KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHOLOGY, KUMASI

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

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DEPARTMENT OF HORTICULTURE

EFFECT OF TRAINING IN GOOD RICE (*ORYZA SATIVA)* CULTIVATION AND POSTHARVEST PRACTICES ON QUALITY OF MILLED RICE PRODUCED IN THE AHAFO ANO NORTH DISTRICT, ASHANTI REGION

BY

RAPHAEL DODZI SORKPOR

NOVEMBER, 2015

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(POSTHARVEST TECHNOLOGY) DEGREE

BY

RAPHAEL DODZI SORKPOR

NOVEMBER, 2015

DECLARATION

I declare that except for specific references duly acknowledged, this thesis is the result of my own effort and has not been submitted either in part or whole for any other degree elsewhere,

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DEDICATION

This work is dedicated to Pastor William Mensah, my sweetheart Evelyn Sorkpor, lovely family and the bride of Christ, who with their motivation, encouragement, selfless love and sacrifice made me endured all the challenges whiles in pursuit of this program.

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LIST OF ABBREVIATIONS

GH	GHANA
IRRI	International Rice Research Institute
JICA	Japan International Co-operation Agency
KNUST	Kwame Nkrumah University of Science and Technology
MOFA	Ministry of Food and Agriculture
USDA	United States Department of Agriculture

ABSTRACT

There has been many interventions from Ghana government in infrastructure provision and capacity building including training for small scale rice farmers to improve locally produced rice. However, the question of whether the training helped improve the quality of the local rice is not known. The purpose of this study was, therefore, to investigate the effects of training in good rice cultivation and postharvest practices on the quality of milled rice produced by Ahafo Ano North of Ashanti region. Trained and non-trained farm zers were purposefully and randomly selected and interviewed using a structured questionnaire. Physical qualities such as milling degree, milling recovery, percent head rice, grain dimension, chalky grain, percent broken grain and 1000 grain weight were assessed. Chemical quality properties such as proximate composition, functional and pasting properties were also determined using official standard methods. The results showed that trained (53.1%) and non-trained (1.9%) farmers prepared and implemented rice cultivation activity plan. Most of the trained farmers (67.9%) obtained their seed rice from reliable and certified sources such Ministry of Food and Agriculture and other donor rice related projects while 81.5% of the non-trained farmers sourced their seed rice from other rice farmers. Paddy fields were first cleared, ploughed, bund constructed, puddled and levelled by trained farmers (72.8%) while non-trained farmers (98.1%) only cleared their paddy fields using cutlass and later applied herbicides on the regrowth. Trained farmers (80.2%) made use of bund and interlocking bund as water harvesting structures with 90.7% of the non-trained farmers using dug-out to supply water to their crop. Most of the trained farmers (71.6%) practiced transplanting method of sowing rice while the non-trained farmers (50%) combined direct and transplanting methods of sowing rice. Both trained and non-trained farmers applied fertilizer with 75.3% of the trained farmers applying the fertilizer two to three times during cultivation period, whereas the 68.5% of the non-trained farmers applied the fertilizer only once during the cultivation period. Most of the trained rice farmers (82.7%) threshed their paddy within one to three days after harvest, but non-trained rice farmers (92.6%) threshed paddy after it has been left on the field for more than three days after harvest. Knowledge of farmers after training on good rice cultivation and postharvest practices was significantly (p>0. 01) higher than before the training. The milled rice from the trained rice farmers were significantly higher in the polished rice by weight (341.43g), head rice (54.0%), milling degree (89.89%) and milling recovery (68.29%) than milled rice from the non-trained rice farmers, i.e. in the polished rice by weight (302.35g), head rice (41.81%), milling degree (80.81%) and milling recovery (60.50%). The proximate analysis carried out on the trained and non-trained farmers‟ rice sample showed no significant difference (p>0. 01) from each other. The result of a functional property of rice flours from trained and nontrained rice farmers sampled showed significant differences in only solubility index (40.01%, 32.00 %) and breakdown (1157.5Rvu: 1244.0Rvu) respectively for pasting properties. The break down showed significant differences (1157.5Rvu, 1244.0Rvu), when pasting properties were analyzed for trained and non-trained rice flour sample respectively. Thus, the training had an impact on the physical quality of milled rice produced than on the chemical quality parameters and therefore, the non-trained farmers should be trained so as to produce a good physical quality milled rice.

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CHAPTER ONE

1.0 INTRODUCTION

A research conducted by the Ministry of Food and Agriculture (2009) pointed out that rice (*Oryza sativa*, L.) is the next essential staple food after maize (*Zea mays*) in Ghana. This makes its‟ consumption keeps increasing due to the fact that urban population is growing, expansion of urban settlement as well as change in eating habit of Ghanaian consumers. Whereas, the yearly production increase of rice keeps changing with respect to cultivated land area, the yield variation may remain the same (Ministry of Food and Agriculture, 2009). In Ghana, total domestic rice production figures between 1996 and 2005 stand as 130,000 and 182,000 tons of milled rice , whiles the total consumption in 2005 was 500,000 tons (JICA, 2007). Hence, Ghana depends largely on imported rice to make up for the deficit in rice supply. The self-sufficiency ratio of rice was 24% as at 2006 (Ministry of Food and Agriculture, 2009).

Globally, there is an increase in rice imports by 80%, thus, from 2.5 billion tons of grain in the early 1990s to 4.5 billion tons in 2004, and are projected to be between 6.5 and 10.1 billion tons in 2020 (Ministry of Food and Agriculture, 2009). Even though in recent years, rice production in Africa has been expanding at a rate of 60% per annum, 70% of production increase was due mainly to land expansion and only 30% can be attributed to an increase in productivity (Ministry of Food and Agriculture, 2009). Therefore, to increase productivity, the majority of poor and illiterate farmers who are dominant workforce need to acquire knowledge in simple good rice cultivation practices that can translate into the production of quality and marketable rice for increase income.

The Government of Ghana in an attempt to address the problem of increased foreign expenditure on rice importation has put in place many rice related policies and intervention programs to help train small scale rice farmers in good rice cultivation practices in order to curb the problem of low productivity and poor quality of locally produced milled rice. In this direction, the Government of Ghana, requested the Japanese Government to lay down the master plan for the promotion of domestic rice. As highlighted by "Project for Sustainable Development of Rain-Fed Lowland Rice Production in the Republic of Ghana," (2014) between July 2009 to 2014, the Government of Ghana collaborated with the Japanese Government to implement the technical cooperation project between Japan International Corporation Agency (JICA) and MOFA in the Ashanti and Northern regions. This was to train farmers on land development, improve rice cultivation techniques, and improve farming support and extension procedure in which Ahafo Ano North district in Ashanti was selected to participate (Project report, 2014).

BF&T (2014) showed that Ghana produced around 600,000 tonnes of rice and consumed about 1.8 million tonnes, had a deficit of 1.2 million tonnes which was imported with estimated US$1billion.The local rice currently produced was not sufficient to feed the Ghanaian consumers yet was faced with the challenge of low patronage especially by upper and middle class rice consumers, who dominated the urban rice market. Due to poor physicochemical rice qualities of locally produced rice, Ghanaian consumers preferred imported rice at the expense of locally produced one leading to less competition in price and therefore low productiveness in production for local Ghanaian farmers.

Manful (2010), found out that rice grown in many African countries was unable to compete with imported rice, and locally produced rice was increasingly ceding market share to imports. Grain quality characteristics from major rice consuming countries dictate the market value of the commodity and play important role in the development and adoption of new varieties (Sassenrath et al, 2008). Furthermore, Fitzgerald, McCouch and Hall (2009) posited that grain quality includes traits such as physical appearance, cooking and sensory properties, as well as nutritional value.

Manful, Akatse and Osei-Yaw (1996) divided the desirable grain qualities on the Ghanaian market into physical and cooking characteristics. The desirable physical characteristics include the absence of unhusked paddy and other foreign matter such as weed seeds, stones, pieces of metal and insects. Others are a low percentage of discoloured and immature grains. Most of these parameters are governed mainly by standard of cultivation and processing techniques.

The study by Guisse (2010) in the Ejisu Municipal Assembly showed that 15% of rice farmers said lack of technical knowledge in the area of post-harvest handling contributed to both quantitative and qualitative postharvest losses in quality of milled rice produced. The current research which was undertaken in Ahafo Ano

North district in the Ashanti region was similar to a previous one conducted by Guisse (2010) in Ejisu Juaben Municipal ,all located in the major rice growing districts of Ashanti region. The technical cooperation project in rice cultivation between JICA and MOFA for the five year period (2009–2014) had been implemented to determine how the technical knowledge received by farmers would influence on the yields and also on the quality of milled rice produced by (Project

Report,2014).

Therefore, this study aimed to determine the effect of training in good rice cultivation and postharvest practices on the quality of milled rice produced in the

Ahafo Ano North District of Ashanti region. The specific objectives were:

1. To verify rice cultivation and postharvest practices in the district and to establish whether the knowledge and the skill acquired through training reflects in the rice cultivation, postharvest activities of the trained farmers.
2. To evaluate the effect of good rice cultivation and postharvest practices on the physical qualities of milled rice produced by trained and non-trained rice farmers,
3. To determine the chemical and functional properties of milled rice flour sampled from trained and non-trained rice farmers.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 DESCRIPTION OF RICE

The two main species of cultivated rice: Asian rice (*Oryza sativa*), and African rice (*Oryza glaberrima*), additionally, the rice varieties grown across the world belongs to the *Oryza Sativa* (O.S) species, in contrast to the cultivation of the *Oryza glaberrima* (O.G.), in mainly African nations. On the other hand, the O.G. varieties are rapidly being phased out and replaced by the O.S due to its higher yields than the O.G and also its ability to tolerate weed, resist pest and mature at a shorter duration (Calpe, 2006) which agreed with the work done by (Dingkuhn et al., 2006) and (Ndjiondjop et al, 2010).

A study by Calpe (2006) and Datta and Khush (2002) asserts that "rice is a major food staple and a mainstay for the rural population and for household food security." This staple food is cultivated by small scale farmers, usually, in an average landholding of about one hectare, and rice is an important factor in determining the "wage commodity for workers" within either cash crop or non-agricultural sectors (Calpe, 2006), however (Moser and Barrett, 2003) expressed the same view regarding the importance of rice as a wage crop . However, the quality of rice, being a common determinant of the wage, has given rise to conflicting policy objectives where person in policy groups intervenes in rescuing farmers when the price drop very low in contrast to making price hikes (Calpe, 2006) and (Lusk, 2003).

In terms of its special importance, rice is ideal to be rich in nutrients to a wide population across the world, spanning from countries in Asia, some regions of Latin America, and the Caribbean and, is greatly consumed also in Africa (Calpe, 2006).

Moreover, rice is seen to have played a major role in food security in more than half of the world‟s population. This food staple, rice, is the main component of numerous communities‟ culture and as a result, rice is considered as a "strategic" food in a lot of nations and is, therefore, a topic of interest to subject to mostly government in controls of the affairs of a nation and its interventions (Rosegrant and Cline, 2003) and (Calpe, 2006).

Rice comes from the plant in the wheat or oat family and can grow up to the height of about 1.8 meters. Meanwhile, on the inside, rice is seen to be in the form of a stem having a hollow cane, without knots. Its leaves are "Lancelot, with tapered endings and parallel venation," and have the "most significant part" having "spikes which are formed by a deciduous panicle where the seed or grains of rice are found". Rice is very high in content such as starch within the endosperm (white beans) which is enclosed by a "hard, clean brown cover," usually referred to as rice bran, protected on the outside by "a clear and papyraceous cover known as husk (Calpe, 2006).

2.1.1 Global Rice Production

De Datta (1981) put the rice growing countries at 111 in all Asia countries, in most West and Northern Africa countries and some part of Central and Eastern Africa, South and Central America, Australia cuts across the world. There are abounding a number of literatures in the field of rice cultivation of which significant countries in the production of this staple food are seen on continents like Asia, Europe, America and Africa. Meanwhile, the main rice producing countries in the world include China, India, Indonesia, Bangladesh, Vietnam, Thailand, Burma and Japan. Other countries, for instance Italy, Spain, Russia, Greece, Portugal, The United States of America, Brazil, Colombia, Peru and Argentina are those countries that are into rice production in the European and American continents. Finally, countries on the African continent that are main producers of rice include: Egypt, Nigeria,

Madagascar and Cote D‟Ivoire.

Rice production worldwide totalled 696 million tons in 2010 in 144 million farms of cultivated arable land of 162 million hectares with Asia continent ranking high in production and consumption of rice as food (Maclean, Hardy and Hettel, 2013).Rice production within the period of forty nine (49) years, thus 1961 to 2010 was three times higher with the growth rate of 2.24% with the producing countries of Asia origin recording 2.21% growth rate. Rain-fed lowland ecology constitute 1.9 million ha cultivated for rice world-wide with an average yield of 2.0t/ha (Maclean *et al*., 2013).

2.1.2 Rice Production in Africa

Africa sub-Saharan has approximately an estimated 130 million hectares of inlandvalley lowlands and its water resource where rice could be cultivated in. West Africa may be credited to have 20 -30 million of hectares of land suitable and can on average give the yield ranging 2.5t/ha to 5t/ha depending on the fertility status of the soil (Maclean *et al*., 2013). Rice is an important and widespread crop in terms of consumption in Africa.

In Africa, Hedge and Hedge (2013) reported that “milled rice production is averaging 11.80 million tonnes”. Even with this tonnes of rice produced in the continent; the consumers in Africa countries have a various negative perception about the rice produced because of the quality difference between the locally produced and the imported rice.

2.1.3 Rice Production in Ghana

Ghana produces two main rice varieties, namely: *Oryza Sativa* and *Oryza Glaberima*. Ghana‟s total rice production ranged from 300,000 tons to about 500,000 tons in 2005-2010. From a study conducted by the Monitoring Food and Agricultural Policies in 2013, the area under cultivation has increased from 0.09 to 0.16 million hectares within a 10 year period whiles the yield per hectare ranges between 1.7 to 2.7 tonnes (Angelucci, Asante-Poku, & Anaadumba, 2013). Rice is mostly cultivated in three ecologies in Ghana; namely: lowland rain-fed ecology (78%), upland rainfed ecology (16%) and irrigated ecology (6%) of cultivated arable land (MOFA, 2009). The large scale irrigation scheme in Ghana, where rice and vegetables are cultivated includes; Kpong, Tono, Vea and Afife irrigation scheme. Good cultivation practices are often a key factor in determining the yield and the quality of rice produced (MOFA, 2009).

2.2 RICE CULTIVATION PRACTICES

2.2.1 Selection of Suitable Valley and Appropriate Paddy Field Preparation

The right kind of ecology for rice cultivation is very important and is much dependent upon availability of water. The paddy field preparation procedure follows the land clearing, ploughing, harrowing, bund construction, use of interlocking bunds to sub divides the field into the same land slope which is well levelled and properly puddled as recommended by IRRI, (2012) and De Datta, (1981). IRRI (2012) gives the benefit of a well prepare levelled paddy fields as crop growth is uniform, less weed control problems, same maturity time and ripening resulting in higher yields.

2.2.2 Appropriate Seed Rice Variety and Seed Selection

The choice of seed rice variety to plant is very important in rice cultivation, especially where the soil nutrient status differs from place to place, hence the selection of true to type, clean and healthy seed would give high yield (IRRI, 2012).

2.2.3 Weed Control and Weed Control Methods

The effect of weeds on rice growth circle is key in the area of competition for nutrient and other growth promoting environment, IRRI (2012) revealed that there is much damage caused to the crop if weeds are not control 30-40 days after transplanting seedling, notwithstanding weed control at the latter stage of the crop would prevent weeds seeding which contaminates paddy during harvesting hence weed dockage in milled rice. Two time weeding with the first one done 2 weeks after transplanting and the last 3 weeks after the first one is recommended.

2.2.4 Time and Rate of Fertilization Application

IRRI (2012), recommended that one basal application and two top dressing using inorganic and organic fertilizers as a supplement for the crop nutrient requirement for better crop growth and yields.

2.2.5 Determination of Time of Paddy Harvest

The appropriate time to harvest paddy is very important since it influence the quality of the milled rice. Therefore, IRRI (2012) enumerated appropriate methods of paddy harvest determination such as: 25-30 days after flowering, when paddy straw colour is between 80-85% dry by visual assessment, grains at the lower part of panicle should be hard, not soft and when pressure is exerted on grain when placed between the teeth it should be firm not easily broken, The paddy when harvested too early would result in more immature grain causing slender shape green, soft, chalky and during milling production of more bran lading to low recovery (IRRI , 2012).

2.2.6 Paddy Harvest and Post-Harvest Practices

The sequence of post-harvest practices were listed as threshing should be done just after harvest, immediately follow by drying, should be sufficiently winnowed and stored at the appropriate grain moisture to avoid spoilage till milling is done (IRRI, 2012)

2.3 RICE QUALITY

2.3.1 Definition of Rice Quality

Study by Manful (2010) found out that rice quality differs in meaning depending upon the one who is defining it, especially actors such as farmers, millers, nutritionist, marketers, policy-makers, and consumer who vary on a rice value chain in their understanding of quality. (Dela Cruz and Khush 2000), deals with physical and physicochemical rice quality which entails grain size, shape, milling recovery, milling degree, appearance amylose content, gel consistency and gelatinization temperature.

