



# **Cost-benefit Analysis of Rating Scale and Criterion Reference Assessment Technique for Determining Students' Performance in Rice Production in Ebonyi State, Nigeria**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The objectives of the study were to determine the difference in costs of ingredients, the benefit in percentage score of students' performance and the difference between the benefit in percentage score of students' performance determined through the two assessment modes RS and CRAT- by implicating rice production in Ebonyi State. The study adopted quasi-experimental design. The population of the study was 570 made up of 20 teachers of agricultural science and 550 students offering agricultural science for the Senior Secondary School Examination (SSCE) in Ikwo and Ivo Local Government Areas of the state. The sample of the study was 100 made up of 60 senior secondary II students and 40 teachers of agricultural science. Four sets of instruments were utilized for data collection. The reliability of the content- validated RS items was determined using

Cronbach alpha formula which yielded a coefficient of 0.82. Split-half and Kuder-Richardson (K-R 20) was utilized to determine the stability of the test items which yielded a coefficient of 0.80. Procedural steps was adopted to administer and collect data from the two schools using the RS and CRAT items. Data collected was analysed using percentage, weighted mean and sign test to answer the research questions. Real limits of numbers were utilized to take decision on percentage. The study found out that the estimate cost of CRAT was cheaper than that of RS by ₦13,643.20. The study also established the benefit of CRAT (over RS) which can be utilized as a substitute to “alternative to practical” mode of determining students’ performance in rice production. It was recommended, among others, that external examination bodies should infuse the use of CRAT into their examination policy and that teachers of agricultural science should seek for training in CRAT development for use in determining students’ performance in relevant areas of agriculture.

*Keywords: Cost-benefit analysis; rating scale; criterion reference assessment technique; rice production; performance.*

## 1. INTRODUCTION

Rice (*Oryza Sativa* L.) is a major cereal crop in tropical agriculture and a principal food staple in Ebonyi State, Nigeria. In Ebonyi state, rice is important as a source of food, employment and income generation to many individuals and the state economy. By-products of rice processing such as rice bran, rice straw and rice hull are useful sources of livestock feed, mulching and bedding materials in livestock pens.

Based on the importance of rice to the people and the state, the Ebonyi State government mandated public secondary schools through the teachers to encourage students offering agricultural science select rice as one of the crops to grow in consonance with the curriculum provision.

The curriculum of agricultural science in senior secondary schools stated that students should grow at least one crop favourable to their locality from a list of six including cereals [1]. The curriculum specified that land preparation and other post-planting operations including storage should be taught to the students by qualified teachers of agriculture and to determine their performance through observation and rating scale.

Rating scale (RS) is a means of measuring personality traits like feelings and preferences concerning a product or an output. Wikipedia [2] described RS as a set of categories stated to elicit information about a quantitative or a qualitative attribute. The author further stated that in the social sciences particularly psychology, a common example is the Likert scale in which a person selects the number which is considered to reflect the perceived

quality of a product. Researchers use rating scale in a study when they intend to associate a qualitative measure with the various aspects of a product. Information from International Encyclopedia of the Social and Behavioural Science [3] described RS as a written list of performance criteria that permits the teacher more than two choices (for instance good, fair, poor or excellent, good, fair, poor) to judge a student’s performance of each criterion. In this study, RS is an assessment instrument with 13 process skill cluster items used by teachers to determine the performance of students in rice production on piecemeal basis for continuous assessment records in the school.

Rating Scale (RS) though used by teachers, cannot be utilized to rate skills in crop production like land preparation to storage of rice within a short period of about two hours (the official duration for determining student’s performance in practical agriculture by external examination bodies). This limitation of the instrument probably compelled the West African Examination Council (WAEC) and the National Examination Commission (NECO) to resort to the use of ‘alternative to practical’. This pseudo mode of assessment enables students to graduate successfully from senior secondary schools with credit passes in agricultural science without acquiring the requisite skills to function effectively in the occupation. There was therefore, the need to search for a substitute mode of determining acquisition of process skills in agriculture by students in a bid to enable them acquire the requisite process skills in rice production. This informed the researchers to investigate the use of criterion reference assessment technique (CRAT), otherwise called psychoproductive multiple choice test.

