but they seem to have some deficiencies. Some of them are Hamblin's five-level model [14], the CIRO (Context, Input, Reaction, Outcome) approach of Warr et al. [15], Virmani and Premila's model, Peter Bramely's model, David Reay's approach, and Kirkpatrick's four-level model [16]. Among these, Kirkpatrick's model is considered suitable for assessing the effectiveness of farming training [17]. The Kirkpatrick Model was assessed as a valuable and influential framework, designed for the evaluation of training programs [18,19]. Kirkpatrick's model is used for this study because of its characteristics, including the simplicity of the process, ease of evaluation criteria, measurement of a limited number of variables, a lack of need to collect the trainees' previous performance, and independence of individual and environmental variables [20–22]. Kirkpatrick developed the four-level model in 1959 to help in evaluating training programs. An evaluation of the effectiveness of a training program is critical to eliminate ineffective programs and improve future programs. The four levels of the training evaluation process consist of reaction, learning, behavior and results [23]. The levels as depicted in Figure 2 are explained as follows:

- Reaction is the first level in response to how yam farmers like the training. This was to inform the level of satisfaction reached by any yam farmer that participated in the GAP training program. At this stage, the reactions of the trainees are understood as the way they perceive the relevance and quality of the training. This stage was developed using the Likert scale from 0 to 3 (with 0 = The farmer was not satisfied with the training; 1 = S/He had little satisfaction from the training; 2 = S/He was satisfied with the training; 3 = S/He was very satisfied with the training). This level was important to determine how farmers felt about the program they attended as the basis for any positive expected outcome, with the hypothesis that farmers who enjoyed the program were more likely to gain maximum knowledge. According to Kirkpatrick, every project should necessarily be assessed at this level to create an opportunity to improve its training program. Evaluation consists of recording the level of satisfaction of the trainees. However, there is still no evidence that any knowledge was gained, unless it reached the next level.
- Learning as the second level evaluates the extent to which the attitudes of the trainees changed, and their skills and knowledge increased because of the training. This level could apply knowledge tests and a survey of attitude to measure learning. The main question that needed responses from the trainees was: skills or attitudes? Did the GAP training result in an increase of knowledge? The second level was based on the Likert scale (0 = Nothing was gained; 1 = The yam farmer gained little from the training workshop; 2 = S/He gained averagely from the training workshop; 3 = S/He gained much from the training workshop).
- Behavior studying the change in farming behavior which takes place because of the training is considered as the third evaluation level. This level used testing and field observations to measure behavior. The key question was: Did yam farmers change their behavior as result of GAP training? Various proposed responses around the before and after basis used the Likert scale (0 = No learned knowledge and gained skills were used; 1 = The yam farmer used little of the learned knowledge and gained skills; 2 = S/He used averagely the learned knowledge and gained skills; 3 = S/He used fully the learned knowledge and gained skills). In addition, field evaluation was carried out by observations during monitoring of the fields.
- Finally, the last level of evaluation assessed the training in terms of results and practices that changed as the main instrument used to answer the following research question: Did the GAP training affect the process or outcomes? This level focused on the results of the program regarding any aspect that might be impacted, such as improved quantity and quality and reduced cost, among others. A Likert scale used was developed around a principle of before/after, and with/without training (0 = No positive result expected; 1 = Few positive results expected; 2 = Average positive results expected; 3 = Much of positive results expected).

The effectiveness of a training program to farmers can thus be conceptualized as being composed of training acquisition and transfer of training [24]. In this context, the transfer of training is indicated by behavioral changes with farming operations. Training is one of the most pervasive methods for enhancing a farmer's productivity and improving farming performance [25]. Training effectiveness is an indication of how well training achieves its intended outcomes, and training evaluation is a critical component of analyzing, designing, developing and implementing a training program [26].

3. Results and Discussion

Descriptive Statistics

Table 1 reveals a high percentage of female farmers engaged by seed companies in the GAPs training in Nigeria. Women represented between 22% for of the total respondents engaged by PS Nutraceuticals International Limited (PSN), and 40% for by Strategic Seeds Nigeria Limited (SSNL) and Da-Allgreen Seeds Limited (DAGS) (Table 1). This value was considered high because women generally were in a disadvantaged position in owning yam farms, although they may contribute to performing some of the yam operations, such as laying seed tubers on the mounds for planting, weeding, packing and transporting of tubers after harvest, etc. [27].

Table 1. Household and field characteristics by seed company.