The issues of good quality rice also are dependent on the user with little differences but in general terms, it should be little or no chalky, translucent in look, having uniform colour, high percentage of head rice, having the shape which should be true to type and with excellent cooking quality (Manful, 2010). Julliano and Duff (1989) revealed that the rice grain quality is influenced by type of rice variety grown, the environment and processing methods employed. The critical growth stages of rice and their handling processes either improve or reduce the quality of grain.

The quality of rice is what sustains the rice farming enterprise. This is usually seen in the following list: head rice or broken percentage, degree of milling, milling recovery, moisture content, and nutritional composition of rice, functional and pasting properties, . In addition, best quality rice could be produced if:

a. The quality of paddy is good and
b. The rice is milled properly.

Rice quality can be grouped into chemical, physical, sensory, functional, cooking and eating quality (Manful, 2010).

2.3.2 Head Rice or Broken Percentage

Head rice according to Bhattacharya (2011) is the state in which the rice grain is after de-husking and polishing, if it is still seen to be one whole grain from the top to the bottom. However, the broke percentage is usually the proportion of the milled rice that is as whole grain but broken.

2.3.5 Moisture Content

The amount of water in the grain is referred to as moisture content and is expressed in percentage terms. For a quality milled rice to be obtained the moisture content of the paddy at milling is very crucial. The higher the moisture content of paddy would lead to high percentages of breakage of the grain because the softness of the grain and the lower the moisture content of paddy would also make it brittle hence resulting in high percentages of broken grain. Bhattacharya (2011) said, the acceptable paddy moisture content of 14% would produce the highest head rice, which is a key milled rice quality parameter. Meanwhile, Calpe (2006) gave the range of 12-14% moisture content of paddy to be ideal for milling. The other postharvest practices such as paddy drying at very high temperature could lead to development of cracks in the paddy in otherwise the re-absorption of moisture by an over dried grains at milling would result in a high percent of broken grain. The milled rice when exposed to atmosphere naturally absorbed moisture, hence become soft predisposing it storage pest attack (Calpe, 2006)

2.3 6 Nutritional Composition of Rice/Proximate

What people consider proximate varies, but usually include water, carbohydrates, proteins, dietary fibers, fatty acids, ash, dietary minerals and alcohol. What makes proximate particular is that the total of various component presence in food, must always sum up to 100%. Perdon, Siebenmorgen, Mauromoustakos, Griffin, and Johnson (2001) revealed that proximate composition and its related amylograph properties of milled rice would depend on the degree of bran removal during milling.

2.3.8 Milling Degree

Perdon *et al*. (2001) referred to milling as the process of breaking down, separating, sizing, or classifying aggregate material. For instance, rock crushing or grinding to produce uniform aggregate size for construction purposes, or separation of rock, soil or aggregate material for the purposes of structural fill or land reclamation activities. Aggregate milling processes are also used to remove or separate contamination or moisture from aggregate or soil and to produce "dry fills" prior to transport or structural filling Milling is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that milling can offer, it is ideal for adding precision features of a part whose basic shape has already been formed (Perdon *et al*. 2001)

Milling Degree is usually defined as the extent to which the bran layers of rice have been removed during milling. Milling removes the germ and the bran layers which include the outer pericarp of the rice kernel, the aleurone layer, and some of the starchy endosperm (Bhattacharya, 1980)

A measure of how much bran was removed during milling is referred to as the degree of milling. The USDA Federal Grain Inspection Service has designated four qualitative degrees of milling categories: well-milled, reasonably well-milled, lightly milled, and under milled. Several methods have been used to objectively measure rice degree of milling. The most common method is calculating the mass lost during milling. Determinations of the amount of surface and total lipids have also been used. Additionally, the Satake milling meter (MM1-B) offers a quantifiable method of determining the degree of milling by using the transmittance and reflectance properties of the milled rice samples (Perdon *et al*. 2001).

Milling degree affects processing properties of rice. Under-milled rice, still, has bran attached to the kernel. This can reduce water absorption, adds fiber, protein, and lipids (thus reducing % starch). This would affect applications such as cooking time, kernel to kernel interactions (stickiness versus separateness), colour of the rice and interactions with other ingredients. Higher lipid content would affect how a rice kernel would pick up the spices or seasoning coating. Highly milled rice will have a higher starch content and lower lipids and protein than rice milled to a lower milling degree. This affects starch pasting properties and the effect can be seen in a higher curve run on an RVA (Rapid Visco Analyser). Gummert (2012) propounded that the physical quality of milled rice is characterized by a combination of desirable and measurable characteristics. In line with the market requirements, these are used to classify rice into grades. The degree of milling or percent brown rice removed as bran affects the level of white rice recovery and influences consumer acceptance. Grades range from under milled, well milled to extra well milled. Well-milled rice has normally 10% of rice removed during whitening. Milling degree influences the colour and also the cooking behaviour of rice as under-milled rice absorbs water slowly and does not cook well.

This characteristic is a combination of varietal and physical characteristics as well as the degree of milling. Whiteness is measured by a colorimeter or as an index number from a whiteness meter. It is often used to determine milling degree. Brown rice gives a reading of approximately 20 on the whiteness meter, whereas well-milled rice is close to 40 (Gummert, 2012)

2.3.9 Grain Dimension

The length and the width of rice grain and hence the shape is a varietal quality characteristic. The slender, bold or short shape of rice grain would demonstrate the ability of the grain to withstand pressure during milling hence broken and head rice recovery and would therefore influence the type of milling machine that can best be ideal to mill a particular grain shape (Bhattacharya, 2011). Bhattacharya (2011) again put rice grain into slender (over 3.0), medium (2.1 -3.0), Bold (1.1-2.0) and round to be 1.0 and less

2.3.10 Rice Functional Qualities

Matil, (1971) defined functional properties are characteristics that govern the behaviour of nutrients in food during processing, storage, and preparation as they affect food quality and acceptability. Rice is processed into various food forms which is mostly used for as breakfast cereal, snacks, baby foods, sauces and packages mixes. To what extent and forms rice is processed depends on the use and affect the quality of the final product. Having a knowledge of the functional properties of rice is very important (Perdon *et al*. 2001).

2.4 TRAINING IN RICE CULTIVATION

Training define by Aguinis and Kraiger, (2009) as step by step guidelines of influencing one's knowledge, skill and attitudes such that the individual, team and organization‟s effectiveness is improved. Improved techniques and ways of rice cultivation more often are made available to beneficiaries through research. Based on a work done by Diack et al, (2011), training rice farmers in pre-harvest activities such as good land preparation, comprising of appropriate ploughing depth and good levelling, good agronomic practices (planting of good seed, weed, diseases and pest control, fertilizer application in the right amount and in a split at critical growth period coupled with good water management) have serious effects on grain yield and quality of milled rice. In addition, harvest and post-harvest operations like manual cutting of rice plant at appropriate maturity stage, pre-drying, threshing, winnowing, drying and bulking have direct bearing on the paddy to be milled which affect the quality of milled rice.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 FIELD SURVEY

3.1.1 Experimental Site

The primary field data used for this research was conducted in 22 rice growing communities within Ahafo Ano North district of Ashanti region.

3.1.2 Questionnaire Design

A structured questionnaire made up of ten parts, namely; general information on the respondents bio-data, pre-cultivation and land preparation activities, rice cultivation, and harvesting, threshing, drying and winnowing, storage and drying before milling, farmers' perception of rice quality, basic farm management principles and lastly farmers‟ perception of the training was administered to the respondents.

3.1.3 Scope and the Sampling Method

A total number of 135 rice farmers, comprising 81 rice farmers who received training in good rice cultivation practices, 54 rice farmers who did not participate in the training were randomly selected from 22 rice growing communities as respondents for the study. The selection of the sample was done by using simple random and purposive sampling techniques where the sample size was the percentage representation of the entire population as cited by Leedy and Ormrod (2005), who proposed that for one to do quality research, at least 30% of the accessible population is a fair sample for acceptable results, hence the use of the above sampling technique.

3.1.4 Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 16 was used for analyzing data collected from the field. Descriptive statistics such as frequencies, percentages and bar charts were drawn.

3.2. LABORATORY WORK

3.2.1. Experimental Site

The measurement of quality parameters on physical, chemical, and functional properties was done in the laboratory of Irrigation Development Authority at

Ashaiman, Animal Science, and Food Science laboratory of Kwame Nkrumah University of Science & Technology in Kumasi respectively and Food Science Laboratory of Crop Research Institute at Fumesua.

3.2.2 Rice Sample Preparation and Milling

Jasmine 85 rice sample of approximately 500 grams each of freshly harvested paddy was sampled from 20 farmers consisting of 10 trained and 10 non-trained farmers respectively. The prepared paddy sample was sent to Ashaiman Irrigation Development Authority for assessment of physical milled rice quality parameters.

Each sample paddy of 500g was weighed using digital weighing machine „Libror EB 2300D "and was well labelled. After checking the moisture content of each sample paddy, it was de-hulled using Satake laboratory de-huller and the brown rice recovered was weighed again before polishing. To polish to a desired whiteness or colour, the adjustment of the regulator was continually done till the desired whiteness or translucent was achieved and then re-weighed. The white rice was graded into head rice and broken grain using rice grader.

3.2.3. PHYSICAL QUALITY PARAMETERS OF MILLED RICE

3.2.3.1 Milling Recovery

Five hundred grams (500g) of Jasmine 85 paddy rice from trained and non-trained farmers respectively, replicated three times (1500g), were first tested for moisture content and then weighed using „Libror EB 2300D weighing scale.

The cleaning component of the Satake rice milling machine was used to clean the paddy rice before it was de-husked. The Satake laboratory rice de-husking machine was used to de-husk the paddy samples after which the weight of the brown rice was taken.

Abrasive Whitener was then used to polish the de-hulled (brown) rice samples followed by weighing the final polished rice after which the samples were then sealed in transparent polyethylene bags (8×13.5, Poly Products (GH) Ltd.).

The milling recovery was calculated by dividing the weight of milled (polished) rice recovered by the weight of the paddy sample, as follows:

% Milling recovery = Wt. Of milled rice/ Wt. Of paddy sample used × 100 (Bhattacharya, 2011)

3.2.3.2 Milling Degree

Milling degree as said by Bhattacharya (2011) is computed based on the amount of bran removed from the brown rice. To obtain the weight of the brown rice, the paddy samples of 500g were de-hulled using the Satake Laboratory Huller and then a polisher used to remove the bran. The percent milling degree was estimated using the following equation:

% Milling degree = Wt. of milled rice/ Wt. Of brown rice × 100

(Bhattacharya, 2011)

3.2.3.3 Head Rice

The white rice, after de-hulling and polishing, was weighed and then graded in broken and head rice using the rice grain Grader. The head rice was weighed using Satake digital weighing scale. The percentage head rice was calculated using the equation:

% Head rice = Wt of Head rice ÷ Total weight of Sample × 100 (Bhattacharya, 2011)

3.2.3.4. Dockage

Light foreign matter, stones, weed seed and other impurities known as the dockage were manually selected and aggregated from 100g weight sample of milled rice after which they were weighed. The dockage percentage in a milled rice was computed using the equation:

% Dockage = Wt. of Dockage/Total weight of Sample× 100 (Bhattacharya, 2011)

3.2.3.5. Moisture Content

Stake Digital Grain Moisture Meter Model ss-7 (MOISTXss7 Satake moisture meter) was used to measure the amount of water in the grain. The moisture meter was appropriately set to take the reading (milled rice). A spoonful of milled rice was poured on a saucer using a plastic spoon and pincette. The grains on the saucer was well even and then inserted into the body, the handle was tighten until it came across the stopper. The measuring button was pushed and the moisture content value indicated was taken. This procedure was followed for each sample picked from the different locations and replicated three (3) times. (Bhattacharya, 2011)

3.2.3.6. Broken Grain

From the 500g of paddy rice weighed and polished, the broken grains were separated from the head rice using the Grain Grader. The broken grain percentage was calculated using the following equations:

% Broken = Wt. of Broken grains/ Wt. of paddy samples × 100

(Bhattacharya, 2011)

3.2.3.7. Chalkiness

A hundred grams (100g) of milled rice were weighed and the chalky grains present were selected and segregated by using the visual rating of the chalky proportion of the grain. The weight of the chalky grain was taken and the percentage chalkiness determined using the equation:

$$\% \text{ Chalky grain} = \text{Wt. of chalky grains} / \text{Wt. of milled rice} \times 100$$

The measure or degree of chalkiness was determined based on the Standard Evaluation System SES scale presented below: (Bhattacharya, 2011)

Standard Evaluation System (SES) Scale 9 for Chalkiness Measure

Scale	**% area of chalkiness**
1	less than 10
5	10-20
9	More than 20

Source: IRRI (2011)

3.2.3.8. Grain Dimensions

Twenty (20) grains of milled head rice were collected at random from each of the three replicates; (60 grains of trained and 60 grains of non-trained samples).Measurement of its dimension was done using Vernier Calipers to obtain the length and width of the milled whole of the grains according to Bhattacharya (2011). Based on the length to width ratio, the shape of the milled rice was determined. L/W ratio is calculated by:

$$L/W \text{ ratios} = \text{Average length of rice (mm)} / \text{Average width of rice (mm)}$$

Using the ISO Classification of Rice Shape as given by IRRI (2011) follows:

Scale	Shape	L/W ratio
1	Slender	Over 3.0
3	Medium	2.1-3.0
5	Bold	1.1 -2.0
9	Round	1.0 or less

Source: IRRI (2011)

3.2.3.9. 1000 Grain Weight

Using a 1000 grain counter, 3 replications of 1000 whole grains of white rice were counted making of total 6000 grains (3000 grains milled rice samples of trained and non-trained). Each of the 1000 whole grain lots was weighed using a Compact Scale HT-500 and the average calculated. This was done according to Omar (2013), methods with slight modifications.

3.2.4 CHEMICAL QUALITY PARAMETERS OF MILLED RICE

3.2.4.1. Moisture Content

The weight of a pre-dried coded pan was taken and 5 grams of the powdered milled rice was weighed and distributed over the base of the coded pan. This pan was then placed in a forced draft oven at a temperature of 105 °C for 4 hours, after which it was cooled in a desiccator. The weight of the sample after drying was taken and the percentage moisture content calculated using the formula below:

% Moisture content = weight of sample- weight of dried sample/ weight of sample × 100

or $$\%\ \text{moisture content} = \frac{\text{weight of sample} - \text{weight of dried sample}}{\text{weight of sample}} \times 100$$

3.2.4.2. Protein determination

The method of protein determination adopted was from - AOAC 984.13 (1990) with slight modifications.Two (2g) of the powdered milled rice was weighed onto a filter paper. This filter paper was folded and placed in a labelled digestive tube. Fifteen (15) mL of concentrated H_2SO_4 was poured over the sample in the digestion tube and a catalyst (Kjeltabs) was added to the sample. The sample was then made to digest at a temperature of 400 °C for about 2 hours using the Kjedahl digester**.** After digestion, the sample was then distillates using the kjeltec distillation apparatus. Eighty milliliters (80 ml) of 40 % NaOH and distilled water was fed into the apparatus. Three (3) drops of screened methyl red was added to twenty five mL (25ml) of 4 % boric acid in a conical flask and connected to the apparatus. The process of distillation was carried out till the boric acid solution changed colour from pink to light blue. After distillation, the resulting solution was titrated against 0.1 NHCl. The protein content was calculated as indicated below:

$$\% \text{ protein} = \left(\frac{T \times N \times M}{10 \times Weight\ of\ sample} \right) \times 6.25$$

T = Titration volume for sample

M = Titration volume for blank

N = Normality of acid to 4 decimal places

3.2.4.3. Crude fiber determination

Three (3g) of the powered milled rice defatted using the AOAC (1990) method. Two hundred milliliters (200 ml) of 1.25 % H2SO4 was measured and poured over the defatted sample in a flat bottom flask which was placed over a hot plate for its content to boil for 30 min. In order to mix the contents in the glass and remove the particles from the side, the mixture was stirred every few minutes manually by rotating the flask. Filtration was then carried out during which warm distilled water was used to wash the residue. The residue was transferred into the flask and 200 ml of 1.25 % NaOH was poured over it. This was also made to boil for 30 mins after which the contents was filtered off and the residue washed with warm distilled water. The residue was then dried in an air oven at a temperature of about 100 °C for 1 hour. The weight of the dried sample was taken and the dried sample was transferred into a crucible. The sample was made to ash for 30 mins after which the weight of ash was taken. The crude fiber content was calculated as indicated below: dietary fiber %=(((R_1+R_2) ⁄2)-p-A-B)/ (((M_1+M_2))⁄2) ×100

Blank (B) = (BR1+BR2)/2-BP-BA

Where: R1 = residue weight 1 from M1

R2 = residue weight 2 from M2
M1 = sample weight 1; M2 = sample weight 2

A = ash weight from R1 p = protein weight

from R2; B = blank

BR = blank residue; BP = blank protein from BR1;

3.2.4.5. Ash determination

The method of ash determination adopted was from AOAC 984.13 (1990).The weight of an already ignited, cooled porcelain crucible was taken. About 3 g of the powdered milled rice was weighed into the crucible. With the help of tongs, the crucible was placed in a Vecstar muffle furnace at a temperature of 600 °C and left to ash for 2 hours. After which the ash was cooled in a desiccator to room temperature and weighed. The ash content was calculated as indicated below:

$$\frac{\text{Weight of Ash}}{\text{Weight of original sample}} \times 100$$

3.2.4.6. Fat determination (Ether Extract)

The method of fat determination adopted was from AOAC (1990).Three (3) g of the powered rice flour was weighed into a folded filter paper which was placed in a thimble and stuffed with non- absorbent cotton. The thimble containing the rice sample was then placed in the extractor of the Soxhlet apparatus. A clean dried Soxhlet flask was weighed and about 240 ml of petroleum ether was measured into it. The Soxhlet apparatus was then being set up. Cold water was turned on so it could pass through the condenser and help condense the organic solvent. The set up was left to run 15 h. The Soxhlet flask which had the extracted fat was detached and dried in an air oven at a temperature of 105 °C for 1 h. It was cooled in a desiccator and weighed.