Criterion referenced assessment technique (CRAT) is a performance objective test designed to ascertain the acquisition of skills in an occupation [4]. CRAT is used to determine whether students have acquired the abilities and capabilities essential for performing step-wise activities for producing a product or an output. CRAT test items are constructed based on Simpson's [5] taxonomy of educational objectives. According to Okeme [6], Simpson's educational objectives have seven (7) levels namely: perception, set, guided response, mechanism, complex overt response, origination and adaptation; each level determining through assessment, gradual acquisition of process skills in an occupation. The author submitted that CRAT was utilized by Simpson [5] to measure skills in vocational home economics education. Warmbrot (1974) also utilized CRAT in determining students' performance in specialized vocational agriculture programmes in Ohio state (USA) and found it suitable for measuring process skills in an occupation. This study, therefore, investigated the use of CRAT in determining students' performance in rice production as a replacement of "alternative to practical" mode of assessment and a substitute to RS through comparison. The CRAT items in this study were developed from the RS items. It was therefore, worthwhile to determine the relationship of RS and CRAT in producing and administering items of the two similar instruments of assessment on students by implicating rice production in terms of cost.

Cost is the economic value on the amount of resources needed to plan, implement and complete a programme (Richardson and Philips, 2012). In production, research, retail and accounting, cost is the value of money that has been used up to produce something or deliver a service [2]. In the context of this study, cost in rice production relates to money spent in purchasing materials and rendering services from land preparation to the storage of rice grains (paddy). This includes payment made for materials inputs such as tools (hoes, cutlasses, gong, tape; or planting materials like rice paddy; fertilizer and the like. Services include honorarium for raters, accommodation/feeding for raters and examiners; honorarium for training in test development, payment for the development of rating scale instrument and data collection, among others. These material inputs that attract cost in RS and CRAT with regards to rice production in the study are referred to as ingredients. Hallack [7] stated that the cost of a

programme or project must be determined in terms of its benefit at a given time. Chukwu [8] defined cost as the value of economic resources used as a result of producing or doing whatever requires monetary payment. The author further stated that cost is an expenditure required to produce some specified output or benefit.

According to Olaitan et al. [4] the benefits of a programme are expressed in monetary terms and those that cannot be determined are excluded. In this study, benefit is the percentage score (% score) obtained by students after the first administration of RS or CRAT in rice production, making use of appropriate tools, equipment and facilities that attract cost. Benefit of a programme can be determined through cost-benefit analysis.

Cost-benefit analysis (CBA) is a systematic comparison of the magnitude of the cost and benefits of a form of investment in order to determine its economic profitability. All forms of investment involve a sacrifice of present consumption in order to secure future benefits in form of higher levels of output or income. Cost-benefit provides a means of appraising these future benefits in the light of the cost that must be incurred in the present. Woodhall [9] stressed that the purpose of the analysis is to provide a measure of the expected yield of the investment as a guide to rational allocation of resources. The author further stated that CBA is a process which reveals the relationship of cost with benefit measured in monetary terms. In this study, CBA is therefore the process of determining the monetary value of the ingredients involved in developing, administering and analyzing the test in comparison with the percentage scores obtained by students offering agricultural science in each process skill in rice production after the first administration of RS and CRAT.

From the foregoing, "ingredients" in this study constitute the material inputs in developing, administering and analyzing RS and CRAT in rice production programme in senior secondary schools in the area of the study.

Levin and McEwam [10] submitted that a simple approach for determining the cost of a programme and the benefit is the adoption of the ingredient method approach. The authors further stated that a typical breakdown of the ingredients in a programme that attracts cost will include

the following: personnel, facilities, equipment and materials in addition to programme and clients' inputs. In this study, ingredients of benefit of RS in rice production are: personnel (honorarium for raters, accommodation and feeding); facilities (money for producing the RS items and for data analysis). Others include money for purchasing tools such as hoes and cutlasses and also miscellaneous expenses. In CRAT, the identified ingredients of benefit in rice production are: personnel (money for feeding and accommodation and honorarium for training in the test development and facilities such as money for producing CRAT items including miscellaneous expenses.

Presently, the production of rice in Ebonyi State is predominated by aged farmers who are conservative and weak in strength to boost its production to meet local and inter-state demands. To meet the soaring demand for rice grains, the state government, therefore, directed public secondary schools in the state through teachers of agricultural science to encourage students offering agricultural science acquire knowledge and practical process skills in rice production. By so doing, the youths, after graduation, could replace the aging farmers in the occupation to meet the increasing demand for rice grains by neighbouring states in the future.

