International specialized medium for agricultural mechanization in developing countries

ISSN 0084-5841

AMA

AGRICULTURAL MECHANIZATION IN ASIA, AFRICA AND LATIN AMERICA

VOL.52, NO.2, SPRING 2021

FARM MACHINERY INDUSTRIAL RESEARCH CORP.

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ISSN 0084-5841

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Edited by

YOSHISUKE KISHIDA

Published quarterly by

Farm Machinery Industrial Research Corp.

in cooperation with

The Shin-Norinsha Co., Ltd.

and

The International Farm Mechanization Research Service

TOKYO

CIRCULATION

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Printed in Japan

This is the 187th issue since its maiden issue in the Spring of 1971

EDITORIAL

Coronavirus infection continues to spread around the world. Development and production of vaccines against coronaviruses has started in some countries and the inoculation of vaccines is going on full swing and most of the people have completed the vaccination.

However, this is not the case in many countries. Even in scientifically and technologically advanced countries such as Japan, vaccine development is still a work-in-progress. As actual war, the war against coronavirus requires concrete strategy and a set of specific and coordinated actions. Therefore, the governments must make a bold budget and carry out the needed action urgently.

However, the reality is that there is a big difference among group of countries where it is done and where it is not. In the world, SDGs are rolled out and many companies are beginning to incorporate this concept into their businesses.

Food, agriculture, forestry and fisheries are the most important things for human beings to live on this earth sustainably.

However, people involved in agriculture, forestry and fishers are aging all over the world. Because of low profits, youngsters don't prefer working in agriculture and continue to go out to the cities for non-agricultural occupations. In Japan and other countries, serious labor shortage, especially during critical agricultural operations has begun due to aging. It's been knowing for more than 20 years, but concrete policy against it has not yet made. It is very unfortunate. The most important concrete strategy is the development and dissemination of technology that increases the labor productivity of agriculture production dramatically.

There is a need for new and appropriate agricultural mechanization that requires urgent formulation and effective implementation of strategies. Globally, the amount of agricultural land per capita is decreasing every year, which means that the land productivity of agriculture must be increased to obtain enough food against all the odds. The most important ingredient to increase the productivity of agriculture is timely and precise agricultural operation. It can only be done by suitable agricultural mechanization.

A strategy to increase agricultural labor and land productivity is needed. It is an urgently-needed agricultural mechanization strategy, which has to be prioritized in each country.

AMA was first published in 1971 with the aim of connecting experts in the world and promoting suitable agricultural mechanization in developing countries; it is now the time for experts in the world to join hands to collectively address this major challenge. I wish that everyone keep safe, healthy and motivated in these difficult and testing times.

Yoshisuke Kishida
Chief Editor
May, 2021

CONTENTS

AGRICULTURAL MECHANIZATION IN ASIA, AFRICA AND LATIN AMERICA

Vol.52, No.2, Spring 2021

Increasing Rice Production in Nigeria Through Sawah Eco-Technology: 2005-2018

by

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Abstract

The Sawah rice on-farm research project was brought to the National Centre for Agricultural Mechanization (NCAM) in 2005 by Prof. Wakatsuki of Kinki State University, Japan for adoption by the Nigerian rice farmers. It has gained wide spread as the project through NCAM's effort over the years has extended to rice farmers in 22 states of the federation for quick adoption of the technology. The traditional method of producing rice in Nigeria was found lacking as it could no longer feed the ever-teeming population resulting from its very low yield. There is need to adopt a better alternative such as the Sawah rice on-farm project, which has seen gaining wide spread in some African countries. It became necessary to promote its adoption in a country like Nigeria - known as the seventh most populous nation in the world and the first in Africa. The continuous import of rice to supplement the short fall in the local production of rice for consumption by the masses became a matter of urgent discussion by the present administration. The government decided to promote the local production of rice by creating a programme called Anchors Borrowers Programme (ABP) in 2015 which is anchored by the Central Bank of Nigeria. The programme that kicked off in Kebbi State of Nigeria adopted the Sawah Eco-technology, extended to their rice farmers by NCAM for high yield production of rice in the State. This paper discusses the journey so far on how NCAM have extended her Sawah Eco-technology to rice farmers in Nigeria.

Keywords: rice, sawah, production, technology, on-farm research, demonstration.