The fat content was calculated using the formula: $\frac{100(W1-W2)}{W}$

where, W_1 is the weight in g of the Soxhlet flask with the extracted oil; W_2 is the weight in g of the empty Soxhlet flask, W is the weight in g of the dry sample taken for the test.

3.2.4.7. Carbohydrate and energy determination

The carbohydrate content of the powered milled rice was determined by computing percentage differences of moisture, fat, protein, ash and fiber. The carbohydrate content was calculated as indicated below:

Carbohydrate (%) = 100 – (% moisture + % fat + % protein + % ash + % fiber)

3.2.5. PASTING PROPERTIES OF THE FLOUR OF MILLED RICE

The pasting properties of the samples were assessed using the Rapid Visco-Analyser (Model RVA series 4500; Perten Instruments, CRI Food Science Laboratory, Kumasi).

A 3.5 g rice flour sample was dispersed in an aluminum canister after which its moisture content was conditioned to 14.0%. The samples were tested according to Standard Profile 1, where the flour-water suspension was held at 50 ^{o}

C for 1 min and then heated to 95oC, held for 10 min, and then cooled to 50^{o}C and held for another 2 min. The starch viscosity parameters measured were pasting temperature, peak viscosity, breakdown viscosity, final viscosity and setback viscosity. The results were expressed as RVU for all of the parameters with the exception of pasting temperature, which is expressed in ^{o}C. Duplicate measurements always agreed within 5 rapid visco units (RVU) over the whole profile.

3.2.6 FUNCTIONAL PROPERTIES

The swelling power and solubility, water absorption capacity, bulk density were the functional property studied on.

3.2.6.1 Swelling Power and Solubility

This was determined using the method described by Leach et al. (1959) with modification for small samples. One gram of the flour sample was mixed with 10 ml of distilled water in a centrifuge tube and heated at 80 °C for 30 min. This was continually shaken during the heating period. After heating, the suspension was centrifuged at 1000 × g for 15 min. The supernatant was decanted and the weight of paste taken. The supernatant was evaporated and the dried residue weighed to determine the solubility. The swelling power was calculated as: Swelling power = weight of the paste / weight of dry flour.

Swelling power (SP) is expressed in g of swollen granules per g of dry starch in the sediment and solubility (%) was expressed as the weight of soluble starch in percent of initial dry starch weight. SP and S were calculated according to following equations.

$$SP = \frac{\text{Weight of Sedimented Past} \times 100}{\text{Weight of Sample on dry basis} \times (100 - \%S)}$$

$$S\ (\%) = \frac{\text{Weight of Soluble starch} \times 100}{\text{Weight of Sample on dry basis}}$$

3.2.6.2. Water Absorption Capacity

This property was determined using the method proposed by Sabularse *et al*. (1991) with modifications to determine water absorption capacity. Two gram of rice was mixed with 20 ml distilled water in a test tube covered with a piece of cotton plug. The test tube was then placed in a thermostatically controlled water bath preheated to 97-99º C to cook the rice. This was then followed by cooling in water, draining of excess water, and the test tube placed upside down for 1 h and then weighed. Water absorption was calculated as increase in weight, and expressed as gram of water per gram of rice. Water absorption Capacity = (weight of cooked rice) / (weight of uncooked rice sample).

3.2.6.2. Bulk Density

A 50 g rice flour sample was put into a 100 ml measuring cylinder and filled to a constant volume. The bulk density (g/cm³) was calculated as weight of flour (g) divided by flour volume (cm³), (Okaka and Potter, 1979).

3.3. Experimental Design

Completely Randomize Design (CRD) was the experimental design used. The experiment was replicated three times.

3.4. Statistical Analysis

3.4.1 Statistical Analysis of the Field Survey

Statistical Package for the Social Sciences (SPSS) was used to analyze the data collected from the field using descriptive such as percentages, bar charts, and pie charts.

3.4.2. Statistical Analysis of the Laboratory Work

STATISTIX (version 9) software was used for the statistical analysis of data collected during the laboratory study. Differences between treatment means were determined using the Student T-test which was replicated three times.

CHAPTER FOUR

4.0 RESULTS

4.1 INTRODUCTION

This chapter presents the findings reported from respondents in the study area. The respondents comprised of rice farmers selected from Ahafo Ano North district in Ashanti region. A total of 135 respondents comprising of 81 trained rice farmers and 54 non-trained rice farmers interviewed. Results for the study which involved survey and laboratory work on the effect of training in rice cultivation practices on quality of rice produced in Ahafo Ano North district in the Ashanti Region are presented in tables and charts.

4.2 FIELD SURVEY RESULTS

4.2.1 Demographic Information for Respondents

4.2.1.1 Gender of Respondents

Figure 4.1 shows that the male and female distribution of rice farmers in the Ahafo Ano North district. It shows the majority of males are into rice cultivation for both the trained (72.8%) and the non-trained (61.1%) respondents and 27.2% and 38.9% of females for both the trained and untrained respondents respectively.

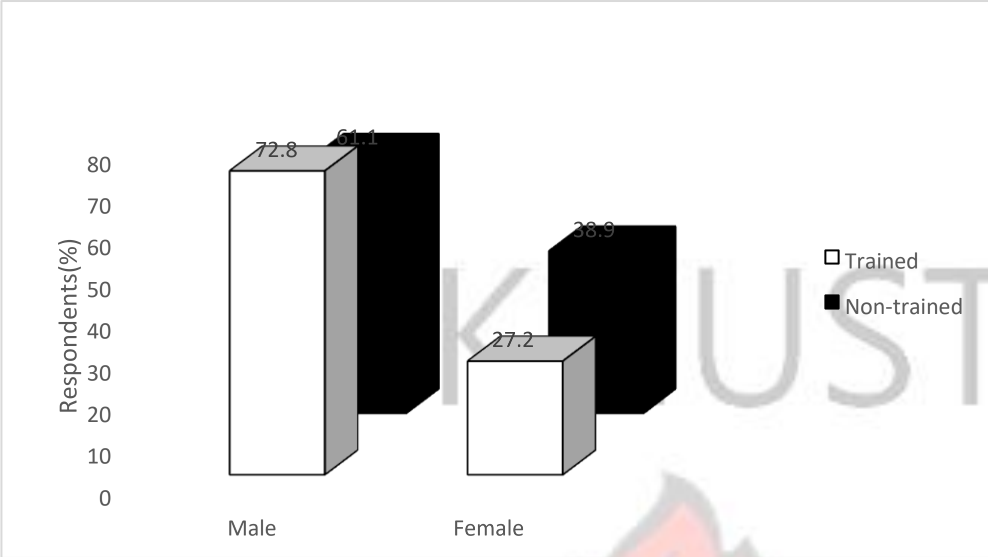
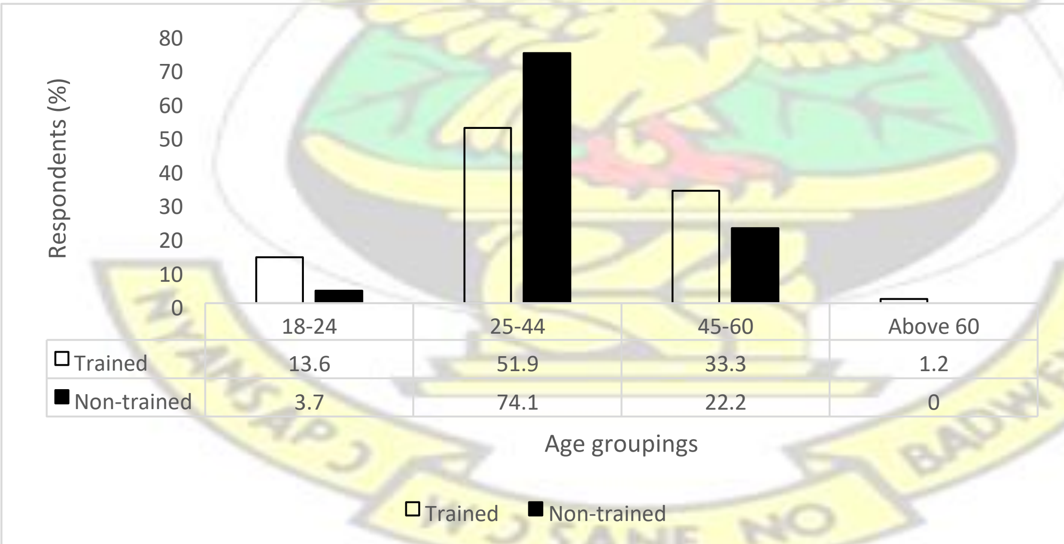


Figure. 4.1: Gender of the trained and non-trained rice farmers

4.2.1.2 Age Distribution of Respondents

Figure 4.2 represents age groupings of rice farmers interviewed. The majority of rice farmers were aged between 25 to 44 years; 52% for the trained and 75% for the untrained rice farmers.



	18-24	25-44	45-60	Above 60
Trained	13.6	51.9	33.3	1.2
Non-trained	3.7	74.1	22.2	0

Figure 4.2: Age Distribution of Respondents

4.2.1.3 Educational Background of Respondents

Table 4.1 shows the educational levels of rice farmers interviewed. The results showed that most of the trained rice farmers (60.5%) had no educational background, 22.2% had Basic education, 8.6% had Junior High School education, and 7.4% had Senior High School education while 1.2% had tertiary education. For the non-trained respondents, the majority (44.4%) had Junior High School education while 25.9%, 20.4%, 7.4% and 1.9% had no formal, basic, Senior high school and tertiary educations respectively.

Table 4.1: Educational Levels of Respondent

		ined	Non-	ned
Educational levels	Frequency	Percentages	Frequency	Percentages
No formal education	49	60.5	14	25.9
Basic	18	22.2	11	20.4
JHS	7	8.6	24	44.4
SHS	6	7.4	4	7.4
Tertiary	1	1.2	1	1.9
Total	**81**	**100.0**	**54**	**100.0**

4.2.2 Years of Experience in Rice Cultivation

Figure 4.3 represents the number of years respondents have been into rice cultivation. The highest years of experience in rice cultivation vary for the two groups. More than half (51%) of trained rice farmers have been cultivating rice for between 1 to 5 years while 48% of the non-trained respondents have been in the rice business for between 6 to 10 years.

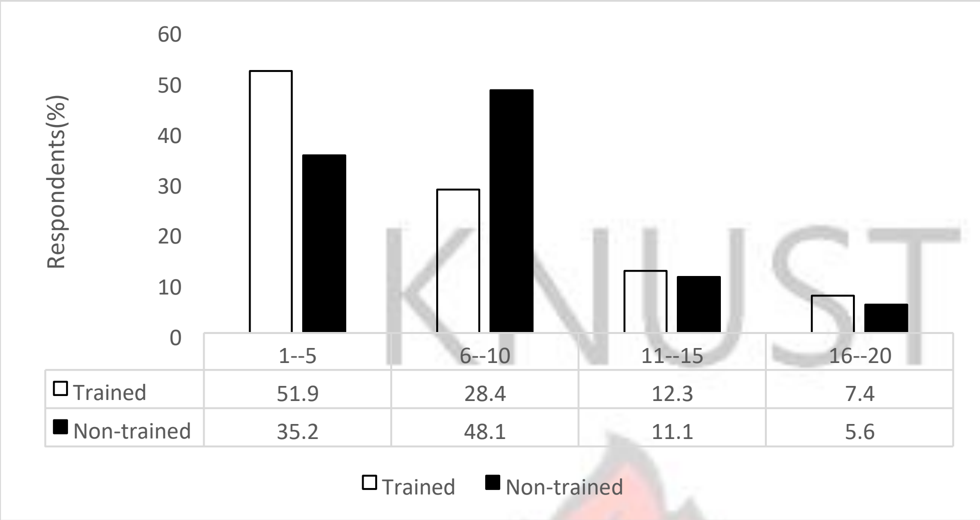


Figure 4.3: Years of experience in Rice cultivation

4.2.3 Paddy Field Sizes

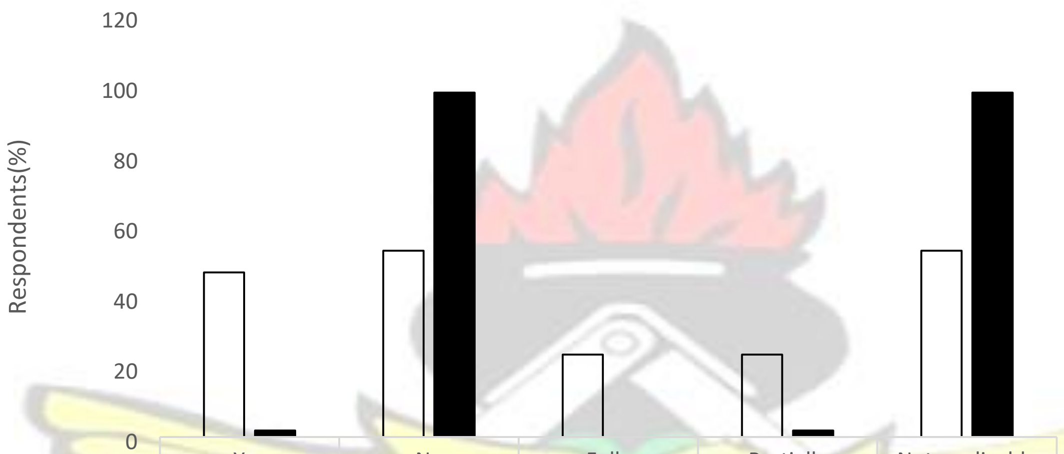
Table 4.2 shows the average area under rice cultivation by individual rice farmers. It showed that majority of trained farmers (44.4%) and untrained farmers (59.3%) cultivated rice on an average size of 0.4 ha of land.

Table 4.2: Paddy Field Sizes

Hectare	Trained		Non-trained	
	Frequency	Percentages	Frequency	Percentages
0.1	6	7.4	2	3.7
0.2	6	7.4	13	24.1
0.4	36	44.4	32	59.3
0.61	10	12.3	3	5.6
0.81	17	21.0	3	5.6
0.81 and more	6	7.4	1	1.9
Total	**81**	**100.0**	**54**	**100.0**

4.2.4 Rice cultivation Activity Plan Preparation and Implementations Levels

Figure 4.3 showed (53.1%) of trained rice farmers prepared rice cultivation activity plans while just (1.9%) of the non-trained farmers prepared the plan. For the trained farmers who prepared the plans, 23.5% fully implemented the plans while the 1.9% of the non-trained rice farmers who prepared the rice cultivation plans partially implemented the plans.



	Yes	No	Fully	Partially	Not applicable
Trained	46.9	53.1	23.5	23.5	53.1
Non-trained	1.9	98.1	0	1.9	98.1

Figure 4. 4: Rice cultivation activity plan preparation and implementation levels.

4.2.5 Rice Seed Varieties and Sources

From the results (Table 4.3), most of the trained rice farmers cultivated Jasmine 85 (39.5%) and Obolo (30.9%) varieties while most of the non-trained rice farmers cultivated Jasmine 85 (35.2%) and Jasmine 75 (53.7%). Most of the trained farmers obtained their seed rice from MOFA/JICA project coordinators (38.3%) and other trained farmers (29.6%) while the majority of the non-trained farmers sourced their seed rice from other non-trained farmers (81.5%).

Table 4. 3: Seed Rice Varieties and Seed Sources

Seed rice varieties	Description	Trained Frequency	Trained Percentages	Non-trained Frequency	Non-trained Percentages
	Jasmine 85	32	39.5	19	35.2
	Jasmine 75	4	5.0	29	53.7
	Obolo	25	30.9	2	3.7
	Wita 7	5	6.2	1	1.9
	Sikamo	8	9.9	1	1.9
	Local	1	1.2	2	3.7
	Agra	4	4.9	0	0
	Amankwatia	1	1.2	0	0
	Jasmine85, Agra, Amankwatia	1	1.2	0	0
	Total	**81**	**100.0**	**54.0**	**100.0**
Seed source	MOFA/JICA project	31	38.3	0	0
	Bought from the market	1	1.2	2	3.7
	MOFA Block farm	12	14.8	4	7.4
	Rice milling centre	6	7.4	4	7.4
	Other farmers	24	29.6	44	81.5
	Farmers own seed	2	2.5	0	0
	MOFA-JICA, other farmers	4	4.9	0	0
	MOFA block farm, Rice mill center	1	1.2	0	0
	Total	**81**	**100.0**	**54**	**100.0**

4.2.6 Seed Selection and Their Selection Methods

Table 4.4 shows the results of seed selection and seed selection methods carried out by rice farmers. Majority of trained (97.5%) and non-trained farmers (100%) practiced seed selection, with the majority of the trained farmers using the salt solution (86.4%) method while the non-trained farmers used the winnowing (74.1%) method.