Teachers of agricultural science in public secondary schools complied with the directive of government and taught the students rice production through the farm and determined their performance through observation and RS. Rating Scale (RS), however, is characterized with some limitations in measuring performance in crop production. These limitations include: error of halo effect, central tendency, generosity rating and block score loading. In addition, RS cannot be used to determine students' performance in all the activities in rice production from land preparation through harvesting to storage within the usual 2 hour duration allowed by WAEC and NECO in agricultural science practical examination.

The WAEC and NECO examine these students for certification on yearly basis at the end of their senior secondary school programme in agricultural science through "alternative to practical". This pseudo practical assessment technique determines cognitive ability and recall of knowledge without practical acquisition of skills in agriculture. Consequently, students

graduated from the schools with good grades but void of practical skills in rice production contrary to the desire of the state government. CRAT was tried in this study in comparison with RS in terms of cost and benefit with a view to probably replacing "alternative to practical" mode of assessment of students in practical agriculture. The purpose of this study, therefore, was to determine the cost-benefit analysis (CBA) of RS and CRAT for finding out students' performance in rice production.

The major purpose of the study was to investigate the cost benefit analysis of rating scale (RS) and criterion referenced assessment technique (CRAT) for determining students' performance in rice production in secondary schools in Ebonyi state of Nigeria. Specifically, the study sought to determine:

- a) The difference between the cost of ingredients for assessing students' performance in rice production through RS and CRAT.
- b) The benefit (percentage score) of students' performance in rice production through RS with focus on the ingredients
- c) The benefit (percentage score) of students' performance determined through CRAT with focus on the ingredients
- d) The difference between the benefit (percentage score) of students' performance in rice production as determined through RS and CRAT.

## 2. METHODS

The study adopted quasi-experimental design in its investigation. In the view of Campbell and Stanley in Gall et al. [11], quasi-experimental design is an experiment that lacks random assignment of research participants to experimental and control groups. Quasi-experimental design is, therefore, suitable for this study as it made use of two intact classes of similar ability (SSII students) without any randomization. Experimentally, the study made use of one intact class (Group 1 students, GIS) from the first school for determining students' performance and another intact class (Group 2 students, G2S) from the second school for determining students' performance on CRAT, both in rice production in the first instance. The data collected and analysed in the two intact classes generated information or inference for decision making.

The study was carried out in Ebonyi state, south eastern Nigeria. In the submission of Oko and Ugwu [12], the state is principally agrarian with soil and climatic conditions optimally conducive for growing both upland and swamp rice varieties and cultivars. Some varieties of upland and swamp rice like FARO 14, MASS, FARO 52, Sippi, awilo and "canada" thrive well in the soil which is predominantly clay loam and poorly drained with gravely sub-soil. The authors stated further that the vegetation of the environment is semi-savannah grassland with shrubs suitable for the growth of cereal crops like maize and rice.

The population of the study was 570 made up of 550 senior secondary two (SSII) students and 20 teachers of agricultural science. The sample of the study was 100 made up of 60 SSII students, 10 teachers of agricultural science engaged as raters and another 30 teachers of agricultural science who responded to the questionnaire on estimate costs of ingredients of RS and CRAT.

The 60 SSII students were chosen from the two intact classes of 30 students each from the two schools selected for the study based on certain criteria. The criteria for selecting the two schools, among others, included the following: (i) schools that teach agricultural science with rice as one of the cereal crops selected by the students. (ii) schools with qualified teachers of agricultural science (iii) schools with students who must have been taught agricultural science with rice as their chosen crop in the previous year (SSI class) among others. Therefore, the sampling was purposive.

The 10 teachers (engaged as raters) in the first school were selected based on simple random sampling technique across the schools in the 3 educational zones of the state where students opted to grow rice as one of the chosen crops. The sampling was carried out as follows: Ebonyi North (Abakaliki) 4; Ebonyi Central (Onueke) 3 and Ebonyi South (Afikpo) 3.

The other 30 teachers of agricultural science who had attained a minimum of senior cadre were purposively selected from 30 schools in the state. These 30 teachers responded to the questionnaire items on current estimate cost of RS and CRAT in rice production.