Introduction

Rice is an important grain food to the world (Okeke and Oluka, 2017). Rice is consumed by over 4.8 billion people in 176 countries and it is the most important food crop for over 2.89 billion people in Asia, over 40 million people in Africa and over 150.3 million people in the Americas (USAID, 2009). According to WARDA (2003), rice (Oryza Sativa) is a cereal crop which has become a staple food of considerable strategic importance in many developing countries, where its consumption among urban and rural poor households has increased considerably. Imolehin and Wada (2000) reported that Nigeria ranks the highest as boll producer and consumer of rice in the West Africa Sub-region. However, in terms of area of land under food crop production in the country, rice ranks sixth after sorghum, millet, cowpea, cassava and yam.

Rice is both a food and a cash crop for farmers, contributing to smallholders revenues in the main producing areas of Nigeria. Rice is grown on approximately 3.7 million hectares of land in Nigeria, covering 10.6 percent of the 35 million hectares of land under cultivation, out of a total arable land area of 70 million hectares; 77 percent of the farmed area of rice is rain-fed, of which 47 percent is lowland, while 30 percent is upland (Ojehomon et al., 2009). Most rice farmers representing 90 percent of the total rice farmers in Nigeria are smallholders, applying a low input strategy to agriculture, with minimum input requirements and low output (IFAD, 2009). Nigeria rice productivity is among the lowest within neighbouring countries, with average yields of 1.51 tonne per hectare (Cadoni and Angelucci, 2013). Onimaes (2013) noted that rice can be grown conveniently in Nigeria because the climate is good. It can be grown both in the forest and savannah areas of Nigeria. According to Baksh (2003), Nigeria, Cote d'Ivoire, Zaire and Madagascar are among the biggest producers of all types of rice in Africa.

The average annual rice production in Nigeria is dominated by smallholder farmers who cultivate small hectares of land using traditional method of farming; yields are low and hence there is a wide gap between demand and supply (Idiong, 2005). There is food crisis in the country because, increase in the demand for staple food, such as rice, has not been accompanied with corresponding rise in production (Okpiliya, 2003). Statistics from the European Association of Agricultural Economics (EAAE), (2005) cited by USAID (2010) reveal that Nigeria is the largest rice importer in West Africa, with an average yearly import of 1.6 million metric tonnes since the year 2000. Total consumption stands at 4.4 million tonnes of milled rice while annual consumption per capital stands at 29 kg and this has continued to rise at 11 percent per annum; induced by income growth. Nigeria produces only about 2.8 million metric tonnes (MT) with a deficit of 1.6 million MT excluding the large quantity smuggled through the porous borders (USAID, 2010).

In order to increase rice production in the country, the federal government of Nigeria has designed policies and programmes aimed at boosting domestic production to meet domestic demand since 1989 (Idiong, 2005). These include amongst others, the Fadama Rice Programme and as well as the River Basin Development Rice Programme. Various Research institutes have been established in the country in order to boost rice production, some of which are the National Cereals Research Institute (NCRI) and National Seed Service (NSS). To further address this problem of low rice production in Nigeria, research institutes such as IITA and NCRI introduced high yielding varieties of rice purposely to boost food security. Upon the release of some improved high yielding varieties of rice for utilization in Nigeria, there still exists low rice production in the country due to the continuous use of the traditional method of rice cultivation where soil fertility which is a special ingredient needed in the soil could not be sustained. A technology called Sawah which is referred to a leveled, bunded and puddled rice field with water inlet and outlet for controlling water and managing soil fertility was introduced to Nigeria in the year 1986. This technology has made significant impact in developing countries like Ghana in the area of rice production and this called for the need for the adoption of such technology in Nigeria to boost our rice production level so as to meet the future need of the country. The country needed to promote the consumption of local rice as it is making tremendous effort to ban the importation of foreign rice into the country. Therefore, this paper discusses the impact of Sawah technology to the rice production system in Nigeria.