Table 4.4: Seed Selection and Seed Selection Methods

Seed selection	Description	Trained		Non-trained	
		Frequency	**Percentages**	**Frequency**	**Percentages**
	Yes	79	97.5	54	100
	No	2	2.5	0	0
	Total	**81**	**100.0**	**54**	**100.0**
Selection methods	Water	6	7.4	12	22.2
	Salt solution	70	86.4	1	1.9
	Handpicking	4	4.9	1	1.9
	Winnowing	1	1.2	40	74.1
	Total	**81**	**100.0**	**54**	**100.0**

4.2.7 Paddy Field Preparation Methods

From Table 4.5, most (72.8%) of the trained framers prepared their paddy field by clearing the land, manual ploughing, bund construction, puddling and levelling while the majority (98.1%) of the non-trained only cleared their land and applied herbicides to the re-growth.

Table 4. 5: Paddy Field Preparation Methods by Rice Farmers

Paddy field preparation methods	**Trai Freque**	**Percentages**	**NonFrequencyained**	**Percentages**
Land clearing, herbicides	3	3.7	53	98.1
Land clearing, herbicides, ploughing	19	23.5	1	1.9
Land clearing, ploughing, bund construction, puddling and levelling	59	72.8	**0**	0
Total	**81**	**100.0**	**54**	**100.0**

4.2.8 Water Management Skill and Water Harvesting Structures

Table 4.6 depicts results on various water harvesting structures and water management skill used by trained and non-trained rice farmers. The majority (50.6%) of the trained farmers had little knowledge of water management skills while 88.9% of the non-trained rice farmers had no knowledge of water management skills. The trained farmers (80.2%) made use of the peripheral bund and interlocking bund as water harvesting structures while the non-trained (90.7%) farmers used dugout and pumping machines to harvest, manage and control water on rice paddy fields.

Table 4. 6: Water Management Skill and Water Harvesting Structures

Water management skill	**Description**	**Train Frequer**	**Percentages**	**NonFrequencyained**	**Percentages**
	Yes, very well	39	48.1	-	-
	Not very well	41	50.6	6	11.1
	No knowledge at all	1	1.2	48	88.9
	Total	81	100.0	**54**	**100.0**
Water harvesting structure	Bund and interlocking bund	65	80.2	1	1.9
	Dyke	1	1.2	-	-
	Dug out	8	9.9	-	-
	Water pumping machine	2	2.5	4	7.4
	Dugout, pumping machine	4	4.9	49	90.7
	Dyke and dug out	1	1.2	-	-
	Total	**81**	**100.0**	**54**	**100.0**

4.2.9 Sowing Methods

From the results (Figure 4.5), 71.6% of the trained farmers‟ transplanted seedlings, 9.9% practices direct sowing while 18.5% combined direct sowing and transplanting. For the non-trained farmers, half of them (50%) combined direct sowing and transplanting, 16.7% sowed directly, 7.4% transplanted while 25.9% broadcasted their seed rice on prepared field.

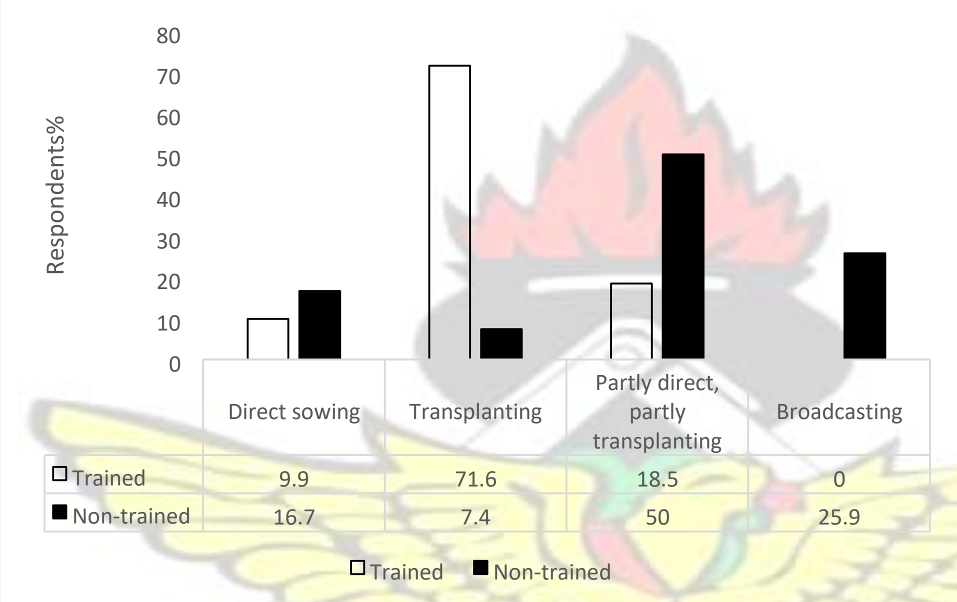


Figure. 4.5: Sowing Methods

4.2.10 Age of Transplanted Seedlings

The result, as shown in Figure. 4.6 presents the various ages at which seedlings are transplanted by rice farmers. The majority (72.8%) of trained farmers transplanted rice seedlings 21 days after nursery whereas most (70%) of the nontrained farmers transplanted seedling beyond 21 days after without determining the exact age at which seedlings are transplanted.

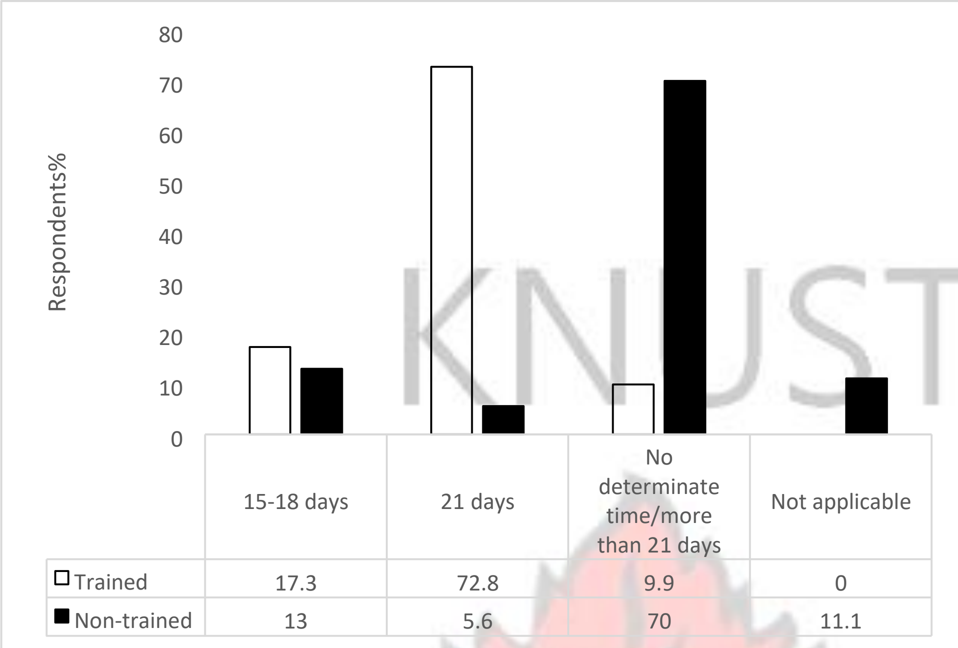


Figure. 4.6: Age of Seedling at Transplanting

4.2.11 Weed Control

Table 4.7 shows the number of time weeding was done before harvest. The majority (51.9%) of the trained farmers controlled weeds in their rice farms twice before harvest, 19.8% weeded once before harvest, 25.9% weeded three times before harvest while 2.5% weeded more than three times before harvest. Most (92.6%) of the non-trained farmers weeded their rice farms twice before harvest, 5.6% weeded once before harvest while 1.9% weeded three times before harvest.

Table 4.7: Frequency of Weed Control

Weed control	**Description**	**Trained**		**Non-trained**	
		Frequency	**Percentages**	**Frequency**	**Percentages**
	Once	16	19.8	3	5.6
	Two times	42	51.9	50	92.6
	Three times	21	25.9	1	1.9
	More than three times	2	2.5	-	-
	Total	**81**	**100.0**	**54**	**100.0**

4.2.12 Fertilizer Application

From the results (Table 4.8), 98.8% of the trained rice farmers and 79.6% of the nontrained farmers applied fertilizer. Most of the trained farmers (39.5%) applied fertilizers three times while 68.5% of the non-trained rice farmers applied fertilizer only once during the entire cultivation period.

Table 4. 8: Fertilizer Application, Frequency and At Critical Stages of Crop Growth

Fertilizer application	Description	Trained		Non-trained	
		Frequency	Percentages	Frequency	Percentages
	Yes	80	98.8	43	79.6
	No	1	1.2	11	20.4
	Total	**81**	**100.0**	**54**	**100.0**
Frequency of fertilizer application	One	6	7.4	37	68.5
	Two	29	35.8	6	11.1
	Three	32	39.5	1	1.9
	Four	14	17.3	0	0
	Not applicable	0	0	10	18.5
	Total	**81**	**100.0**	**54**	**100.0**
Application at all critical growth stages	Yes	38	46.9	2	3.7
	No	43	53.1	52	96.3
	Total	**81**	**100.0**	**54**	**100.0**

4.2.13 Bird Scaring and Methods

Farmers were asked how they controlled birds in their rice fields (Figure 4.7). All rice farmers whether trained or not trained scared birds away from paddy fields. (51.9%) of trained rice farmers scared birds away from their farms using the fishing net to cover the paddy whiles majority (87%) of non-trained farmers do same

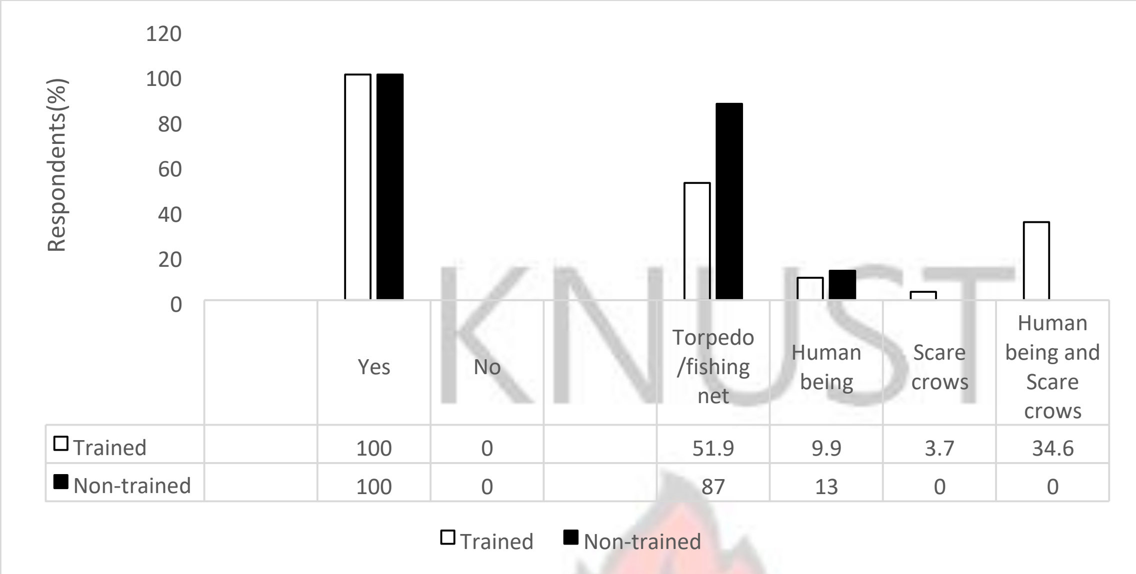


Figure. 4.7: Birds Scaring and Methods

4.2.14 Off-Type Removal Activities

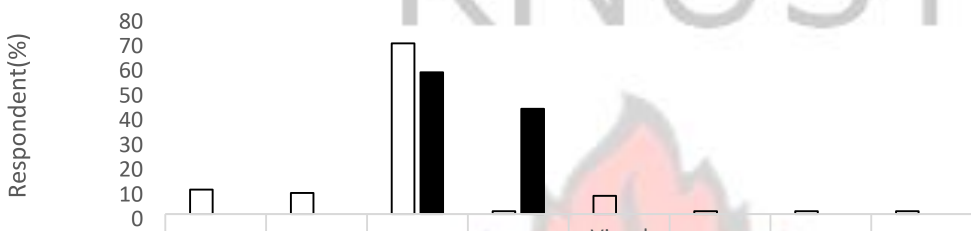
Table 4.9 shows result of rice farmers‟ participation in off-type removal activities. Both the trained, 65.4% and non-trained 96.3% rice farmers do not practice off-type removal in their paddy fields. Only 3.7% of the non-trained farmers participated in off-type removal activities while 34.6% of the trained farmers participated in removal of off-type rice varieties.

Table 4.9: Off-Type Removal Activities

Offtype removal	**Participation**	**Trained**		**Non-trained**	
		Frequency	**Percentages**	**Frequency**	**Percentages**
Off-type removal	Yes	28	34.6	2	3.7
	No	53	65.4	52	96.3
	Total	**81**	**100.0**	**54**	**100.0**

4.2.15 Determination Appropriate Paddy Harvesting Time

Figure 4.8 Show the result on how rice farmers determine the appropriate time to harvest paddy. More than half of both the trained (69.1%) and non-trained (57.4%) rice farmers harvested paddy using the visual appearance of straw colour when it is 80-85% dry.



	Use of Action plan	By the help of AEAs using moisture meter	Visual appearance of paddy(80-85% dry)	Visual appearance of paddy (100% dry)	Visual appearance of paddy (80-85)- Visual appearance of...	Action plan, moisture meter, visual (80-85% dry)	Action plan, Moisture meter	Action plan, visual(80 - 85%dry)
Trained	9.9	8.6	69.1	1.2	7.4	1.2	1.2	1.2
Non-trained	0	0	57.4	42.6	0	0	0	0

Trained Non-trained

Figure 4.8: Determination of Appropriate Paddy Harvesting Time

4.2.16 Duration between Paddy Harvest and Threshing and Materials Used

Table 4.10 shows results for the duration between paddy harvest and threshing and the materials used by farmers for threshing rice. The majority (82.7%) of the trained group threshed paddy within the same or 3 days after harvest by using the tarpaulin while most (92.6%) of the non-trained farmers harvest and threshed until they have finished threshing the paddy i.e. beyond three days and more.

Table 4. 10: Duration Between Paddy Harvest And Threshing And Materials Used For Threshing The Paddy.

Duration between harvest and threshing	Duration	Trained Frequency	Percentages	Non-trained Frequency	Percentages
Duration of drying	Same day	38	46.9	1	1.9
	Within 3 days	29	35.8	3	5.6
	Till finish threshing	14	17.2	50	92.6
	Total	81	**100.0**	**54**	**100.0**
Materials for threshing	Tarpaulin	69	90.1	53	98.1
	Bare floor	5	1.2	1	1.9
	Polythene sheet	6	3.7	-	-
	Sewn fertilizer sacks	1	4.9	-	-
	Total	**81**	**100.0**	**54**	**100.0**

4.2.17 Paddy Threshing Methods

Figure 4.9 shows various paddy threshing methods used among rice farmers when processing paddy after harvest. Majority of the trained farmers threshed paddy by hitting the harvested straw against a wooden box (38.3%) while majority of non-trained farmers (87%) threshed rice by hitting the harvested straw with sticks to separate the grain from the straw.

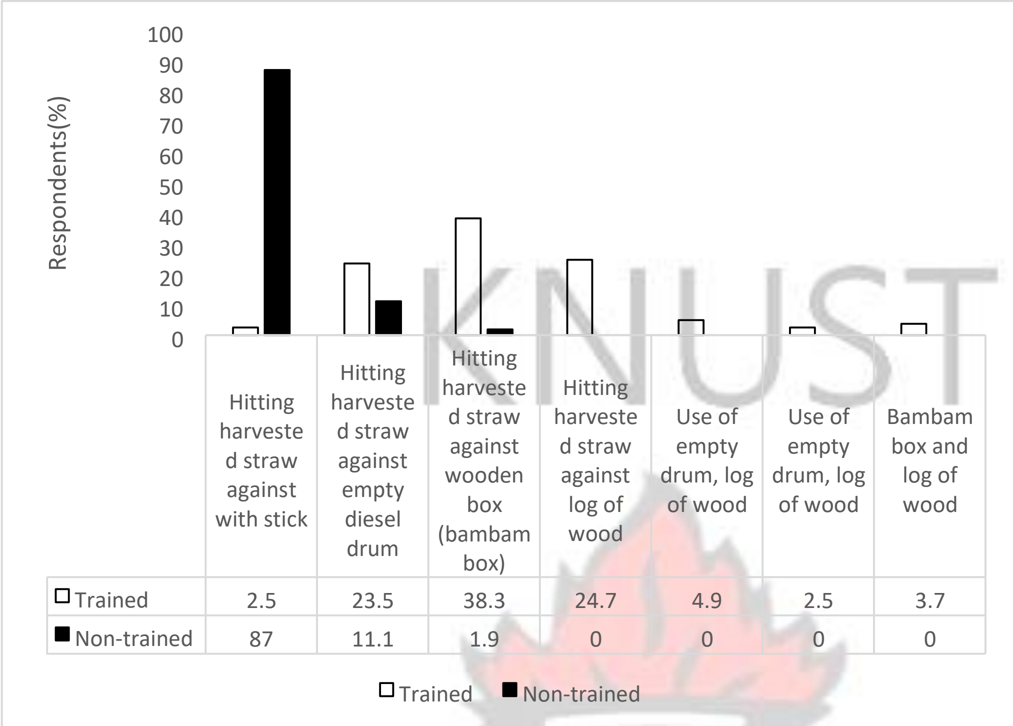


Figure 4.9: Paddy Threshing Methods

4.2.18 Materials for Drying the Paddy

Figure.4.10 shows materials and floors on which paddy is dried in the study area. The majority of the trained (85.2%) and non-trained (77.8%) rice farmers" dried paddy on the tarpaulin. However, 6.2% of the trained farmers dried paddy on the cemented floor, 7.4% dried on only the polyethylene sheet and 1.2% dried on either the tarpaulin or polyethylene sheet while 13% of the non-trained farmers dried paddy on only the polyethylene sheets and 9.3% dried on both the tarpaulin and polyethylene sheet.