Four (4) sets of instruments were utilized for data collection namely:

- a. Questionnaire on current estimate cost of ingredients of rating scale (CECIRS) in rice production.
- b. Questionnaire on current estimate cost of ingredients of CRAT (CECICRAT) in rice production. The researchers visited 3 teachers of agricultural science and management/personnel units in 3 schools in the state, one school from each of the 3 educational zones, to find out the items and services used for conducting internal examinations outside the farm. Data gathered from these 3 sources enabled the researcher to compare information and develop the final questionnaire on CECICRAT in rice production.
- c. Rating Scale (RS): The rating scale was developed as follows (i) rice production skill items were obtained from literature reviewed on growing of rice (ii) skills were developed into 13 cluster items that were subjected to face and content validation. Thereafter, it was developed into a rating scale instrument with a response option scale of high performance (HP) average performance (AP), slight performance (SP) and low performance (LP) with corresponding values of 4,3,2 and 1 respectively. This was utilized by raters to determine students' performance in rice production.
- d. Criterion reference assessment technique (CRAT): One hundred (100) multiple choice skill items of CRAT was developed and face-validated for the test administrations.

Three (3) of the 4 sets of instruments were subjected to face validation only. The 3 sets were: (a) questionnaire on current estimate cost of ingredients of RS in rice production (b) questionnaire on current estimate cost of ingredients of CRAT in rice production, and (c) the CRAT items.

The instruments on cost of ingredients of RS and CRAT (that is (a) and (b) above were face-validated by 3 experts. These experts were teachers of agricultural science teaching rice production to students in public secondary schools in the area of study other than the two schools selected for the study. Their remarks and suggestions were used to develop the final instruments on the costs of ingredients that were utilized for the study.

The 4<sup>th</sup> instrument (CRAT items in rice production) was face-validated by 3 experts. These experts were lecturers of the rank of senior cadre and above from the Department of Agricultural Education, University of NigeriaNsukka. Remarks and suggestions from the experts were utilized to develop 100 CRAT items used for determining students' performance. The CRAT items were not subjected to content validation because the 13-cluster rating scale items in rice production from which they were developed had already been validated content-wisely.

The content –validated 13 cluster items in the questionnaire on rice production was subjected to test of reliability to determine the internal consistency of the items. Ten (10) copies of the instrument were administered to teachers of agricultural science who taught their students rice production in secondary school in UzoUwani Local Government Area of Enugu State (another state other than the area of this study). The questionnaire was retrieved and analyzed using Cronbach Alpha formula and a coefficient of 0.82 was obtained.

Ten (10) copies of the CRAT test, out of the 100 items were administered on 20 students in community secondary school, Nrobo in Uzouwani Local Government Area of Enugu State who have been taught rice production in Senior Secondary One (SSI). The copies were retrieved and analysed using split-half technique and Kuder-Richardson (K-R 20) formula to determine the stability of the test items which yielded a coefficient of 0.80.

Data collection for the study adopted the following procedure: (a) the researcher administered the questionnaire on current estimate cost of ingredients of criterion reference assessment technique (CECICRAT) on 30 teachers of agricultural science in senior secondary schools in Ebonyi state outside the two schools selected for the study. This was carried out through two research assistants. (b) one intact class was identified in each of the two schools selected for the study. The schools were:

- i. Enyi Community Secondary School, Enyibichiri in Ikwo Local Government area, (School 1 or first school).
- ii. Akaeze community secondary school, Iyioji in Ivo Local Government Area (School 2 or second school).

The rating scale was administered on the students based on the following steps:

In Enyi Community Secondary School (School 1):

- i. The researcher obtained permission from the principal to administer the instrument on rice production on the students. The cooperation of the agricultural science teacher to organize instruments and students for the administration was also sought by the researchers.
- ii. A copy of the ingredients of rating scale (RS) was given to a teacher of agricultural science in the school to study and requested the SSII students to assemble their own materials for practice.
- iii. Ten teachers of agricultural science were hired as raters to participate in the assessment of the students' practical process skills using RS three weeks before the agreed date and time of assessment. The researcher briefed the raters on what to do at the recruitment station on the day of assessment. Each of the raters were given 3 copies of the RS instrument for use during the assessment. Three (3) raters rated 9 students on the first day; 3 raters rated 9 students on the second day and 4 raters rated 12 students on the third day. The researchers were there to monitor the exercise for the three days.
- iv. After each day's rating, completed copies of the RS were collected from the raters by the researchers who appreciated the principal and the teacher of agricultural science for the successful exercise.
- v. The researchers revisited the school after 3 months for second assessment of the students using the CRAT items.

In Akaeze Community Secondary school, Iyioji in Ivo Local Government Area (school 2), the following steps were taken to get approval for the school to participate:

- i. One of the researchers travelled to the school to seek for permission from the principal and for the participation of a senior agricultural science teacher to administer the CRAT test items on the students.
- ii. The question papers were packaged in an envelope by the researchers and sent to the principal for safe keeping prior to the examination day.