Characteristics		BIO (*n* = 39)	DAGS (*n* = 41)	NASICL (*n* = 39)	PSN (*n* = 40)	SSNL (*n* = 20)	Pool (*n* = 179)
Gender (% female)		35.9	40.0	35.9	22.5	40.0	34.3
Age of the farmer (years)		45.8	47.4	51.1	52.1	50.0	49.1
Field size (m^2)		156.1	138.8	156.2	146.0	225.9	157.8
Type of seedbed preparation (%)	Mounds	100.0	65.0	20.5	100.0	100.0	74.7
	Ridges	0.0	35.0	76.9	0.0	0.0	24.7
	Both	0.0	0.0	2.6	0.0	0.0	0.6

At the time of the survey, the average age of the farmers under study was 49 years, with a range of about 46 to 52 years. This represents a group of yam farmers that are still economically active, with the ability and strength to carry out yam farming, which is known mostly as laborious. Land allocated to the demonstration plots were between 139 to 226 m^2, with mounds as the preferred method of seedbed preparation. Ridges that were recommended by the project were adopted only by farmers from DAGS and NASICL companies, who needed more time and conviction to completely abandon the practice of mounding (Table 1). Indeed, the project was encouraging farmers to adopt ridging for seed production, instead of yam mound-making that is backbreaking and costly, thereby representing one of the biggest constraints to yam production expansion [2].

Kirkpatrick's model assesses the effectiveness of training programs according to the different levels mentioned above. To evaluate each level, participants were requested and encouraged to fill the questionnaire using the four-scale Likert method to express their honest feedback about the training, using a grade per criterium from 0 to 3 scale. Furthermore, the responses indicating the effectiveness at all stages from various farmers from different seed companies were tabulated.

The reaction of the yam farmer to capture the level of satisfaction on the training was determined using the following criteria: (1) The training program agenda/content met its stated objectives; (2) The trainers and resource persons were able to keep and motivate participation; (3) The program used appropriate materials/handouts and other means to help understanding of the content; (4) The trainers made use of field activities to demonstrate practices and issues and; (5) The overall program was helpful for the trainees in improving trainees' performance.

Evaluation of the first level of Kirkpatrick's model demonstrated a difference between the participants' learning scores after the training workshop (Table 2).

Table 2. The Reaction of farmers to the training.

SCs	Respondents	Score	Overall Score
BIO	39	2.46	
DAGS	39	2.38	
NASICL	38	2.79	
PSN	40	2.93	
SSNL	19	3.00	
Total	175		2.68

Source: Field survey, 2019 [28].

From Table 2, the overall reaction score was about 2.68, which was above 2.5, depicting a highest performance score, thereby indicating that a best quality of training was organized for farmers. The detailed results of the first level Kirkpatrick evaluation indicated that 124 farmers (70.9%), who participated in the new learning methods, practices and workshop, declared that they were very satisfied with the training. This undoubtedly showed that the quality of the workshop was excellent. A total of 46 farmers (26.2%) were satisfied with the teaching, while 5 farmers, representing 2.9% of workshop's participants, reported to have had a little satisfaction from the training. However, none was unsatisfied. The general level of satisfaction reached was very satisfactory and should be maintained sustainably, especially with farmers from SSNL, PSN and NASICL. Nonetheless, an improvement of the reaction of farmers from BIO and DAGS needed to be strengthened, although, it can be concluded that the farmers who participated were satisfied with the training program. Farmers' satisfaction became the most important piece of the program, and this was expected to affect positively their motivation for success. The satisfaction could emanate from the quality of training materials, facilities used or quality of trainers [29–31].

To ascertain the learning performance, the knowledge and skills gained by each of the farmers trained and the evaluation covered all the modules that were discussed and taught to farmers by the respective seed companies. The scores were tabulated by seed companies as shown in Table 3.

Table 3. Learning performance of farmers.

SCs	Respondents	Score	Overall Score
BIO	39	2.54	
DAGS	39	2.67	
NASICL	38	2.84	
PSN	40	2.95	
SSNL	19	3.00	
Total	175		2.78

Source: Field survey, 2019 [28].

Evaluation of the second level of Kirkpatrick's model demonstrated a difference between the participants' learning scores after the training. Table 3 indicates that the overall score about the participants learning was about 2.78. This indicates that the learning took place with all farmers from all the seed companies participating. From exhaustive results at this second stage, 138 farmers (78.9%) who participated in the workshop revealed they gained much from the training, thereby indicating that the quality of the workshop was excellent. A total of 35 farmers (20.0%) gained averagely from the training workshop, while only 2 farmers (1.1%) reported a little gain from the training workshop. In general, farmers did gain much from the training, and this should be maintained sustainably with all the seed companies. These results were in line with training in healthcare industry referred by Dorri et al. and Pourjahromi et al. [32,33].

In the third level of the Kirkpatrick program evaluation model, the authors assessed whether the teaching and learning were put into practice in the field through interviews

by using an observational checklist. This checklist contained five different parts which included: (1) degree of yield challenge; (2) mastery of GAP; (3) skill improvement in planting material treatment and management; (4) entire project achievement and; (5) depth of analysis and insight. The project team, expert observers, attended all the farmers' interviews and assessed the sections based on this checklist. The results of this assessment are shown in Table 4.