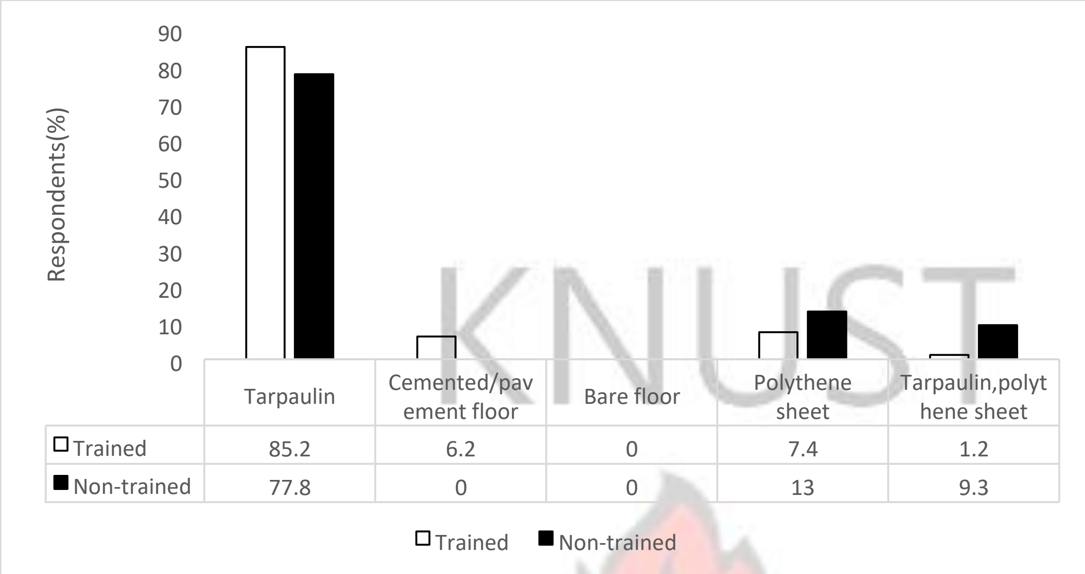


Figure 4.10: Paddy Drying Materials

4.2.19 Drying Duration and Winnowing of Paddy

Figure 4.11 represents paddy drying durations and practices of paddy winnowing after threshing and drying by rice farmers. The majority (76.5%) of the trained farmers dried three days after threshing while (88.9%) of the non-trained rice farmers dried the paddy 7 days (1 week) after threshing. For winnowing of the paddy, (95.1%) of the trained farmers practiced winnowing while (77.8%) of the non-trained farmers practiced winnowing.

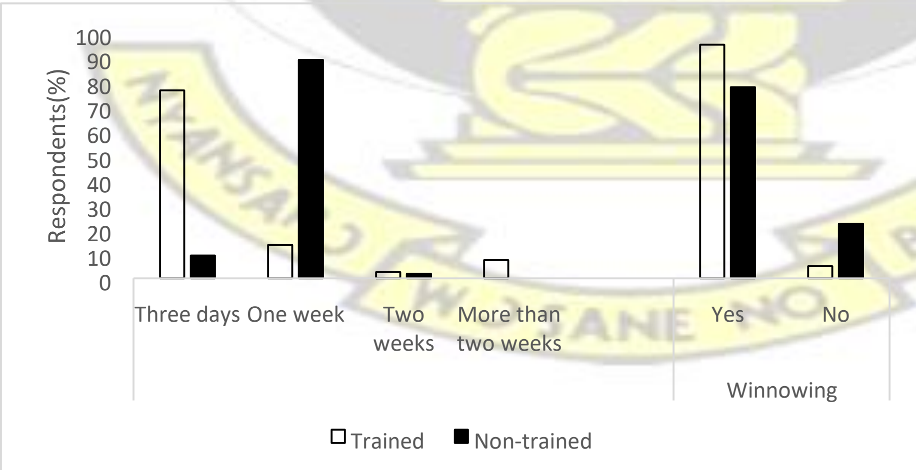


Figure 4.11: Drying Duration and Winnowing Practices by Farmers

4.2.20 Storage Methods and Structures Used for Paddy

From Table 4.11, (80.2%) of the trained farmers stored their paddy while (96.3%) of the non-trained farmers stored their paddy. Most (59.3%) of the trained farmers stored the paddy in sacks on raised platforms while (17.3%) stored the paddy in rice milling centre. For the non-trained farmers, (53.7%) and (42.6%) stored the paddy in sacks on raised platform and in the rice milling centre respectively.

Table 4.11: Paddy Storage and Storage Structures Used By Rice Farmers

Storage	**Participation**	**Trained**		**Non-trained**	
		Frequency	**Percentages**	**Frequency**	**Percentages**
	Yes	65	80.2	52	96.3
	No	16	19.8	2	3.7
	Total	**81**	**100.0**	**54**	**100.0**
Storage structures	Kitchen	1	1.2	2	3.7
	Bare floor in store room	6	7.4	-	-
	In Rice milling Centre	14	17.3	23	42.6
	In sacks on raised platform	48	59.3	29	53.7
	Rice mill and in sack on raised platform	11	13.6	-	-
	Not applicable	1	1.2	-	-
	Total	**81**	**100.0**	**54**	**100.0**

4.2.21 Farmers Perception of Quality Milled Rice

Farmers were asked about what they perceived to be quality milled rice (Table 4.12).

The majority (88.8%) of the trained farmers indicated quality milled rice to be a combination of parameters such as stone free, high heed rice, no impurities, aromatic and translucent white colour while the majority of the non-trained farmers indicated quality milled rice to be a single parameter with aroma (68.5%) ranking the highest among the parameters.

Table 4.12: Farmers Perception of Quality Milled Rice

Quality Criteria	**Trained**		**Non-trained**	
	Frequency	**Percentages**	**Frequency**	**Percentages**
Stone free	1	1.2	4	7.4
High head rice	0	0	3	5.6
No impurities	0	0	4	7.4
Aromatic	0	0	37	68.5
White in colour	0	0	6	11.1
Stone free, % high head rice, no impurities, Aromatic, white in colour	16	19.8	0	0
Stone free, % high head rice, Aromatic	4	4.9	0	0
Stone free, no impurities, white colour	5	6.2	0	0
Stone free and white colour	8	9.9	0	0
Stone free, % high head rice, no impurities, white in colour	9	11.1	0	0
Stone free, % high head rice, no impurities, Aromatic	12	14.8	0	0
Stone free and white in colour	7	8.6	0	0
Stone free, no impurities, Aromatic, white in colour	2	2.5	0	0
Stone free, % high head rice, white in colour	6	7.4	0	0

Stone free and % high head rice	6	7.4	0	0
Stone free, no impurities, Aromatic	5	6.2	0	0
Total	**81**	**100.0**	**54**	**100.0**

4.2.22 Farmers Perception Before and After Training

Table 4.13 shows farmers‟ perception before and after training. The results showed significant differences (p<0. 01) between before training and after training. Farmers had (22.22%) knowledge on technical training before the training, but (77.77%) of it after training while farmers had 3.70% knowledge on post-harvest training before the training but 96.30% knowledge after the training. Knowledge on the use of certified seeds was significantly higher after training (93.83%) than before training (6.17%) while knowledge on how to determine the right time to harvest rice was significantly higher after training (96.30%) than before the training (3.70%).

Table 4.13: Farmers Perception on Before and After Training in Good Rice Cultivation and Postharvest Practices

Activities	Period	Mean
Technical training	Before	22.222b
	After	77.778a
On- site training	Before	2.4691b
	After	97.531a
Number of trainings	Before	6.1728b
	After	93.827a
Post-harvest trainings	Before	3.7037b
	After	96.296a

Rice Cultivation trainings	Before	11.111b
	After	88.889a
Skill in ploughing	Before	6.1728b
	After	93.827a
Use of certified seed	Before	6.1728b
	After	93.827a
Off- type removal	Before	3.7037b
	After	96.296a
Determination of right time of harvest	Before	3.7037b
	After	96.296a
The use of empty diesel drum as a threshing tool	Before	97.531a
	After	2.4691b

4.3 PHYSICAL QUALITIES OF MILLED RICE

Table 4.14 and 4.15 shows the results of the physical quality parameters of milled rice samples from trained and non-trained rice farmers. There were no significant differences (p>0. 01) between the milled rice from the trained and non-trained rice farmers for moisture content. Milled rice from the trained farmers recorded 13.25% of moisture while milled rice from non-trained farmers recorded 13.27% of moisture. For 1000 grain weight, no significant difference (p>0. 01) was observed between the milled rice from both the trained and non-trained farmers. 1000 grain weight was 2.15g in milled rice from trained farmers and 2.07g in milled rice from non-trained farmers. Grain dimension of milled rice from trained farmers (4.01) was not significantly different (p>0. 01) from the grain dimension of milled rice from non-trained farmers (4.18).

Milled rice from trained farmers (341.43g) had significantly higher polished rice on weight recover than milled rice from non-trained farmers (302.35g).

Broken grain from trained farmers (14.20%) was not significantly different (p>0. 01) from broken rice from non-trained farmers (18.66%).

There was no significant difference (p>0. 01) between milled rice from trained farmers and non-trained farmers for chalky grains. The milled rice from trained farmers had 0.79% of chalky grains while milled rice from the non-trained farmers had 1.03% of chalky grain.

Head rice of milled rice from trained farmers (54.09%) was significantly higher than head rice of milled rice from non-trained farmers (41.81%).

Significant differences (p<0.01) were observed between the milled rice from both the trained and non-trained farmers for the milling degree and milling recovery. Milled rice from the trained farmers had a significantly higher milling degree (89.88%) and the milling recovery (68.29%) while milled rice from non-trained farmers had the least milling degree (80.81%) and the least milling recovery

(60.47%).

Table 4.14: Physical Qualities of Milled Rice

Sample	**Moisture content (%)**	**1,000 grain weight (g)**	**Grain dimensions (mm)**	**White Rice Weight (g)**	**Broken grain (%)**
Trained	13.250a	2.1500a	4.0062 a	341.43a	14.200a
Non-trained	13.267a	2.0667a	4.1754a	302.35b	18.660a

Table 4.15: Physical Qualities of Milled Rice

Sample	Chalky grain (%)	Head rice (%)	Milling Degree (%)	Milling recovery (%)
Trained	0.7883a	54.087a	89.888a	68.287a
Non-trained	1.0800a	41.810b	80.807b	60.470b

4.4 CHEMICAL QUALITIES OF MILLED RICE

4.4.1 Proximate Characteristics

From the results (Table 4.16), there were no significant differences (p>0. 01) between the milled rice from the trained farmers and non-trained farmers for all the proximate composition parameters. The moisture contents in the milled rice were 12.67% of samples from trained farmers and 12.33% of samples from non-trained farmers. Ash content in both milled rice of the trained and non-trained farmers were 0.50% each. Carbohydrate recorded was 70.33% in the milled rice from trained farmers and 71.10% for milled rice from non-trained farms. Fat was marginally high in milled rice from trained farmers (3.00%) than that recorded in the milled rice from the non-trained farmers (2.67%). Protein in milled rice from trained farmers was 13.10%, while the protein in non-trained farmers were 12.40%.

Table 4.16: Proximate Analysis of Milled Rice

Sample (Milled Rice)	Moisture Content (%)	Ash Content (%)	Carbohydrates (%)	Ester Extract (%)	Protein (%)
Trained	12.667a	0.5000a	70.733a	3.0000a	13.100a
Non-trained	12.333a	0.5000a	72.100a	2.6667a	12.400a

4.4.2 Functional Properties

Table 4.17 shows the functional properties of milled rice from trained and nontrained farmers. Solubility index was significantly higher in milled rice from trained farmers (40.00g/L) than milled rice from non-trained farmers (32.00g/L). Swelling power, water absorption capacity and bulk density of milled rice from trained farmers were not significantly different from milled rice from non-trained farmers. Swelling power, water absorption capacity and bulk density were 10.60%, 15.00% and 0.86% respectively in milled rice from trained farmers and 10.24%, 20.00% and 0.91% respectively in milled rice from non-trained farmers.

Table 4.17: Functional Properties of Milled Rice

Rice Samples	Solubility Index (%)	Swelling Power (%)	Water Absorption Capacity (%)	Bulk Density (g/cm³)
Trained Sample	40.000a	10.6000a	15.000a	0.8640a
Non-trained Sample	32.000b	10.240a	20.000a	0.9086a

4.4.3 Pasting Properties

From the results (Table 4.18), no significant differences were observed between the milled rice sampled from the trained farmers and non-trained farmers. Milled rice from the trained farmers had 3278.5%, 2121.0Rvu, 5632Rvu, 1157.5Rvu, 3511.5Rvu, 78.75sec. and 78.75^{0}C of peak viscosity, trough viscosity, final viscosity, breakdown, setback, peak time and pasting temperature, respectively while milled rice from the non- trained farmers had 3147.5Rvu, 1903.5Rvu, 5311.0Rvu, 1244.0Rvu, 3407.5Rvu,89.08sec. and 89.08^{0}C of peak viscosity, trough viscosity, final viscosity, breakdown, setback, peak time and pasting temperature respectively.

Table 4.13: Chemical Analysis of Milled Rice (Pasting Properties)

Rice Samples	Peak Viscosity (Rvu)	Trough Viscosity (Rvu)	Final Viscosity (Rvu)	Breakdown (Rvu)	Setback (Rvu)	Peak Time (Sec.)	Pasting Temp. (^{0}C)
Trained	3278.5a	2121.0a	5632.5a	1157.5b	3511.5a	78.750a	78.750a
Non-trained	3147.5a	1903.5a	5311.0a	1244.0a	3407.5a	89.075a	89.075a

CHAPTER FIVE

5.0 DISCUSSION

5.1 INTRODUCTION

This chapter involves the interpretation of results, its implications and conclusion. Moreover, it includes field survey, physical milled rice qualities and chemical qualities of milled rice (proximate, functional and pasting properties).

5.2 FIELD SURVEY

5.2.1 Gender

The result showed that majority of rice farmers in the study were males for both trained and non-trained farmers. This could be because rice cultivation was highly labour intensive and needs more physical strength in most of the cultural practices, especially, in paddy field preparation, which involves manual ploughing, bund construction, levelling and puddling which could be disadvantage to female rice farmers who are perceived to less physical compared to their male counterparts. This corroborates findings of Blench, Kranjac-Berisavljevic and Zakariah (2003) which stated that rice cultivation in Ghana is predominantly done by male farmers. The low female male ratios in rice cultivation could further be attributed to the multiplicity of roles women are engaged in; for instance, child care and other house chores, which reflects the findings of (Adekunle, 2013).

5.2.2 Age of Respondent

As shown in Figure. 4.2, the greater population of both trained and non-trained rice farmers had their ages ranging from between 25 and 44 years. This age trend for both groups could be important for Ghana‟s rice cultivation and future sustainability to make the nation attain self-sufficiency in rice. The farmers of this age group participating in rice cultivation is very important, since the rice cultivation practices of the majority of Ghanaian rice farmers are still at its rudimentary level, especially in the activities such as ploughing, bund construction, levelling, puddling and transplanting which are still in done manually. Therefore, if farmers of this age group could remain in rice cultivation, the older farmers in the rice cultivation could pass onto the new and upcoming farmers for sustainability. Furthermore, when knowledge and skills about production of good quality rice acquired are passed onto the new and upcoming young generations in the rice cultivation enterprise, the nation could reduce rice importation since the consumers taste for quality rice would be met.

5.2.3 Educational Levels of Respondent

From the results, most of the trained farmers had no formal education, whereas the non-trained rice farmers had their highest educational status to be Junior High School. Low education of farmers could lead to difficulties in training farmers understanding training topics and adopting them. They could only have a better understanding if the training approach is that of on-site or on-the- job training since they cannot read and write. This could imply that having a higher educational background is a prerequisite for understanding and implementing technical information in good rice cultivation practices as pointed out by Al-Hassan (2008) who stated that a farmer‟s educational level has an effect on his ability to adopt good rice agricultural practices and the ability to mobilize and apply inputs. Notwithstanding, although the educational level of farmers is important for the adoption of good rice cultivation practices, improvement of farmer‟s efficiency in rice cultivation can be accomplished not only through formal education but rather non-formal education as proposed by Al-Hassan

(2008).

5.2.4 Years of Experience in Rice Cultivation

Evans, Giordano and Clayton (2012) put the mean year of farmers experience in rice cultivation in the Ashanti region at 12.5 years, however, this current study proves lower. The results revealed that most of the trained rice farmers have been cultivating rice between one to five years, whereas the non-trained farmers had between six to ten years of experience in rice cultivation.

The results showed an increasing interest in rice cultivation among trained farmers could mean that new farmers are engaged in rice cultivation either by shifting from cultivation of their traditional crops such as maize as a cash crop for rice, or more farmers are adopting rice culture because of the sensitization received during trainings in good rice cultivation practices in the Ahafo Ano North district. The other reasons could be that farmers now know there is ready market and high profitability in rice cultivation. Further implication could mean that because trained farmers have few years‟ experience in rice cultivation, they may not have much knowledge as to how to produce good quality milled rice like their counterparts who have had a longer years of experience in rice cultivation. However, with training and constant practicing, they could improve their skill to produce quality milled rice for consumption.