- iii. The researchers requested the teachers of agricultural science to participate in the supervision of the students during the one hour test.
- iv. The teacher of agricultural science and the researchers administered the test on the students on the agreed date and venue and retrieved the scripts after the examination.
- v. The researcher appreciated the principal and the senior agricultural science teacher after the examination and revisited the school after 3 months for a second administration of the test on the students using similar CRAT test items

Data collected for the study were analysed using percentage, weighted mean and sign test to answer the research questions. In taking decision on percentage, real limits of numbers were utilized for scores of RS and CRAT as follows:

Values: 4(25%); 3 (25%); 2 (25)% and 1 (25)% at 25% block score for RS

Real limits; 87.5- 100 (High performance, (HP)  
62.5 -84.7 (Average Performance, (AP)  
37.5-62.4 (Slight Performance (SP)  
25- 37.4 (Low performance, (LP)

The sign test involves the use of symbols of plus (+) and minus (-) to indicate the higher score between two variables on a pair of observations, horizontally and vertically for decision making (Mendenhal and Ott; Spiegel and Stephens as cited in Elom [13]).

In this study, Group I (GIS) in Enyi community secondary school, Enyibichirilkwu was assigned (+) while group II (G2S) in Akaeze Community secondary school Iyioyi was assigned minus (-) sign. Where the score of group 1 is higher than that of Group 2 in any cluster, plus (+) is recorded. If the score of Group 2 is higher than that of Group 1, minus (-) is recorded. Vertically (that is, for the 13 cluster items) the number of plus (+) and the number of minus (-) were calculated to find the difference for decision making.

### 3. RESULTS

The results of the study were obtained from the research questions answered through data collected and analyzed as presented in Tables 1 – 4:

#### 3.1 Research Question 1

What is the difference between the cost of ingredients for determining students performance through RS and CRAT in rice production?

Table 1 revealed that the 21 items had positive signs (+) indicating that the cost of RS is greater than the cost of CRAT in each of the 21 items. However, two items (3 and 4) had negative signs (-) which indicated that the cost of RS was less in each of the 2 items.

On the aggregate, the estimate cost of RS is greater than that of CRAT by thirteen thousand, six hundred and forty-three naira, twenty kobo (₦ 13, 643.20) which has a plus sign (+) as shown in the gap column. This indicated that if a student were to be examined in practical in rice production, he/she will pay the amount of ₦ 13,643.20 higher than when the student is to be examined through the use of CRAT. Therefore, the cost of CRAT was cheaper than that of RS.

#### 3.2 Research Question 2

What is the benefit (percentage score) of students' performance in practical in rice production as determined through rating scale (RS)?

Table 2 showed that the benefit (percentage score) of students' performance determined through RS on the 13 production skill cluster items ranged from 73.3 – 91.7%. This indicated that the student exhibited average to high performance as shown by real limits (p. 10).

#### 3.3 Research Question 3

What is the benefit (percentage score) of students determined through CRAT with focus on the ingredients?

Table 3 showed that the benefit (percentage score) of students' performance determined through CRAT on the 13 production skill cluster items ranged from 19.00 – 46.75%. This indicated that the students exhibited low to slight performance as indicated by real limits on page 10

#### 3.4 Research Question 4

What is the difference between the benefit (percentage score) of students' performance determined through RS and CRAT?

**Table 1. Difference between the estimate cost of ingredients for determining students' performance in rice production through rating scale (RS) criterion reference assessment technique (CRAT)**

S/N	Ingredient	RS-Unit Cost (₦)	CRAT Unit Cost (₦)	GAP (RS-CRAT)	Sign test RS = (+) CRAT = (-)
1	Honorarium for raters/examiners	2, 500	2,000	500	+
2	Accommodation/feeding for raters/examiner	6,000	4,000	2000	+
3	Honorarium for training in test development	0	3,500	3,500	-
4	Production of rating scale/test items	70	300	230	-
5	Stationeries (files/biropens)	40	0	40	+
6	Hoes	1000	0	1000	+
7	Cutlasses	4500	0	450	+
8	Gong	65	0	650	+
9	Tape	600	0	600	+
10	Pegs	200	0	200	+
11	Rice paddy	70	0	70	+
12	Empty jute bags	150	0	150	+
13	Local mats	350	0	350	+
14	NPK (15:15:15) fertilizer	4500	0	4500	+
15	Pick – axe	1800	0	1,800	+
16	2 – prung metal forks	300	0	300	+
17	Traps	350	0	350	+
18	Sickles	300	0	300	+
19	Knives	250	0	250	+
20	1½metre long pole	200	0	200	+
21	Head pans	1450	0	1,450	+
22	Computer services	2000	0	2000	+
23	Miscellaneous expenses (actual)	244	30.80	213.20	+
<b>Total Cost</b>		<b>23,474</b>	<b>9,830.80</b>	<b>13,643.20</b>	