An Overview of Rice Cultivation and Processing in Nigeria

The cultivation of rice, according to Okeke and Oluka (2017), begins with seed bed preparation which includes land clearing, tillage, ploughing etc depending on size of farm. After land preparations, planting begins by planting either water-soaked rice or dry rice seeds. Seeds can be sown using a machine that places the seed in the soil in large farms but in developed countries low flying planes broadcast rice seeds on the already prepared fields. After one month or less of growth, the seedlings are transplanted in bunches from nursery beds to main field if it is not planted directly to the field. First weeding commences 1 month after transplanting or 21 days after germination for those planted directly to the field. Second weeding may be done 36 days after first weeding. Prior to transplanting fertilizer may be broadcasted and puddle into the soil according to the farmers schedule. Some farmers may schedule for first top dressing or broadcasting 2-3 weeks after transplanting. Application of fertilizer depends on the farmers' schedule.

At maturity stage (approximately four months after planting) the grains begin to ripen, the tips begins to drop and the stem yellows - the water in the field is drained if it is a flooded field (Jahn et al., 2005). As the field dries up, the grains ripe further and rice is due for harvesting. Depending on the size of the farm and the level of mechanization, rice is either harvested by mechanized means or manual labour. According to FAOSTAT (2014), 60 percent of farmers in Africa uses manual labour. Threshing of rice follows the harvesting operation, but in a full mechanized system where rice is being harvested with rice combine, harvesting and threshing are done simultaneously with combine harvester. After harvesting and threshing, the paddy rice is parboiled and milled using manual or mechanical method. Before milling, rice grain is dried in order to reduce the moisture content to about 19 percent to avoid breakage of the seeds during milling. The drying can be done through sun drying. In developed countries drying can be done with artificially heated air. Rice is processed at mill using automated processes. The paddy rice undergoes many processes like hulling, polishing, grading, de-stoning etc. before marketing or storage.

After hulling which is the removal of the outer husk to get the bran rice, polishing of the bran rice begins by removing the outer bran layer to get the white rice. Grading follows after polishing. Grading is the process of separating the long rice from the broken rice. De-stoning follows immediately after grading. Foreign rice at stage of polishing do undergo further processes which is also called coating which is either done by coating with protein material or any other substance (Okeke and Oluka, 2017). Various agricultural wastes such as rice straw, and groundnut husk have been used to produce bricks. Rice husk ash was used to treat the compressibility characteristics of black cotton soil as fillings for embankment (Akinyele et al., 2015).

Problems Associated with Rice Production in Nigeria

In Nigeria, rice has emerged as one of the fastest growing agricultural sub-sector and has oved from a ceremonial to a staple food in many Nigerian homes within the last two decades, such that some families cannot do without eating rice in a day. Nwachukwu et al. (2008) reported that as a staple food in Nigeria, rice accounts for 40 percent of the diet of the country's population but production has been growing at a slow rate relative to consumption within the last years. Idiong et al. (2006) quoting Akpokodje et al. (2001) reported that rice is an important food and cash crop in Nigeria and that it serves multipurpose roles. It immensely contributes to internal and external African Sub-Regional trade as well as food security for the nation. Also, rice contribution in Nigeria has been on the increase over the years.

Olatoye (2011) noted that a farmer can harvest close to 3-5 tonnes of rice in one hectare depending on the variety which is about 100 bags (25 kg). A 25 kg of rice is about ₦3,500. So about ₦350,000 can be realized from 1 hectare of land. An investment on 100 hectares of land will yield ₦35,000,000 and rice can be grown twice a year if it is mechanized. Uba (2013) noted that rice milling could be done on cottage, small, medium and large scale bases depending on availability of capital and the raw materials paddy rice. Output could be from 2 MT to 150 MT per day. Generally, 1 MT of paddy rice yields about 60 kg - 70 kg of milled rice, depending on milling efficiency company management practice and the variety of rice purchased.

The potential in investment in rice production in Nigeria cannot be overestimated. This is why both indigenous and foreign investors are seriously going into it. It has also been found out that our local rice (Ofada for example) is more nutritious than the imported ones (Nwalieji, 2016). However, rice cropping system in Nigeria is beset with problems associated with low-labour output, low yield, relatively high production costs, poor producer price and marketing system.

Fig. 1 Lead farmers and government officials at green field day at a farmer managed SERIF field day in Kebbi State of Nigeria

Fig. 2 Monitoring SERIF rice field at Badegi, Niger State of Nigeria

Fig. 3 Using power tiller to carry out ploughing operation in Kebbi State of Nigeria

Fig. 4 Leveling operation in SERIF at Gbajigi, Niger State of Nigeria

Adeniyi (1987) and Oni and Ikpi (1979), observed that related problems of that nature have led to the low yield and hence to the decline in the local production of this crop.