5.2.5 Paddy Field Sizes

The majority of trained and non-trained rice farmers cultivated on an average of 0.4ha paddy field size. This implies that the majority of the rice farmers in the area was small scale subsistence farmers. However, they can best be in moderate to large scale rice cultivation if the tedious aspect like manual ploughing, bund construction puddling, levelling and weed control is taken care of by the introduction of mechanization. Mortensen et al. *(*1995) reported that 80% of respondents of rice farmers assert they would have increased their farm sizes if weed infestation were less. The small land holding could also cause Ghana inability or a longer period to attain the rice self-sufficiency it yearns for. Since the consumption of rice in Ghana keeps increasing, the rice farmers would have to increase the crop area per farmer while mechanization can be encouraged.

5.2.6 Rice Cultivation Activity Plan Preparation and Levels of Its Implementation

The results showed that the majority (46.9%) of trained farmers prepared rice cultivation activity plan and partially to fully implement the plan while few (1.9%) of the non-trained rice farmers could plan and partially implement activities in the plan for rice cultivation.

This could probably be because preparation of the rice cultivation activity plan and its implementation might be more technical and could require some level of formal basic education which majority of trained farmers do not have (Table 4.1). Furthermore, their inability to prepare and implement plans could mean technical activities would be untimely carried out; hence, the quality of produce would be compromised especially when they delay in the time of paddy harvest.

For the rice farmers in the area to be able to meet the demand for consumer preference and taste for high quality milled rice, they would have to make rice cultivation plans and in addition adhere and implement the content of the plan which would lead to timely performance of farming activities such as timely harvesting which would intend influence the quality of rice.

5.2.7 Seed Rice Varieties Sown and Their Sources

From the results, most trained and non-trained farmers used improved seed rice for planting. However, most trained farmers acquired their seed rice from sources deemed certified while most of the non-trained rice farmers acquired seed rice from other rice farmers.

Farmers who used improved varieties could produce high quality and true to type milled rice of similar quality parameters which would meet the consumer‟s quality preference. The sources of these improved seeds if highly reliable and of certified source could be disease free, drought resistant and having not been mixed with other varieties would make the determination of harvest time very easy for quality milled rice to be produced. This agrees with the study by Quaye, Gayin, Yawson, and Plahar (2009) who stated that the importance of planting a good seeds would greatly improve the quality of their produce.

5.2.8 Seed Selection and Selection Methods

The majority of trained rice farmers‟ selected seed rice by using a salt solution to obtain heavy and healthier seed for the production of good quality grains while nontrained rice farmers selected seed rice before sowing by winnowing. The majority of the non-trained farmers depended upon only the natural wind, i.e. winnowing to select good seed rice.

Selection of good seed rice would lead to good germination stand of a strong and vigorous seedling which can withstand harsh weather condition and grow to develop into a good crop stand resulting in the production of quality milled rice for consumption. Mushobozi, (2010) from his findings suggested selection of seed and rootstock was the critical step in the good agricultural practice of obtaining quality, high yielding and uniform produce for market. Furthermore IRRI (2012) also buttressed the point that good seed selection reduces the amount of seed to sow per unit area, provides good germination, healthy and strong seedlings, gives a uniform crop stand in the field, and results in higher yields. Therefore, when training extends to the non-trained farmers, they would also produce good quality milled rice.

5.2.9 Paddy Field Preparation Methods

From the results, paddy field prepared by trained farmers would give the growing seedlings an ideal growing condition compared to paddy fields prepared by nontrained farmers. The well levelled field would make the water available and help in uniform distribution. Even though, the land development and preparation process practiced by the trained farmers seem to be more laborious than the traditional one, weed growth is suppressed which reduces competition for nutrients and sunlight leading to high yield. IRRI (2012) reported that a well prepared paddy field makes a maximum use of available water, nutrients, reduce weed infestation and aid in the maintenance of soil quality.

5.2.10 Water Harvesting Structures and Water Management Skill

With high knowledge in water management skills, trained farmers used water harvesting and control structures such as bunds and interlocking bunds. However, non-trained farmers had no knowledge at all and depended on water pump and dug out to provide water for the needs of their crop. The use of bunds and interlocking as water harvesting and control structures could contribute to the production of quality milled rice. The water harvesting and control structures are also sustainable and cost effective and would be used by even less resourced farmers.

5.2.11 Sowing Methods

The results showed that trained farmers practiced transplanted method of sowing while the non-trained farmers practiced direct sowing method. Transplanting of seeds in rice cultivation, although more technical, leads to the production of high quality milled rice. The transplanted seedlings also have advantages over weeds in terms of growth, nutrient uptake and consequently, a better quality produce.

The fact that transplanting methods most often give high yields could have been the driving force for the adoption of the transplanting method by the trained group. Furthermore, the trained farmers might have had the much knowledge and skill in seed selection, nursery management and transplanting especially the selection of valley that is suitable for the transplanting method such as valley bottoms with a permanent water source to be use as a supplementary irrigation.

5.2.12 Age of Seedlings before Transplanting

According to IRRI (2012) suggested that only 18 to 30 days old seedlings are ideal for transplanting. Thus, the young seedlings (at three weeks) transplanted by trained farmers might have had a good ability to withstand transplanting shock and a greater ability of root regeneration, establishment, development and growth of crop culminating in production of good quality rice. The non-trained farmers who, however, transplanted overgrown seedlings would produce rice of low yields and poor quality. Khartoum (1995) also reported that there was a higher tiller production in seedlings that had been transplanted at 30 days old while Surrender Reedy and Bucha Reddy (1992) also reported that over age rice seedlings of 30, 40 and 60 days old when transplanted, results in lower sterility. Hence, the right stage of seedling transplanting would be very critical for yield and quality of grain produced.

5.2.13 Frequency and Methods of Weed Control

Both trained and non-trained farmers respectively controlled weeds three or more times before harvest as shown in the results. This could have been attributed to the fact that paddy fields overgrown with weeds could result in contaminating milled rice when harvested together. Contaminated milled rice also reduces the quality because of the high percent of weed dockage. Moreover, paddy rice field when thoroughly prepared reduced quick growth of weeds which compete with the crop for nutrients and other essential elements. Chikoye, Schulz and Ekeleme (2004) indicated that there was 42% rice yield loss difference in quantitative and qualitative terms between farmers who weeded their paddy field only once and those who weeded three times.

5.2.14 Fertilizer Application, Frequency and Critical Stages of Fertilizer Application

Wopereis-Pura, Watanabe, Moreira and Wopereis (2002) emphasized that fertilizer applications may affect grain quality substantially where there is increase in headrice ratio by 12% and 24% in the wet and dry seasons.

The four split fertilizer application at all critical growth periods practiced by trained rice farmers in the study area could lead to increased number of tillers, increased number of panicles, grains well filled, higher grain weight compared to the nontrained farmers who applied fertilizer once. Nutrient uptake by the plant is small at a time while some are lost through leaching as well, therefore, the one-time application denies the crop the necessary nutrient needed at various critical growth periods such as panicle initiation, booting, heading and grain filling stage which is key in grain quality determination. Farmers know or do not know when to apply fertilizer; however, they might be pressed up with time and lack labor due to a multiplicity of other farming activities that compromise grain quality Futakuchi, Manful and Sakurai (2001) by applying fertilizer only once during cultivation.

5.2.15 Birds Scaring

For the study, all the rice farmers in the study area scare birds with the majority of the non-trained farmers using fishing net to cover the field to prevent the birds from consuming rice as they could cause a total lost to the crop (Futakuchi et al., 2001).

On the other hand, the majority of the non-trained farmers making use of the net could be attributed to the ingenuity of rice farmers with long (5-10) years of experience in rice cultivation as shown in Figure 4.3. This effective practice by the non-trained farmers could have encouraged participation of some of the trained farmers in using the net to scare birds. The failure of most trained farmers in using the net could be as a result of lack of money and or difficulty in access the net.

5.2.16 Off-Type Removal

The result showed that the majority of both trained and non-trained farmers respectively did not practice off-type removal. This practice if not encouraged would result in different varieties mixed with the intended sown variety and would also affect the determination of the right time to harvest the paddy. Delayed in harvesting could lead to high broken grains and early harvesting leading to high percent of chalky grains, therefore, affecting the percent head rice and consequently the cost of sale of produce.

Both categories of the farmers were not also practicing the off-type removal activity probably because they did not appreciate or had no knowledge of the importance of off-type removal as means of rice quality improvement hence their refusal to take out non-true to type varieties. The majority of farmers could felt that removal of admixture varieties to obtain pure varieties sown would rather leads to reduction in yields and waste of time.

5.2.17 Determination of Appropriate Paddy Harvest Time

Most trained farmers employed the use of a moisture meter, action plan, harvesting paddy between 80-85% of paddy moisture by visual assessment and combinations of these methods while most non-trained farmers depended on only visual assessment of paddy at 80-85% moisture to determine the appropriate time of harvesting.

This practice implied that the majority of the trained farmers would harvest paddy with the right moisture content at the right time and this could result in low chalky grains, optimum-dried paddy and low percent of broken grains. Thus the trained farmers could cultivate good quality milled grains with high percent head rice, percent milling degree and good percent recovery.

5.2.18 Duration between Paddy Harvest and Threshing and Materials Used

Harvesting and threshing of paddy rice was done by most trained farmers within 3 days day compared to the non-trained farmers who harvested and threshed paddy till they were done with the whole activity. Harvested paddy rice left on the field could reabsorb moisture from the field causing fermentation in the grain, hence the colour change in the rice grains and could lead to high grain breakage. Scarcity of labour during the peak of the harvesting period could also have contributed to non-trained farmers‟ not threshing promptly an attitude of leaving the paddy on the field for a long time before threshing. Farmers dependency on rainfall, where all different farming activities coincides during the major raining seasons also could made it difficult for rice farmers to access labourers for paddy harvesting, threshing and drying.

However, both groups of farmers used tarpaulin and other improvised polyethylene materials during threshing. The knowledge of farmers to use a tarpaulin while processing paddy could be to avoid introduction of stone and other impurities contaminating the milled rice.

5.2.19 Paddy Threshing Methods

Although the majority of the trained farmers threshed paddy by hitting the handful harvested paddy against either a piece of log or threshing box while the non-trained farmers threshed the paddy by hitting the harvested straw with sticks. Threshing using sticks could cause grains cracking in the husk especially during delayed harvesting, which could contributes greatly to the production of poor quality milled rice i.e. higher broken grains.

5.2.20 Drying Duration and Winnowing After Threshing

A majority of both the trained and non-trained farmers dried their paddy well and winnowed as well. This was encouraging as paddy well dried and for the appropriate days would also result in the appropriate moisture content of paddy. This would also help in producing high head rice with less broken grain during milling and this practice could attracts better price due to the paddy"s high quality. The winnowing of the paddy also prevents a lot of impurities and other inert materials contaminating the milled rice. Better quality rice with better head rice and less dockage would also be produced.

5.2.21 Paddy Storage Structures

Most of the trained and non-trained farmers practiced good storage by storing paddy in sacks and packing on a raised platform. This practiced could be done by rice farmers while waiting for a better price, especially during the peak harvest period where there could be a glut of milled rice in the market causing reduction in the price. Thus the storage method employed could be important as the quality of the stored paddy could be maintained or slightly reduced during and after storage.

5.2.22 Farmer Perception of Quality of Milled Rice

Most trained farmers had the perception that quality milled rice comprised of a combination of multiple physical quality parameters such as stone-free, high percentage of head rice, no impurities, aromatic and milled rice, which is translucent in colour, whereas non-trained farmers perceived that a sole quality parameter such as only stone free, high head rice percentage, no impurities, aromatic and translucent in colour could be used to qualify the quality milled rice.

The high level of knowledge of the trained farmers on what quality rice is could be as a result of the training they had in good rice cultivation practices compared to the non-trained farmers who had no training.

Thus, training in various pre-harvest and post-harvest cultivation practices like the sowing of good seed, seed selection, use of tarpaulin, timely harvesting and technical training information received by farmers through Agriculture Extension Agents of MOFA or other Donor partner organization would enhance the production of quality milled rice.

5.2.23 Farmers Perception Before and After Training in Good Rice Cultivation Practices

Farmers" perception after the training was significantly different from before the training. This implied training influenced how farmers carried out rice cultivation activities and for that reason, could result in production of quality milled rice. The trained farmers" performance in rice cultivation practices from the study drastically changed for the better and these were confirmed from laboratory investigations conducted on the physical, functional and pasting qualities of the milled rice.

5.3 PHYSICAL QUALITIES OF MILLED RICE

5.3.1 Moisture Content

The finding revealed there was no significant difference in moisture content for milled rice from the non-trained farmers and that of trained farmers. However, moisture content of the paddy for both was low and this could be because most of the trained and non-trained farmers harvested 80-85% of their paddy grains was straw in colour or dry. This corroborates studies by IRRI (2012) which stated that mature crop should be harvested when 80−85% of the grains is dry and is straw-colored. This implied the milled rice could be stored for a longer period without mold growth or fermentation.

5.3.2 Chalky Grain

From the results, although chalky grains of milled rice from the non-trained farmers were marginally higher compared with that from trained farmers, but statistically not different from each other ($p>0.01$).

The high chalky grain percent in milled rice from non-trained samples could be attributed to the source of seeds rice used by non-trained farmers. Most non-trained farmers sourced their seeds from other rice farmers and could be full of admixtures of different rice varieties. This would have resulted in harvesting immature grains with physiologically matured ones due to different times of headings and maturity as agreed with the work of Kaul (1970) some cultivation practices and maturity factors turns to affect the degree of chalkiness to some extent in milled rice.

5.3.3 Percent Broken Grain

The result showed the percentage broken grain of milled rice from non-trained farmers were marginally higher than that of rice from trained farmers with no significant difference ($p>0.01$) between each sample.

Milled rice from the non-trained farmers recorded high broken rice after polishing probably due to the inability of the rice farmers to practice vigorous off-type removal. It could also be due to planting of not true-to-type seed rice, which could constitute a mixture of different varieties which results in different heading in the same field, making harvesting difficult, resulting in high grain breakage (Futakuchi et al. 2013). Bhattacharya (1980) also reported that alternate drying and moisture re-absorption of grains due to lateness in paddy harvest could lead to sun cracking which aid in producing more broken gains at the expense of head rice. Thus, the failure of the farmers to thresh and dry paddy on time due to lack of labor at the time of harvesting (Rickman Moreira, Gummert and Wopereis, 2013) leads to a high percentage of broken rice.

5.3.4 White Rice or Polished Rice

The findings revealed that the weight of the white rice from the non-trained farmers sample was significantly lower as compared to the polished rice from the trained farmers. This could be attributed to the fact that much bran was removed from the brown rice of the non-trained farmers‟ sample, as the laboratory polisher was further set higher in order to achieve the translucent colour of the rice. The off colour (nontranslucent) of the non-trained milled rice could be as a result of the paddy left on the field for a longer period before threshing as shown in Table 4.14 from the physical quality of milled rice analysis.

5.3.5 Percent Head Rice

The percent head rice is the weight of whole grain kernels in a quantity of milled rice (Bhattacharya, 2011). The result showed significant difference in percent head rice for milled rice from trained and non-trained farmers. The percentage head rice of non-trained farmers sample was lower than the percentage head rice from trained farmers. This could be attributed to the good rice cultivation practices adopted and practiced by trained farmers.

Though percent head rice is an inherent trait based on the variety, Bhattacharya (1980) revealed that environmental factors such as temperature and humidity during ripening and at post-harvest stages are known to influence grain breakage at milling.

5.3.6 1000 Grain Weight

The result showed a lower 1,000 grain weight for milled rice from non-trained farmers compared to the sample from trained farmers. However, the difference between the two samples were not significant ($p>0.01$). The training in good cultivation and postharvest practices could have contributed significantly to the increase in 1,000 grain weight of the milled rice from the trained farmers. Bhattacharya (1980) reported that 1,000 grain weight quality characteristic is not only attributed to varietal differences, but could also be influenced by other cultivation factors such as harvesting, drying and milling process. The non-trained farmers having being a lower mean 1,000 grain weight sample could also be attributed to the inability of most of them not been able

to practice split fertilizer application at critical growth stages of the crop as suggested by (Wopereis-Pura et al.
2002).

5.3.7 Percent Rice Milling Degree

Significant differences ($p<0.01$) were observed in the percentage milling degree of milled rice from the non-trained and trained farmer‟s sample.

This observation was made probably because of less bran removal from milled rice of the trained farmer than milled rice from the non-trained farmers. The training received in good rice cultivation practices could have also led to a high degree of milling, which is an important milled rice quality parameter to consume in relation to preference and taste.

5.3.8 Percent Milling Recovery

The milling recovery of rough rice estimates the quality of head rice and total milled rice produced from a quantity of paddy rice. The result showed that the trained farmers‟ rice gave significantly a higher yield than the milled rice from the nontrained farmers. The low recovery of milled rice from the non-trained farmers sample might be as a result of high wastage through excessive removal bran and also could be due to higher percentage of chalkiness associated with their grain. The knowledge and skills acquired by trained farmers would have led to the production of quality milled rice of a higher milling recovery.

5.3.9 Grain Dimension

Grain dimension of rice produced by both trained and non-trained farmers were not significantly different from each other. Grain dimension describes the shape and is varietal traits of the rice cultivated, thus there was no difference in the varietal traits of rice from both groups of farmers. The training received by the trained farmers could not have also caused a change in the trait of the varieties cultivated. The results also showed the trained and non-trained farmers might have maintained some levels of seed purity without segregation.