Key: RS = Rating scale; CRAT = criterion reference assessment technique; + = RS >CRAT in terms of cost; - = RS <CRAT in terms of cost



The data for answering the research question are presented in Table 4.

Table 4 showed that the benefit (percentage score) of students determined through the use of RS in rice production is higher than the benefit (percentage score) of students determined through the use of CRAT as indicated by the gap which ranged from 31.5 – 65.7% for the 13 cluster items. The difference in favour of RS was indicated by plus sign (+) in the sign test for all the 13 items.

On the average, the benefit (percentage score) of students which was 82% is higher as determined through RS per score of students than the benefit score (31.4%) of students' performance in rice production as determined through CRAT. This was also indicated by 50.8% gap (82%-31.4%) in favour of RS and also a plus sign (+) in favour of RS, respectively. Therefore, the use of RS is more profitable (beneficial) than the use of CRAT in determining students' performance in rice production.

#### 4. DISCUSSION

Based on the information revealed in Table-1, the difference in cost using RS and CRAT is ₦13,643.20. This difference appears to be an extra payment for a parent who has a student to be examined in only one subject (agricultural science practical) out of 9 subjects to be registered with the WAEC or NECO. If RS were to be used for assessing practical in agricultural science, it then suggests that many parents will have to withdraw their children from school because of their inability to pay for the cost of practical examination, except if government decides to give scholarship to students offering agriculture because of the importance of agriculture in the nation's economy. If the government cannot offer scholarship to students offering agricultural science, probably because of other competing interests in revenue allocation, it would be a heavy financial burden for parents to register for examination of students using RS. Therefore, in terms of cost, CRAT, with the cost of ₦9,830.80 appears to be affordable for the stakeholders than RS.

The results of this study is in consonant with the research result carried out by Musebe et al. [14] on cost and efficiency of operating coffee hand-pulpers in Ethiopia. The study was conducted to assess farmers' perception, examine the efficacy, measure, profitability (benefit), and

assess the effectiveness of the hand pulpers to establish how they compare with the traditional sun-dried method.

Data were analysed using paired t-test. Economic viability was assessed using the net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR). The study revealed, among others, that;

- (a) Assessment of the variable costs of pulped coffee was twice the cost of sun dried coffee.
- (b) Exclusive production of pulped coffee would be more profitable than sun-dried coffee.
- (c) Based on economic viability, it was worthwhile to invest money in the hand-pulpers than in the sun-dried coffee growers.

Table 2 revealed that the benefit (percentage score) of students' performance in rice production determined through RS was 82.2% while their performance determined through CRAT was 31.4% as shown in table 3. The difference in these scores (82.2%-31.4%) is 50.8%. This gap, that is very high and in favour of RS, may be due to the limitations of RS and probably the CRAT which were reflected in the scores to create the wide gap. For example, the high score of 82.2% obtained by students (average score) through the use of RS might have been influenced by those limitations outlined by Okpala et al. [15]. The limitations included halo effect, error of central tendency, error of leniency or generosity. Errors due to these favours towards a particular student might have made the difference due to personal or unexpressed reasons. In this study, such a favour may involve shifting from low to slight or from slight to average performance. This is because each of these shifts attracted to a student, a block score of 25% on a 4point RS option.

This limitation of RS observed by the researchers and as depicted in Fig 1 further explains the high performance in RS as opposed to the students' performance when determined through CRAT. It means that in any rating carried out by a rater on any student, the student is given 25% mark in a block. That is, the least score a student can obtain in any of the 13 items in Table 2 is 25% if rated. This is not so in CRAT where the loading used by this study is just 2% for any correct answer (that is 50 test items ×2% each =100%, that is, 50 x 2 = 100% in a 50 CRAT test items).