Rice is one of the most valuable staple food for large chunk of Nigerian population; but despite its nutritional and economic values; mechanization of its production and/or processing in some rural areas have not received much attention making the production, processing and even storage difficult for the local farmers. One major reason for the low level of output most times is low level of agricultural mechanization resulting from poor financial background of the farmers to procure farm machineries (Oduma et al., 2014).

Introduction of Sawah Technology into Rice Production System in Nigeria

Origin of Sawah Technology

According to Wakatsuki et al. (2009), Sawah is a man-made, improved rice-growing environment with demarcated, bunded, levelled, and puddle fields, for water control. Sawah is soil based eco-technology. In a more simpler form the term Sawah refers to leveled, bunded and puddled rice field with water inlet and outlet to control water and manage soil fertility, which may be connecting irrigation and drainage facilities including Sawah to Sawah irrigation and drainage. The term originated from Malayo-Indonesian. In the absence of water control, fertilizers cannot be used efficiently. Consequently, the high yielding varieties performed poorly and soil fertility cannot be sustained. The potential of Sawah based rice farming is enormous in Sub-Sahara Africa (SSA), especially in West Africa. Ten to twenty million hectares of Sawah can produce additional food for more than 300 million people in future. The Sawah based rice farming can overcome both low soil fertility and scarce water resources through the enhancement of multi-functionality of Sawah type wetlands as well as geological fertilization processes in watersheds.

The Beginning of Sawah Technology in Nigeria

On-farm research for the introduction of Sawah-based rice farming was initiated in 1986 in two Inland Valleys in Gara and Anfani near Bida area of Niger State of Nigeria by Prof. Toshiyuki Wakatsuki through the International Institute for Tropical Agriculture`s Hirose Project. In 1987, an additional Inland valley in Gadza which is in Bida area of Niger State of Nigeria was also included in the study. The initial research efforts were not adopted due to low level of innovation and interaction with the farmers.

Nigerian researchers were invited to Ghana's Sawah sites for observation and replication in Nigeria. This led to another on-farm research and demonstration study in 2001 at Ejeti, Bida area of Niger State of Nigeria. The success of these activities led to the innovative adoption of the technology in the demonstration site from where further research activities were carried out and dissemination activities started in earnest.

Between 1987 and 2001, extensive agronomic and irrigation research continued for the adoption and adaptation of Sawah among local farmers around the study area. In 2001, Watershed Initiative Nigeria 2001 (WIN2001) started a collaborative adaptive research with the National Cereal Research Institute (NCRI), Bida with support from Kinki University, Nara, Japan through Action Research. The Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) sponsored several On-the-job training and capacity building (OJCB) in collaboration with the International Cooperation Centre for Agricultural Education (ICCAE) of Nagoya University, Nagoya and Institute for the Studies of Advanced Sustainability of the United Nations University (UNU-IAS), Tokyo, Japan for the extension of Sawah Eco-

Fig. 5 Women returnees empowered by SERIF at Tisi, Salamat region; Tchad 2016

Fig. 6 On-the-Job training for returnees on SERIF at Gos taguela near Haraze, Tchad 2017

Fig. 7 A project Coordinator inspecting SERIF rice field at Massamagre, Tchad 2017

Fig. 8 Sawah expert and government official inspecting rice paddy store at Massamagre, Maguegeu region; Tchad 2016

technology in Nigeria.

The Sawah Eco-technology has been researched, tested, improved, demonstrated, and implemented successfully in Nigeria, Ghana, Togo, Benin and Chad from 1997 to 2018. **Figs. 1** to **8** show some of the activities carried out on Sawah Eco-Technology in Nigeria. The research on machinery application in Sawah fields started at the National Centre for Agricultural Mechanization (NCAM), Ilorin in 2005 and has continued till date.