5.4 CHEMICAL QUALITIES OF MILLED RICE

5.4.1 Proximate Composition of Milled Rice

The proximate composition of the milled rice from the trained farmers was not significantly different from milled rice from the non-trained farmers. However, milled rice from the non-trained farmers were marginally low in fat, protein and moisture content but higher in carbohydrate content compared to milled rice from the trained farmers. The ash content remained the same for milled rice from the both non-trained and the trained farmers.

The milled rice from the non-trained farmers were lower in protein content but higher in carbohydrates content than milled rice from the trained farmers probably because the milling degree at polishing was set higher for non-trained farmers than that for the trained farmers. The bran which contains protein might have been lost in the bran removed and used as either livestock or poultry feed. The ash content also measures the presence of an array of minerals in food. Thus, the mineral content in the milled rice from the two groups of farmers might have been similar. However, it can generally be deduced that the training in good rice cultivation practices had no or minimal effect on the nutritional qualities of milled rice produced.

5.4.2 Functional Properties of Milled Rice Flour

The functional properties of milled rice flours of the trained and non-trained farmers were not significantly different from each other except for the solubility index.

Functional properties are characteristics that govern the behavior of nutrients in food during processing, storage, and preparation as they affect food quality and acceptability (Matil, 1971). The bulk density measures the heaviness of a flour sample; swelling power indicates the water absorption index of the granules during cooking while water absorption describes the association between the flour and water. These functional properties of milled rice flour from both the trained and nontrained farmers were of similar behavior in terms of nutrients during food processing.

The solubility index of the flour gives an indication of the penetration ability of water in starch granules of flours. The high solubility index of the rice flour sample from the trained farmers implied the grains had the ability to absorb water much better than grains from the non-trained farmers. In food preparations where the maximum solubility of protein is desired, such as aqueous emulsions and gel food preparations, flours with a good nitrogen solubility are useful (Akinyele, Onigbinde, Hussain, and Omololu, 1986). Higher solubility also permitted better digestibility (Johnson, Aderele, Osinusi, and Gbadero, 2001)

5.4.3 Pasting Properties of Milled rice

The result of pasting properties (peak viscosity, trough viscosity, final viscosity and setback) of milled rice from trained farmers after cooking were not significantly different (p>0. 01) from milled rice from non-trained farmers.

Pasting characteristics of starches are associated with cooking quality and texture of various food products (Moorthy, 2002). Aryee, Oduro, Ellis and Afuakwa (2006) also reported for selection of crop species for use in the industry as thickeners, binders or for any other use, pasting characteristics played an important role. Thus, both grains from both groups of farmers had similar pasting characteristics and could be used for similar purposes in the food industry.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The results showed significant improvement in the rice cultivation practices of farmers who received training from those who did not in terms of preparation of rice cultivation activity plans and its implementation, sources of seed rice, preparation of paddy fields, water management skills and water harvesting structures, sowing methods, weed control, fertilizer application, harvesting, threshing, drying and winnowing of paddy rice and the storage methods of the paddy rice.

Farmers‟ perception and knowledge before training were also significantly different (p<0. 01) from their perception and knowledge after training. Farmers acquired more knowledge on good rice cultivation, which helped in producing milled rice of high quality as shown in the physical quality parameters measured for the milled rice.

Significant differences were observed in most of the physical quality parameters observed for milled rice from trained farmers than milled rice from the non-trained farmers in Ahafo Ano North district in the Ashanti region. The milled rice from the trained farmers recorded high 1000 grain weight, white rice weight, percentage head rice, percentage milling degree and percentage milling recovery compared to milled rice from the non-trained farmers.

For the chemical quality parameters studied such as the proximate composition, functional properties and pasting characteristics, there were also no significant differences in milled rice from both the trained and non-trained farmers except for solubility index. The solubility index of the milled rice from the trained farmers was significantly higher than that for the non-trained farmers.

In conclusion, significant improvement was observed in the rice cultivation practices of farmers who received training from those who did not. The good rice cultivation practices also resulted in milled rice with high physical qualities. However, the good rice cultivation practiced by the trained farmers had no effect on the chemical qualities of the milled rice because two rice samples analyzed were all Jasmine 85 cultivated within the same agro ecological zone.

6.2 RECOMMENDATION

The findings provide the following insights for future research:

1. Further research on key rice cultivation practices and on post-harvest management practices that have direct influence on rice quality should be considered. The post-harvest stakeholders in conjunction with MOFA should clearly define and provide a method of evaluating the said key cultivation and postharvest practices.
2. Further work could be done on evaluating the knowledge and the skill competency of trained farmers. This could be carried out in conjunction with MOFA, Research Institutes, Universities and other donor partners.
3. A study could also be done to assess the effect of milling machines on the physical quality of the milled rice produced in Ahafo Ano North District, Ashanti Region.

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APPENDICES

APPENDIX A: QUESTIONNAIRE FOR RESPONDENTS

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI
EFFECT OF TRAINING IN GOOD RICE CULTIVATION PRACTICES
ON QUALITY OF MILLED RICE PRODUCED IN THE AHAFO ANO NORTH DISTRICT,
ASHANTI REGION, GHANA

This questionnaire is designed to evaluate effects of training in rice cultivation practices on the quality of milled rice produced. Information given to the questions below will be treated with confidentiality.

A. GENERAL INFORMATION

1. Farmers" Name;
2. Community Name;
3. Educational Background: No formal education [], Basic level [], Junior High School level [], Senior High School level [], Tertiary level
4. Sex: [Male] or [Female]
5. Household dependents;
6. Age: 18-24 [], 25-44 [], 45-60 [], Above 60 []
7. Years of experience in Rice farming;
8. Did you work with MOFA, JICA project? Yes [] 2. No []
9. When did you start applying MOFA/JICA improved rice cultivation techniques? 5 years ago [], 4 years ago [], 3 years ago [], 2 years ago [] I do not apply the techniques

B. PRE-CULTIVATION LAND PREPARATION ACTIVITIES

10. Do you prepare a written down, cropping plan (Action plan) to guide your rice cultivation activities? Yes [] No [].
11. Had you strictly followed what was in the cropping plan (Action plan)? Yes fully [], partially [], Not able to follow [].
12. How did you prepare your paddy field? Land clearing, herbicide application on regrowth [], land clearing, herbicides application on regrowth, ploughing] land clearing, herbicide application on regrowth, ploughing, bound construction, leveling, puddling []
13. Do you have enough skill to manage the available water resources in your paddy field? Yes, very well [], Not very well [], No at all [].
14. What water harvesting structure did you have in place? Bund and interlocking bunds [ ], Dyke [], Dug out [], Water pumping machine [], none.
15. Which rice variety do you cultivate? Jasmine 85 [ ], Jasmine 75 [ ], Obolo [ ], Wita 7
    [ ], Sikamo [], Local variety [], Agra [], Amankwatia [].
16. Why did you sow the variety of your choice? Highly marketable [], High yielding [] Short maturity period [], No reason [].
17. Where did you get the seed for sowing? MOFA/JICA project [], Bought from the market
18. [ ], MOFA Block Farm [], Rice milling center [], from other farmers [], Own seed.
19. Did you perform seed selection before planting? Yes [] No []

20. Why did you do seed selection? To get heavy and healthy seeds for good germination [], Good germination [], To remove and discard chaff []
21. How did you select seed? Use of water to float the bad seeds [], Use salt solution and fresh egg to float the bad seeds [], By hand picking a few bad seeds out of the lot [] Just winnow using wind [].

C. RICE CULTIVATION PRACTICES

22. Which sowing methods do you follow? Direct sowing [], Transplanting [], Partly direct sowing and Partly transplanting [] Broadcasting []
23. At which seedling stage/age is it appropriate for transplanting? 15-18 days after sowing [], 3 weeks [], No determine age [].
24. How many times do you control weeds on your fields before harvesting? One time [], Two times [], Three times [], More than three times []
25. Which weeds control method you adapt? Hand weeding [], Hoe weeding [], Hoeing and hand picking [], Herbicides [], Herbicides and hand picking [], Pushweeder []
26. Do you apply fertilizer to your cultivated paddy field? Yes [] No []
27. If yes number of times you apply fertilizer, One time [], Two times [], Three times [], Four times [], others []
28. Are you able to apply fertilizer at the various growth stages of rice? Yes [] No []
29. Do you scare the birds from eating your rice? Yes [] No []
30. Which methods do you use? Torpedo net/fishing net [], Employed Human beings to use catapults and make noise to drive them away [], Use scarecrows []
31. Do you practice rouging? Yes [] No []
32. Why? For seed grain purity [], for uniform maturity and drying [], For good quality milling [], Waste of time [], Reduce yields [] No reason []

D. HARVESTING

33. How do you determine the appropriate harvesting time? Use of action plan based on life span of variety [], By the help of Agriculture Extension Officer using moisture meter[],Visual appearance of the paddy (80-85% dry) [ ], Visual appearance of the paddy (100% dry [ ]
34. How many days do you finish threshing paddy after harvest? Same day [], Within 3 days [], As many days till threshing finished []
35. Why? Inadequate Labor [], for bright white rice [], Because I make use of „Noabow"labour system []

E. THRESHING

36. On what material do you thresh paddy? On Tarpaulin [], on the bare floor [], Polythene sheet [], Fertilizer sacks [].
37. What is the reason for the material used? To avoid introducing stone and other impurities into rice [], It is convenient for me [], Easy to handle when processing [], I do not have money to buy tarpaulin []
38. How do you thresh? Heating the harvested straw with Stick [], Heating the harvested straw against the old empty diesel drum [], Heating the harvested straw against a Wooden threshing box or bambam box [], Heating harvested straw against a piece of wood [], Mechanical thresher []

F. DRYING AND WINNOWING

39. Where do you dry your paddy? On Tarpaulin [], Cemented/pavement floor [], Bare floor [], Polythene sheet []
40. How many days do you dry paddy at average sunshine intensity before milling? Three days [], One week [], Two weeks [], More than two weeks []
41. Do you winnow the dried paddy before milling? Yes [] No []

G. STORAGE, DRYING BEFORE MILLING

42. Do you store produce after harvest? Yes [] No []
43. Where do you store the produce? In the Kitchen [], On the bare floor in the store room [], In the rice milling Center [], In sacks packed on raised wooden platforms []
44. How long do you dry paddy after storage before milling? Less than a day [], One day [], Two days [], More than two days []

H. QUALITY RICE

45. In your opinion, what is quality milled rice? Stone free [], High percent of head rice [], No impurities [], should be aromatic [], should be white in color []
46. Can you mention some key activities that significantly improve the quality of milled rice you produce? Acquiring good seed from a reliable source [], Seed selection [], Use of tarpaulin [], Timely harvesting [], Technical information received through trainings [], Use of threshing box []

I. BASIC FARM MANAGEMENT PRINCIPLES

47. Do you keep written records of all rice farming activities? Yes [] No []
48. Give reasons? To track all expenditures and incomes [], Days each activity is done [], For easy determination of profit [], Because being an illiterate [], I feel lazy to keep records []
49. What was the size of your rice field? Quarter (¼) of an acre [], Half (1/2) of an acre [], One (1) acre [], One and a half acres (1.5) [], 2 acres [] More than 2 acres []
50. What was your total cost of production of the previous season?
51. What was the total sale of rice?
52. What was the profit made during the past season?

Training Impact on Production Activities/Quality of Rice	**Before the project (Without training)**		**After the project (With training)**	
	High	***Low***	***High***	***Low***
PRE-PRODUCTION LAND PREPARATION				
Level of participation in farmer group activities				
Extension service training to farmers				
Skills training during on-site (on the job)				
Technical training				
Number of Training of farmers				
Land development and preparation training				
Rice cultivation trainings				
Postharvest training				
Farm management trainings				

Marketing Trainings				
Skill in plouging,bunding,puddling and leveling				
Use of good seed from certified source				
Use of torpedo net to prevent birds from eating rice				
Water management skill				

RICE CULTIVATION PRACTICES				
Knowledge in sowing of good seed				
Knowledge of critical Growth stages of rice crop				
Key cultural practices in rice cultivation				
Motivation for rice cultivation				
Knowledge of own pure seed production				
Transplanting method of rice cultivation				
Skill in rouging				
Skill in seed selection				
Skill in disease identification, prevention and control				
Rice yields				
RICE HARVESTING				
Skill in timely rice harvesting				
Knowledge of the use of tarpaulin				
Use of sickle				
THRESHING				
Use of sticks				
Plastic mineral crates				
Empty diesel drum				
Threshing box or Bambam box				
WINNOWING				
Degree of winnowing				
DRYING				

Pavement				
Bare floor				
Tarpaulin				
RICE QUALITY				
Production of milled rice				
Discolored rice				
Percent Head rice				
Broken rice percentage				
Percentage of impurities in milled rice				
Demand for the rice containing the stone				
STORAGE				
Knowledge on best storage practices				
Duration of Storage paddy				
Use of specific structure for paddy storage				
FARM MANAGEMENT				
Knowledge of Farm management				
Skill in Action preparation and use				
Knowledge and use of cropping calendar				
Record keeping				
Ability to produce what the consumers need				
Ability to sale				
Gross income				
Net Profit				

1. Rice Cultivation Practices before and after training

Two-Sample T Tests for determina by trt

trt	**N**	**Mean**	**SD**	**SE** After
3	96.296	1.0000	0.5774	

Before 3 3.7037 1.0000 0.5774

Difference 92.593 1.0000 0.8165

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference

Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	113.40	0.0000	88.833	96.352
Satterthwaite	Unequal	4.0	113.40	0.0000	88.833	96.352

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	1.00	0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for numbertra by trt

trt	N	Mean	SD	SE
After	3	93.827	1.0000	0.5774
Before	3	6.1728	1.0000	0.5774
Difference		87.654	1.0000	0.8165

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference

Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	107.35	0.0000	83.895	91.414
Satterthwaite	Unequal	4.0	107.35	0.0000	83.895	91.414

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	1.00	0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for offtypere by trt trt

N **Mean** **SD** **SE** After 3

96.296 10.000 5.7735

Before 3 3.7037 1.0000 0.5774

Difference 92.593 7.1063 5.8023

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	15.96	0.0001	65.878	119.31
Satterthwaite	Unequal	2.0	15.96	0.0036	36.870	148.32

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	100.00	0.0099

Cases Included 6 Missing Cases 0

Two-Sample T Tests for onsitetra by trt

trt **N** **Mean** **SD** **SE** After

3 97.531 1.0000 0.5774

Before 3 2.4691 1.0000 0.5774

Difference 95.062 1.0000 0.8165

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	116.430.0000		91.302	98.821
Satterthwaite	Unequal	4.0	116.43	0.0000	91.303	98.821

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	1.00	0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for postharve by trt

trt **N** **Mean** **SD** **SE** After

3 96.296 1.0000 0.5774

Before 3 3.7037 1.0000 0.5774

Difference 92.593 1.0000 0.8165

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	113.40	0.0000	88.833	96.352
Satterthwaite	Unequal	4.0	113.40	0.0000	88.833	96.352

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	1.00	0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for riceculti by trt

trt **N** **Mean** **SD** **SE** After

3 88.889 10.000 5.7735

Before 3 11.111 1.0000 0.5774

Difference 77.778 7.1063 5.8023

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	13.40	0.0002	51.063	104.49
Satterthwaite	Unequal	2.0	13.40	0.0051	22.055	133.50

Homogeneity of Variances **DF** **F** **P**

Folded F Test 2,2 100.00 0.0099

Cases Included 6 Missing Cases 0

Two-Sample T Tests for skillinpl by trt trt

N **Mean** **SD** **SE** After 3

93.827 1.0000 0.5774

Before 3 6.1728 1.0000 0.5774

Difference 87.654 1.0000 0.8165

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference

Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	107.35	0.0000	83.895	91.414
Satterthwaite	Unequal	4.0	107.35	0.0000	83.895	91.414

Homogeneity of Variances **DF** **F** **P**

Folded F Test 2,2 1.00 0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for techtrain by trt

trt **N** **Mean** **SD** **SE** After

3 77.778 0.1000 0.0577

Before 3 22.222 1.0000 0.5774

Difference 55.556 0.7106 0.5802

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference

Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	95.75	0.0000	52.884	58.227
Satterthwaite	Unequal	2.0	95.75	0.0001	49.983	61.128

Homogeneity of Variances DF F P

Folded F Test 2,2 100.00 0.0099

Cases Included 6 Missing Cases 0

Two-Sample T Tests for usecertif by trt trt

N Mean SD SE After 3

93.827 1.0000 0.5774

Before 3 6.1728 1.0000 0.5774

Difference 87.654 1.0000 0.8165

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	107.35	0.0000	83.895	91.414
Satterthwaite	Unequal	4.0	107.35	0.0000	83.895	91.414

Homogeneity of Variances DF F P

Folded F Test 2,2 1.00 0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for useofempt by trt

trt N Mean SD SE After

3 2.4691 0.1000 0.0577

Before 3 97.531 1.0000 0.5774

Difference -95.062 0.7106 0.5802

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-163.83	0.0000	-97.733	-92.390