Table 4. Behavioral change of farmers.

SCs	Respondents	Score	Overall Score
BIO	39	2.36	
DAGS	39	2.54	
NASICL	38	2.68	
PSN	40	3.00	
SSNL	19	3.00	
Total	175		2.69

Source: Field survey, 2019 [28].

From Table 4 above, the overall behavior score was 2.69, denoting the behavior of farmers under study was recognized to be at a very good level. The comprehensive results of the third level of the Kirkpatrick evaluation indicated that 123 farmers (70.3%) who participated in the training workshop declared to have used fully the learned knowledge and gained skills from the training. Consequently, the quality of this workshop was excellent. A total of 49 farmers (28.0%) reported to have used averagely the learned knowledge and gained skills, while only 3 farmers (1.7%) declared a little use of the learned knowledge and gained skills from the training. The knowledge acquired and skills gained from the training workshop were generally used and should be maintained sustainably, especially with farmers from SSNL, PSN and NASICL. However, such uses should be improved upon with farmers from DAGS and BIO, due to lower scores obtained. Therefore, with respect to putting the teaching and learning to practice, there was expectation of high degree of yield, sound mastery of GAPs and highly noticeable skill improvement in treating and managing planting materials. Moreover, there should be evidence of increased achievement of project goal and objectives being provoked by deeper analysis and insight occasioned by the quality of teaching and learning.

The last step of the Kirkpatrick model was dedicated to discovering if there was any expected positive effect, as a consequence of the training. The project team had this session still on the trainees' respective fields to observe the field maintenance and management, measure some elements of GAP taught, such as intra and inter spacing among yam plants, emergence of crops, and improvements that were tutored during the training.

The overall positive score of 2.71 was very good (Table 5) and should be maintained. The disaggregated results of the last stage evaluation indicated that 127 farmers (72.2%) who participated in the training workshop had much positive results expected from the training, implying that the quality of this workshop was brilliant. A total of 47 farmers (26.7%) reported to have average positive results expected, while only 2 farmers (1.1%) had few positive results. This fourth level of the Kirkpatrick evaluation program showed that the training about teaching and learning GAP for high-quality seed production is a fundamental factor in delivering effective agricultural training.

The results of our study indicate that seed companies' training can be used as an efficient method for providing seed production education to all farmers.

Table 5. Results of training workshop.

SCs	Farmers	Score	Overall Score
BIO	39	2.49	
DAGS	40	2.58	
NASICL	38	2.74	
PSN	40	2.90	
SSNL	19	3.00	
Total	176		2.71

Source: Field survey, 2019 [28].

4. Conclusions

Each evaluation model generally presents some levels of strengths and weaknesses in measuring training programs. To gauge the effectiveness of the training in GAPs for quantity and quality seed yam production, this study uses the Kirkpatrick hierarchical model that was found to be more appropriate than any other model. The model helped to objectively analyze the effect of the training on seed production through GAPs, to know how well farmers learned and to improve their learning in the future, thereby ensuring that the training program was relevant, engaging and effective. Each successive level of the model represents a more precise measure of the effectiveness of a training program. The model in this case used four levels, including Reaction, Learning, Transfer and Results. We looked at each level of measurement and explored how it could be applied. The first component on reaction made people feel that the training was valuable. Measuring how engaged yam farmers were, how actively they participated in the training, and how they reacted to it helped to understand how well they received it. The second level on learning focused on measuring what farmers learned or did not learn. This measured what they thought they will do differently because of the training, how confident they were that they could do it, and how motivated they were to make changes. This level helps to understand how well people apply their training. It can also reveal where people might need help. The third level of transfer focused on whether there was any change in behavior.

The study recorded high level performance at all the evaluation stages, indicating that the farmers' training on GAP was effective, being supported by the four facts. The benchmark performance was placed at 2.50. From farmers' feedback, the reaction as first fact scored 2.68 and showed the effectiveness of the training in terms of reaction. Learning scored 2.78 for effective learning, while behavior and results had average effectiveness scores of 2.69 and 2.71, respectively. Putting the teaching and learning to practice is expected to result in a high degree of yield, sound mastery of GAPs and highly noticeable skill improvement in treating and managing planting materials. Consequently, there should be evidence of increased achievement of project goal and objectives being provoked by deeper analysis and insight occasioned by the quality of teaching and learning. The satisfactory results at the beginning of the hierarchical model have implications on the satisfactory results at the end. So, improving the effectiveness of a training depends on defining factors such as (i) Training based on satisfaction in meeting the needs of your trainees and the seed production business; (ii) Training based on learning objectives in improving the trainees' skills and knowledge; and (iii) Training based on learner attitude change in applying new skills and knowledge in the fields.

Study limitations: The limitation of the present study is the small number of training participants. Another limitation is that measuring the fourth level of the Kirkpatrick model could have been better assessed after a significant period.

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