**Table 2. Benefit (percentage score) of students' performance in rice production as determined through rating scale (RS) and rated by the raters. N = 30**

S/N	Item Statement	Mark obtainable by N = 30	Mark obtained	% score
1	Clear the grass, park, burn and stump	120	110	91.7
2	Till the soil with a hoe	120	104	86.7
3	Mark out the farm into blocks with lines at 30cm apart	120	98	81.7
4	Plant 4 – 5 seeds (paddy) 30cm apart on rows	120	94	78.3
5	Inspect for germination, supply missing stands and thin to 3 seedlings per stand	120	95	79.2
6	Weed as soon as other plants are observed growing on the farm	120	104	86.7
7	Apply 10grams of NPK fertilizer (15:15:15) around the base of the plant and cover slightly with soil	120	94	78.3
8	Drive birds away using drums/gongs when the tassels approach maturity	120	99	82.5
9	Control rodents with traps	120	96	80
10	Test rice seeds (paddy) for maturity before harvesting	120	95	79.2
11	Harvest the matured panicles with sickles or knives	120	105	87.5
12	Thresh the paddy	120	100	83.3
13	Park the paddy in bags and store	120	88	73.3
				<b>Average = 82.2%</b>

*Key: Mark obtainable by N=30 means Maximum mark that any of the 30 students can score; that is 4X30 =120 in a four rating scale of 4, 3, 2 and 1; 4, being the highest. Mark obtained = Actual score obtained by each student in each item statement. % score = the percentage score obtained by each of the 30 students, e.g.  $\frac{110}{120} \times \frac{100}{1} \% = 91.7\%$  as in item 1*

**Table 3. Benefit (percentage score) of students' performance in rice production as determined through CRAT.N = 30**

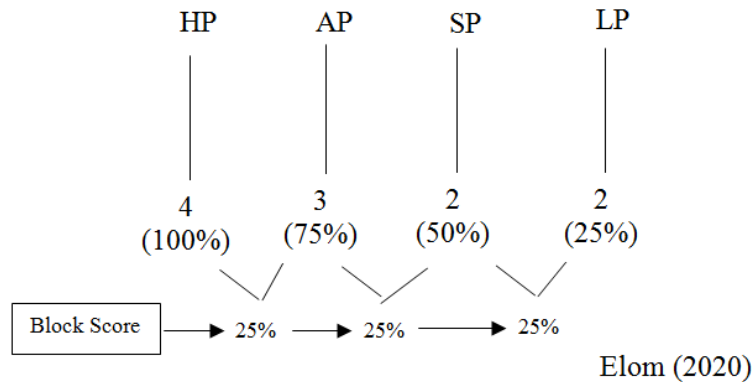
S/N	Item Statement	No. of CRAT items	No. obtainable by N = 30	No. obtained correct	Mean ( $\bar{x}$ ) score	BMS %
1	Clear the grasses, park, burn and stump	10	300	112	3.73	37.3
2	Till the soil with a hoe	2	60	16	0.53	26.67
3	Marks out the farm into blocks with lines at 30cm apart	4	120	37	1.23	30.75
4	Plant 4-5 seeds (paddy) 30cm on the rows	4	120	40	1.33	33.25
5	Inspect for germination, supply missing stands and thin to 3 seedlings per stand	4	120	47	1.57	39.25
6	Weed as soon as other plants are observed growing on the farm	3	90	19	0.63	21.00
7	10 grams of NPK (15:15:15) fertilizer around the base of the plant and cover slightly with soil.	4	120	56	1.87	46.75
8	Drive birds away using drums/gongs when the tassels approach maturity	4	120	40	1.33	33.25
9	Control rodents with traps	3	90	17	0.57	19.00
10	Test rice seeds (paddy) for maturity before harvesting	2	60	15	0.50	25.00
11	Harvest the matured panicles with sickles or knives	4	120	38	1.27	31.75
12	Thresh the paddy	2	60	26	0.87	43.50
13	Park the paddy in bags and store	4	120	25	0.83	20.75
						<b>Average = 31.4%</b>

Key: CRAT = Criterion reference assessment technique; BMS (%) Benefit Mean score in percentage; No. obtainable by N=30 means  $20 \times 10 = 300$  as in item 1; No obtained correct = No of item obtained correct by students out of 300 as in item 1.  $\bar{X}$  average means score of students in each item eg  $112/30 = 3.75$  as in item 1

**Table 4. Difference between the benefit (percentage score) of students' performance in rice production determined through RS and CRAT. N= 30**