Satterthwaite Unequal 2.0 -163.83 0.0000 -100.63 -89.489

Homogeneity of Variances DF F P

Folded F Test 2,2 100.00 0.0099

Cases Included 6 Missing Cases 0

2. Physical Milling Quality

Two-Sample T Tests for MoisureCo by trt

trt N Mean SD SE NTS

6 13.267 0.5203 0.2124 TS 6

13.250 0.2345 0.0957

Difference 0.0167 0.4035 0.2330

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	0.07	0.9444	-0.7217	0.7550
Satterthwaite	Unequal	7.0	0.07	0.9450	-0.8006	0.8339

Homogeneity of Variances DF F P

Folded F Test 5,5 4.92 0.0525

Cases Included 12 Missing Cases 0

Two-Sample T Tests for grainwt by trt

trt N Mean SD SE NTS

6 2.0667 0.0816 0.0333

TS 6 2.1500 0.0548 0.0224

Difference -0.0833 0.0695 0.0401

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	-2.08	0.0646	-0.2105	0.0439
Satterthwaite	Unequal	8.7	-2.08	0.0686	-0.2148	0.0481

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	2.22	0.2007

Cases Included 12   Missing Cases 0

Two-Sample T Tests for Graindime by trt

trt **N** **Mean** **SD** **SE** nts

3 4.1754 0.0136 7.85E-03 ts 3

4.0062 0.0799 0.0461 Difference

0.1691 0.0573 0.0468

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					95% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	3.62	0.0225	0.0392	0.2991
Satterthwaite	Unequal	2.1	3.62	0.0632	-0.0220	0.3603

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	34.56	0.0281

Cases Included 6   Missing Cases 0

Two-Sample T Tests for WhiteRice by trt

trt **N** **Mean** **SD** **SE** NTS

6 302.35 9.5460 3.8972

TS 6 341.43 5.2317 2.1358

Difference -39.083 7.6973 4.4441

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference

Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	-8.79	0.0000	-53.168	-24.999
Satterthwaite	Unequal	7.8	-8.79	0.0000	-54.133	-24.034

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	3.33	0.1064

Cases Included 12   Missing Cases 0

Two-Sample T Tests for Broken by trt

trt	**N**	**Mean**	**SD**	**SE**
NTS 6	18.660	3.8284	1.5629	
TS	6	14.200	1.8375	0.7502
Difference		4.4600	3.0027	1.7336

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference

Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	2.57	0.0278	-1.0344	9.9544
Satterthwaite	Unequal	7.2	2.57	0.0360	-1.5533	10.473

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	4.34	0.0665

Cases Included 12   Missing Cases 0

Two-Sample T Tests for chalky by trt

trt	**N**	**Mean**	**SD**	**SE**
NTS 6	1.0800	0.4096	0.1672	
TS	6	0.7883	0.1493	0.0610
Difference		0.2917	0.3083	0.1780

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	1.64	0.1323	-0.2724	0.8557
Satterthwaite	Unequal	6.3	1.64	0.1500	-0.3552	0.9386

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	7.52	0.0225

Cases Included 12 Missing Cases 0

Two-Sample T Tests for perheadri by trt

trt	**N**	**Mean**	**SD**	**SE**
NTS	6	41.810	5.5204	2.2537
TS	6	54.087	1.9541	0.7977
Difference		-12.277	4.1408	2.3907

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	-5.14	0.0004	-19.854	-4.6998
Satterthwaite	Unequal	6.2	-5.14	0.0019	-21.005	-3.5480

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	7.98	0.0199

Cases Included 12 Missing Cases 0

Two-Sample T Tests for MillingRe by trt

trt	**N**	**Mean**	**SD**	**SE**
NTS	6	60.470	1.9092	0.7794

TS	6	68.287	1.0463	0.4272
Difference		-7.8167	1.5395	0.8888

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	-8.79	0.0000	-10.634	-4.9998
Satterthwaite	Unequal	7.8	-8.79	0.0000	-10.827	-4.8068

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	3.33	0.1064

Cases Included 12   Missing Cases 0

Two-Sample T Tests for MillingDe by trt

trt	**N**	**Mean**	**SD**	**SE**
NTS	6	80.807	1.9313	0.7884
TS	6	89.888	0.9167	0.3742
Difference		-9.0817	1.5117	0.8728

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	10	-10.41	0.0000	-11.848	-6.3157
Satterthwaite	Unequal	7.1	-10.41	0.0000	-12.115	-6.0483

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	5,5	4.44	0.0638

Cases Included 12   Missing Cases 0

3. Proximate Analysis

Two-Sample T Tests for ash by trt

trt N Mean SD SE nts

3 0.5000 0.0500 0.0289 ts 3

0.5000 0.1000 0.0577 Difference

0.0000 0.0791 0.0645 **T-Tests for Mean Difference**

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					95% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	0.00	1.0000	-0.1792	0.1792
Satterthwaite	Unequal	2.9	0.00	1.0000	-0.2078	0.2078

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	4.00	0.2000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for carbo by trt

trt N Mean SD SE nts

3 72.100 3.6510 2.1079 ts 3

70.733 0.5774 0.3333 Difference

1.3667 2.6137 2.1341

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					95% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	0.64	0.5568	-4.5586	7.2919
Satterthwaite	Unequal	2.1	0.64	0.5848	-7.4093	10.143

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	39.99	0.0244

Cases Included 6   Missing Cases 0

Two-Sample T Tests for fat by trt

trt **N** **Mean** **SD** **SE** nts

3 2.6667 0.5774 0.3333 ts 3

3.0000 1.0000 0.5774 Difference

-0.3333 0.8165 0.6667

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					95% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.50	0.6433	-2.1843	1.5176
Satterthwaite	Unequal	3.2	-0.50	0.6495	-2.3819	1.7152

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	3.00	0.2500

Cases Included 6   Missing Cases 0

Two-Sample T Tests for moisture by trt

trt **N** **Mean** **SD** **SE** nts

3 12.333 0.2887 0.1667 ts 3

12.667 0.5774 0.3333 Difference

-0.3333 0.4564 0.3727

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					95% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.89	0.4216	-1.3681	0.7014
Satterthwaite	Unequal	2.9	-0.89	0.4382	-1.5329	0.8662

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	4.00	0.2000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for protein by trt

trt	**N**	**Mean**	**SD**	**SE** nts
3	12.400	4.1509	2.3965 ts	3
13.100	0.0000	0.0000		

ERROR: T-statistic is very large or very small.

ERROR: Data may be nearly constant or may need to be scaled.

Cases Included 6 Missing Cases 0

4. Functional Properties

Two-Sample T Tests for Breakdown by trt

trt	**N**	**Mean**	**SD**	**SE** NTS
3	1244.0	10.000	5.7735	
TS	3	1157.5	0.0500	0.0289
Difference		86.500	7.0712	5.7736

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	14.98	0.0001	59.918	113.08
Satterthwaite	Unequal	2.0	14.98	0.0044	29.203	143.80

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	40000.0	0.0000

Cases Included 6 Missing Cases 0 **Two-Sample**

T Tests for BulkDensi by trt

trt	N	Mean	SD	SE NTS
3	0.9086	1.00E-03	5.77E-04	
TS	3	0.8640	0.1000	0.0577
Difference		0.0446	0.0707	0.0577

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	0.77	0.4830	-0.2212	0.3104
Satterthwaite	Unequal	2.0	0.77	0.5206	-0.5282	0.6174

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	10000.0	0.0001

Cases Included 6 Missing Cases 0

Two-Sample T Tests for FinalVisc by trt

trt	N	Mean	SD	SE NTS
3	5311.0	1000.0	577.35	
TS	3	5632.5	1000.0	577.35
Difference		-321.50	1000.0	816.50

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.39	0.7138	-4080.7	3437.7
Satterthwaite	Unequal	4.0	-0.39	0.7138	-4080.7	3437.7

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	1.00	0.5000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Pastingte by trt

trt	**N**	**Mean**	**SD**	**SE** NTS
3	89.075	10.000	5.7735	
TS	3	78.750	0.1000	0.0577
Difference		10.325	7.0714	5.7738

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	1.79	0.1483	-16.258	36.908
Satterthwaite	Unequal	2.0	1.79	0.2156	-46.960	67.610

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	10000.0	0.0001

Cases Included 6 Missing Cases 0

Two-Sample T Tests for PeakVisco by trt

trt	**N**	**Mean**	**SD**	**SE** NTS
3	3147.5	100.00	57.735	
TS	3	3278.5	1000.0	577.35
Difference		-131.00	710.63	580.23

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.23	0.8324	-2802.4	2540.4
Satterthwaite	Unequal	2.0	-0.23	0.8420	-5703.3	5441.3

Homogeneity of Variances	**DF**	**F**	**P**

Folded F Test 2,2 100.00 0.0099

Cases Included 6 Missing Cases 0

Two-Sample T Tests for SOLUBILIT by trt

trt	N	Mean	SD	SE NTS
3	32.000	1.0000	0.5774	
TS	3	40.000	0.5000	0.2887
Difference		-8.0000	0.7906	0.6455

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-12.39	0.0002	-10.972	-5.0281
Satterthwaite	Unequal	2.9	-12.39	0.0012	-11.846	-4.1540

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	4.00	0.2000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for SWELLINGP by trt

trt	N	Mean	SD	SE NTS
3	10.240	1.0000	0.5774	
TS	3	10.600	0.1000	0.0577
Difference		-0.3600	0.7106	0.5802

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.62	0.5686	-3.0314	2.3114
Satterthwaite	Unequal	2.0	-0.62	0.5972	-5.9323	5.2123

Homogeneity of Variances DF F P

Folded F Test 2,2 100.00 0.0099

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Setback by trt

trt N Mean SD SE NTS

3 3407.5 1000.0 577.35 TS 3

3511.5 0.1000 0.0577

Difference -104.00 707.11 577.35

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.18	0.8658	-2762.2	2554.2
Satterthwaite	Unequal	2.0	-0.18	0.8736	-5834.1	5626.1

Homogeneity of Variances DF F P

Folded F Test 2,2 1.0E+08 0.0000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for TroughVis by trt

trt N Mean SD SE NTS

3 1903.5 0.1000 0.0577

TS 3 2121.0 1000.0 577.35

Difference -217.50 707.11 577.35

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.38	0.7255	-2875.7	2440.7

Satterthwaite Unequal 2.0 -0.38 0.7426 -5947.6 5512.6

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	1.0E+08	0.0000

Cases Included 6 Missing Cases 0

Two-Sample T Tests for WaterAbso by trt

trt	**N**	**Mean**	**SD**	**SE**
NTS	3	20.000	10.000	5.7735
TS	3	15.000	0.5000	0.2887
Difference		5.0000	7.0799	5.7807

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

					99% CI for Difference	
Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	0.86	0.4359	-21.615	31.615
Satterthwaite	Unequal	2.0	0.86	0.4779	-51.895	61.895

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	400.00	0.0025

Cases Included 6 Missing Cases 0

TCW3 Report

8/24/2015 1:42:13PM User Winrhizo

Security ID = 130606150946099

Test Details Samples

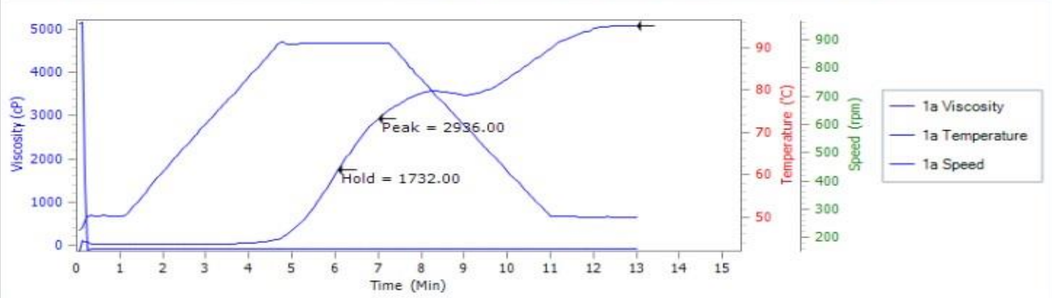
01 C:\Users\uaser\Desktop\FdSci\1a
Date 2015/08/24 Time 12:37:46 Tester Winrhizo Instrument 2122823
Sample Weight 3.50 (g) Water Weight 25.66 (g) Sample Moisture 12.02 (%) Moisture Basis 14.00 (%)

Test Results

Test	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time
01 1a	2936.00	1732.00	1204.00	5103.00	3371.00	7.00

Test	Pasting Temp
01 1a	89.75

	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.00	1.07	1.13	1.20
1a Viscosity	-145	102	79	79	9	12	12	12	12	11	11	11	11	11	11	12	11	11
1a Temperature	47.00	47.55	49.15	50.30	50.40	50.35	50.35	50.35	50.40	50.40	50.35	50.30	50.30	50.25	50.25	50.20	50.40	51.00
1a Speed	957	961	396	156	160	160	160	160	160	160	160	160	160	160	160	160	160	160



TCW3 Report

8/24/2015 1:41:59PM User Winrhizo

Security ID = 130606150946099

Test Details Samples

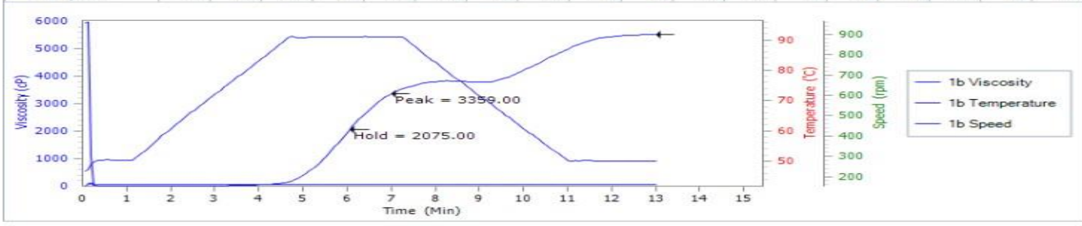
02 C:\Users\uaser\Desktop\FdSci\1b
Date 2015/08/24 Time 12:55:18 Tester Winrhizo Instrument 2122823
Sample Weight 3.50 (g) Water Weight 25.66 (g) Sample Moisture 12.02 (%) Moisture Basis 14.00 (%)

Test Results

Test	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time
02 1b	3359.00	2075.00	1284.00	5519.00	3444.00	7.00

Test	Pasting Temp
02 1b	88.40

	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.00	1.07	1.13	1.20
1b Viscosity	0	92	78	78	7	8	8	7	8	8	7	8	8	7	7	7	7	8
1b Temperature	46.75	47.20	48.80	49.80	50.15	50.25	50.40	50.45	50.45	50.40	50.35	50.35	50.35	50.40	50.25	50.20	50.40	51.00
1b Speed	958	960	306	158	160	160	160	160	160	160	160	160	160	160	160	160	160	160



TCW3 Report

8/24/2015 1:41:33PM User Winrhizo

Security ID = 130606150946099

Test Details Samples

03 C:\Users\uaser\Desktop\FdSci\2a

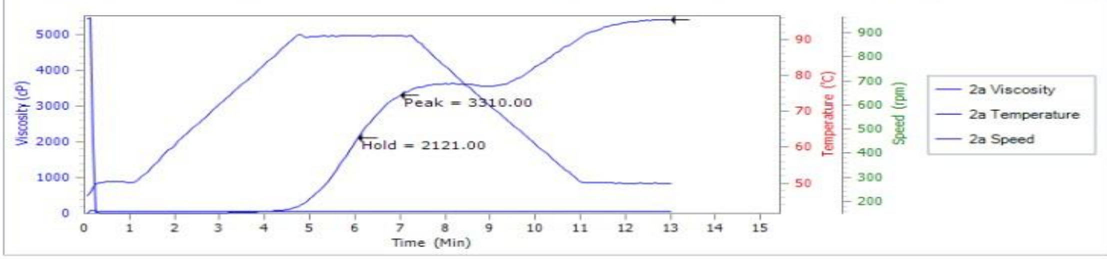
Date 2015/08/24	Time 01:09:31	Tester Winrhizo	Instrument
Sample Weight 3.50 (g)	Water Weight 26.04 (g)	Sample Moisture 10.85 (%)	Moisture Basis 14.00 (%)

Test Results

Test	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time
03 2a	3310.00	2121.00	1189.00	5419.00	3298.00	7.00

Test	Pasting Temp
03 2a	89.10

	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.00	1.07	1.13	1.20
2a Viscosity	0	92	78	78	5	7	7	7	7	6	6	5	7	7	7	5	7	6
2a Temperature	46.60	47.45	48.75	49.90	50.20	50.30	50.35	50.40	50.45	50.45	50.40	50.35	50.35	50.30	50.25	50.25	50.45	51.00
2a Speed	957	961	436	155	160	160	160	160	160	160	160	160	160	160	160	160	160	160



TCW3 Report

8/24/2015 1:41:16PM User Winrhizo

Security ID = 130606150946099

Test Details Samples

04 C:\Users\uaser\Desktop\FdSci\2b

Date 2015/08/24	Time 01:23:44	Tester Winrhizo	Instrument
Sample Weight 3.50 (g)	Water Weight 26.04 (g)	Sample Moisture 10.85 (%)	Moisture Basis 14.00 (%)

Test Results

Test	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time
04 2b	3247.00	2121.00	1126.00	5846.00	3725.00	7.00

Test	Pasting Temp
04 2b	68.40

	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.00	1.07	1.13	1.20
2b Viscosity	0	124	111	111	22	33	31	32	39	41	18	40	31	46	26	39	34	35
2b Temperature	46.95	47.60	48.95	49.95	50.25	50.35	50.35	50.45	50.45	50.40	50.45	50.40	50.35	50.35	50.30	50.40	50.45	51.00
2b Speed	954	965	591	143	162	160	159	160	160	159	160	160	160	160	160	160	160	160