Benefit of Sawah Eco-Technology over Traditional Method of Rice Production

The benefits of Sawah Eco-technology over the traditional method of rice production in Nigeria include:

i. Increase in rice yield from 1-2.5 ton/ha to 4-8 ton/ha;
ii. If appropriate lowlands are selected, developed and managed, sustainable rice productivity of lowland Sawah is more than ten times that of upland rice fields;
iii. Minimal rouging and no weeding is observed in a well prepared Sawah field;
iv. Sustaining the soil nutrients by utilizing geological and irrigation fertilization resulting from mineralization of nutrients and translocation due to movement of top soil from upland;
v. Sawah help combat global warming and other environmental problems;
vi. Carbon sequestration through control of oxygen supply. Methane emission under submerged condition, nitrous oxide emission under aerobic rice;
vii. De-nitrification of nitrate polluted water;
viii. Watershed agro-forestry, SATOYAMA describes active Sawah in the lowland and forestry in the upland; this encourages conservation of the environment, forest generation, enrichment of the lowland through various geological processes;
ix. Sawah contributes to control of flooding and soil erosion;
x. Sawah has the potential to generate hydro-electricity; and
xi. Sawah in its terraced form can create a beautiful cultural landscape;
xii. In communal settings, Sawah promote fair water distribution systems for collaboration and fair society.
xiii. The Sawah systems are the field laboratory for research and technology generation and the factory for dissemination of the technology developed.

Presented in **Table 1** is the dissimilarity that exists between the use of Sawah and the traditional system of rice production.

Journey so Far

In the year 2005, a team of researchers visited NCAM, Ilorin from IITA, Ibadan and NCRI, Badeggi. This visit was the point of introduction of Sawah to NCAM. The success of this embryonic visitation and collaborative research activities led to the involvement of some of NCAM researchers in Capacity Building Research programme sponsored by the Japanese government between 2007 and 2009 in several hosting Institutions in Ghana and Nigeria.

The NCAM Sawah Eco-technology has been extended to different States in Nigeria which include Akwa Ibom, Anambra, Benue, Cross River, Delta, Ebonyi, Ekiti, Enugu, Kaduna, Kano, Katsina, Kebbi, Kwara, Kogi, Lagos, Nasarawa, Niger, Ogun, Ondo, Osun, Taraba and Zamfara states with proven results in the communities that adopted the technology. The rice revolution which is currently being experienced in Kebbi state was made possible by the wise intervention by the then governor of the Kebbi state through this similar method. More than 2,000 lead farmers have been trained and about 2,000 hectares of sawah infrastructures have been developed.

The NCAM-hosted Sawah Eco-technology project in the past years has entered into effective collaboration for speedy adaptation, adoption and technology transfer with different organizations and agencies such as Third National Fadama Development Project (Fadama III); Soil Research Institute (SRI), Kumasi, Ghana; International Cooperation Centre for Agricultural Education (ICCAE); Sawah, Market Access and Rice Technology in Inland Valleys (SMART-IV project) of the Africa Rice Center (ARC); Shimane University, Matsue, Japan; Nagoya University, Nagoya, Japan; International Organization for Migration (IOM), Chad Republic; United Nations University - Institute for

Table 1 Difference between the use of Sawah and the traditional system of rice production

S/No.	Sawah method	Traditional system
1.	Relatively high yield that is greater than 7 tons/ha.	Low yield that is less than 2 tons/ha.
2.	Requires land development.	Relies on natural landform.
3.	Ploughing operation carried out using power tiller.	Manual scattering of mounds.
4.	Puddling operation carried out for proper pulverization.	No puddling operation.
5.	Nursery establishment followed by transplanting.	Direct sowing followed by broadcasting.
6.	Defined plant spacing operation.	Plant spacing undefined.
7.	Tillering is profuse.	Low tillering.
8.	High fertility management.	Low fertility management.
9.	Water control is high.	Minimal water control.

Sustainability and Peace (UNU-ISP); United Nation University - Institute for Advance Studies of Sustainability (UNU-IAS); Commercial Agricultural Development Project (CADP); Ekiti State Agricultural Development Programme; Kwara State Fadama II; Osun State Quick Impact Intervention Program (QIIP); and Some private farms.

Conclusion

The National Centre for Agricultural Mechanization (NCAM), Ilorin which is saddled with responsibility of promoting agricultural mechanization in Nigeria has over the years made tremendous effort in promoting the increase of rice production in Nigeria by training rice farmers in Nigeria on Sawah Eco-technology. The NCAM Sawah Eco-technology have been extended to rice farmers in 22 states of the federation. In few years to come, it is expected of the nation through the dissemination of NCAM Sawah Eco-technology to all states of the federation to be food sufficient in the area of rice production.