S/N	Items	No. Of CRAT Items	RS - MS	CRAT - MS	RS - MS (%)	CRAT- MS (%)	GAP (RS-CRAT) %	Sign test RS = (+) CRAT = (-)
1	Clear the grass, park, burn and stump	10	3.67	3.73	91.7	37.3	54.3	+
2	Till the soil with a hoe	2	3.47	0.53	86.7	26.7	60.0	+
3	Mark out the farm into blocks with lines at 30cm apart	4	3.27	1.23	81.7	30.8	50.9	+
4	Plant 4 – 5 seeds (paddy) 30cm apart on rows	4	3.13	1.33	78.3	33.3	45.0	+
5	Inspect for germination, supply missing stands and thin to 3 seedlings per stand.	4	3.17	1.57	79.2	39.0	40.2	+
6	Weed as soon as other plants are observed growing on the farm	3	3.47	0.63	86.7	21.0	65.7	+
7	Apply 10grams of NPK fertilizer (15:15:15) around the base of the plant and cover slightly with soil.	4	3.13	1.87	78.3	46.8	31.5	+
8	Drive birds away using drums/gongs when the tassels approach maturity	4	3.30	1.33	82.5	33.1	49.4	+
9	Control rodents with traps	3	3.20	0.57	80.0	19.0	61.0	+
10	Test rice seeds (paddy) for maturity before harvesting	2	3.17	0.50	79.2	25.0	54.2	+
11	Harvest the matured panicles with sickles or knives	4	3.50	1.27	87.5	31.8	55.7	+
12	Thresh the paddy	2	3.33	0.87	83.3	43.5	39.8	+
13	Park the paddy in bags and store	4	2.93	0.83	73.3	20.8	52.5	+
					<b>Average =</b>	<b>Average</b>		
					<b>82.2%</b>	<b>=31.4%</b>		

Key: RS-MS = Rating scale mean score; CRAT-MS = Criterion reference assessment technique mean score; CRAT- MS (%) = Criterion reference assessment technique mean score in percentage



**Fig. 1. Block score loading of students' performance by the use of RS**

Key: HP= High Performance; AP= Average Performance; SP= Slight Performance; LP = Low Performance

The low to slight average performance of students in production skill cluster items (19.000-46.75%) might be due to the following qualities which are probably ignored in the use of RS by the raters. They are: (a) the CRAT items assessed communication language of each student, that is, ability to read and interpret the questions in the direction they were asked (b) ability of the student to understand body movement or actions such as astride, bend, stoop, hand on knees and so on which are vividly expressed in the CRAT items, among others.

The researchers also observed that the students experienced the CRAT items for the first time in their programme while their teachers might have been rating them for continuous assessment (CA) examination purposes. Therefore, their limiting experiences in CRAT may be a contributory factor. Same or similar reasons apply to the difference between the benefit (percentage score) of students' performance in rice production as determined through RS (82.2%) and CRAT (31.4%) which yielded 50.8% as indicated in Table 4.

### 5. CONCLUSION

Rice production in Ebonyi State provides a means of livelihood to many farmers and revenue generation to the state government. This motivated the government to make concerted efforts in increasing production of the commodity in the near future as the occupation is presently predominated by aged and conservative farmers incapable of boosting production to meet increasing demands by neighbouring states.

Government directive to secondary schools through the teachers to empower students with requisite process skills in the occupation and to

determine their performance through the school farm proved abortive as students graduated from schools void of the needed skills in growing rice. This informed the researchers to carry out this study aimed at determining the cost benefit analysis of rating scale (RS) and criterion referenced assessment technique (CRAT) which revealed students' performance in rice production using the ingredient method approach in the area of the study. The study made the following contributions to knowledge and practice in rice production; (i) provided information to the state government and teachers of agricultural science on the low cost (₦ 9,830.20) of CRAT as against the high cost of RS (₦ 23,474.00) in determining students' performance in rice production, practically and (ii) established the benefit of CRAT which can be utilized as a substitute to "alternative to practical" in rice production.

### 6. RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

- a. The West African Examination Council (WAEC) and the National Examination Commission (NECO) should integrate the use of CRAT into their examination policy and to adopt it in examining and assessing their students.
- b. The Ebonyi State government should mandate the state secondary schools to implement the CRAT for determining students' performance in practical in relevant areas of agriculture like crop or animal production because of the affordable cost of its use in determining students' performance in rice production.

- c. Teachers of agricultural science should seek for training in the development of CRAT items for determining their students' performance in relevant areas of agriculture.

### CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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