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■■

ABSTRACTS

The ABSTRACTS pages is to introduce the abstracts of the article which cannot be published in whole contents owing to the limited publication space and so many contributions to AMA. The readers who wish to know the contents of the article more in detail are kindly requested to contact the authors.

1820

Effect of Separating Sieve Parameter on Average Height of Potatoes and Soil Mixture and Performance of Separating Sieve: Xie Shengshi, Wang Chunguang

In order to achieve the effect of separating sieve parameter on the average height of potatoes and soil mixture and performance of separating sieve, the experiment on average height of potatoes and soil mixture and performance experiment on swing separating sieve were performed, respectively. Taking the crank rotational speed, sieve inclination and machine forward speed as experiment factors, taking average height of potatoes and soil mixture as the experiment indicator, the significant between factors and indicators were determined; taking obvious rate and abrasion rate as the index of swing separating sieve, through single factor test, the effect of swing separating sieve parameter on performance of separating sieve were determined. Test results are as follows. The crank rotational speed, sieve inclination and machine forward speed had the significant influence on the average height of potatoes and soil mixture, and the correlation coefficient were -0.846, -0.98 and 0.988, respectively. With the growth of crank rotational speed, the obvious rate and abrasion rate were first increased and then decreased. The obvious rate and abrasion rate reduced first and then increased with the increase of sieve inclination. The abrasion rate showed a tendency of first decrease and then increase with the increase of machine forward speed. The appropriate parameter of swing separating sieve are: the crank rotational speed is 230 r/min, the machine forward speed is 2.03 km/h. The study results may be of help and provide reference for the design of swing separating sieve on potato digger.

1823

Strength Analysis of a Thai-made Walking-type Tractor-Structural Modification of a Mainframe: Napat Kamthonsiriwimola, Hideo Hasegawa

In this study, a Thai-made walking-type tractor, e.g. Hongthong, Thailand, was analyzed through modification of a prototype. Major related factors including maximum von Mises stress and eigenfrequency were discussed by using a finite element method (FEM). To implement numerical approach, a side-member of mainframe was changed from L-shape to C-shape to gain more stiffness. Cross-members and ribs were placed to the mainframe while the cross-member was attached to a handle for further reinforcement. The FEM results indicated that the maximum von Mises stress and the maximum displacement of the modified model were the same as the ones of conventional model. As for the vibrational feature, the first five eigenfrequencies exhibited saliently bigger value under heavier mass condition. This may be useful to discuss the applicability in conjunction with the strength-related constraints. Furthermore, the presence of second eigenmodes suggested a possibility in improving torsional capability, particularly in the front portion of mainframe. Accordingly, a modified model was manifested to cause an increase of mass by 1.8% compared with the conventional model. To improve this impractical result, the replacement of material which can be characterized by higher durability and lighter mass were used as an alternative mainframe. In addition, since its complicated shape tended to cause the rise of a manufacturing cost, low-cost materials available in a marketplace were adopted for further designing innovation which might lead to encourage the medium-sized manufacturers.

1826

Single Locking Cotton Feeder for Enhancing Ginning Efficiency of Double Roller Gin: V. G. Arude, S. P. Deshmukh, P. G. Patil, S. K. Shukla

Single locking cotton feeder was designed and fabricated with an aim to maintain constant feeding rate of individual locules at the ginning point of Double Roller (DR) gin. It comprises of a pair of feed roller, spiked cylinders, grid, feeder hopper and distributor chute. Spiked cylinder has spikes, its tips were spaced closer to the feed rollers than the thickness of a lock of cotton. The spiked cylinder travel at a greater linear speed than the feed rollers, whereby cotton bolls held between the feed rollers are struck by the spikes of spiked cylinder, thus ensuring single locking of cotton. The effect of single locking of cotton on ginning efficiency of DR gin was studied. Extent of unlocking was determined by measuring the change in bulk density of cotton before and after passing through the feeder which decreased with increase in spike cylinder speed. DR gin output was found to increase by 15-20% with use of single locking feeder as compared to conventional feeding system comprising of auto-feeder and micro-feeder. Cotton quality was also found to improve in terms of colour grade. Single locking feeder observed to be highly useful for Indian cotton ginneries.

1840

Development and Evaluation of Walnut Cracking Machine: Jagvir Dixit, K. Ravindra, R.M. Shukla

In traditional method, walnut cracking done manually using hammer or stone is laborious, time consuming, and cumbersome with huge wastage. A prototype machine was developed and evaluated under three different levels of shell moisture content (db) (25-30%, 15-20% and 8-12%) and three different levels of roller speeds (25 rpm, 43 rpm and 69 rpm) of the cracking unit. The machine consists of motor, frame, hopper, conveying tray, cracking unit, conveying chute and collecting bin. The main working principle of cracking unit is based on the compression of the walnut between two rollers rotating in opposite direction. The rupture force was recorded minimum (90.16 N) along Z-axis (suture line) and at 8-12 % (db) shell moisture content while it was found maximum (200.90 N) along X-axis and at shell moisture content of 25-30% (db). The effective throughput capacity significantly increased with rotational speed of the rollers. The cracking efficiency was found highest (82.1%) at 43 rpm and 15-20% shell moisture content, while it was lowest (70.9%) at 63 rpm and 8-12% (db) shell moisture content. The kernel damage increased linearly with the rotational speed of roller and found highest (21.8%) at 69 rpm and 8-12 % (db) shell moisture content, while it was lowest (11.7%) at 25 rpm and 15-20% (db) shell moisture content. At standardized speed of operation (43 rpm) and shell moisture content (15-20%), the throughput capacity of the machine was recorded as 56.1kg/h with cracking efficiency of 82.1% and kernel damage of 13.8%. While throughput capacity observed with traditional method was 2.5 kg/h with cracking efficiency of 85.9%, and kernel damage of 8-9 %.

1842

Development and Evaluation of Single Row Power Weeder for Rice: Ajay Kumar Verma, Aditya Sirmour

Weeding is the most arduous job in rice farming. Mechanical weeding is preferred to chemical weeding as weedicide application is usually harmful, selective and expensive. Mechanical weed control not only uproot the weeds between the crop rows while keeping the soil surface loose, ensuring better soil aeration and water intake. Lack of man-power has been identified as one of the major problems for the sustainability of rice crop. Consequently seeders, planters and transplanters were well adopted as a step for rice mechanization in India. However, mechanized weeding is still not well developed as it is performed under submerged heavy soil condition and narrow row spacing. In order to assess the possibility of mechanization of the weeding operation of row seeded or mechanical and manual transplanted rice, the power operated single row rice weeder was designed and developed by Southern Agro Engine Private Limited, Chennai, India. It was further improvised by Indira Gandhi Agricultural University, Raipur, Chhattisgarh for the row seeded/ transplanted rice crop. The weeder consists of a 1.4 kW 6,000 rpm, 2-stroke petrol engine, a centre driven transmission box with worm gear box, rotor shaft with L-shaped blades, plastic float, handle, mudguard, mud flap, accelerator lever and an engine on/off switch. The tine width of the developed weeder can be adjusted at 140 mm, 190 mm or 240 mm. It is equipped with rotating blades with 176 rpm. Its compactness and low weight (14.5 kg) makes it easily maneuverable.

The developed power weeder was tested in the System of Rice Intensification (SRI) check row (25 × 25 cm) transplanted fields at 15 and 30 days after transplanting (DAT). The working speeds of operation were found to be 0.69 and 0.72 m/s for 15 & 30 DAT respectively. The fuel consumption, field capacity and weeding efficiency of power weeder at 15 DAT were found to be 0.74 l/h, 0.054 ha/h and 84.6% respectively. Similarly at 30 DAT it was found as 0.71 l/h, 0.059 ha/h & 86.3% respectively. Improvement in soil aeration and root growth after using the equipment has prompted higher production of tillers. The cardiac cost involved and energy expended in the operation of power rice weeder were 108 beats/min and 19.50 kJ/min, respectively. The oxygen uptake in terms of VO_2 max was 46% which was above the acceptable limit of 35% of VO_2 max. The work- rest study clearly indicates 6-8 min of rest can be provided to the operator after every 25-30 minutes of work (4 h work then 2 h rest followed by after 3 h work in a day of 8 h). ■■

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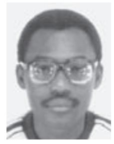
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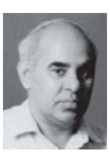
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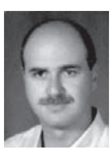
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