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AMA

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YOSHISUKE KISHIDA

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EDITORIAL

Shin-Norinsha Co. Ltd., the parent company of the AMA publisher, the Farm Machinery Industrial Research Corp. has celebrated it's 80th anniversary this year. We will hold a celebratory ceremony on October 23, 2013.

The AMA magazine commenced publishing in 1971 under the title of "Agricultural Mechanization in South Eastern Asia", followed by "Agricultural Mechanization in ASIA" from the second issue. 10 years later, the journal has changed it's title to the current "Agricultural Mechanization in Asia, Africa, and Latin America" and publishes quarterly. Thanks to all cooperation and support from many professionals around the world for this long period of time, we are able to continue publication up until today.

The objective of the publication of AMA is to narrow the gap between the urban and rural regions and discuss ways for especially farmers in developing countries to become sufficient by themselves with the introduction of a chain of appropriate technologies. As the world gets smaller due to the development of transportation and communication tools; if we leave this widening disparity on the globe, world peace will never come true.

The farmers who are engaged in food production to support human lives, the most important goals of all, need to be wealthy. In the developed countries, the trading conditions are very much against the agricultural side compared with the non-agricultural sides, consequently farmers still continue to produce milk and rice for costs cheaper than water. Agriculture does not only bring food but also provides us with gifts such as abundant forests, beautiful flowers, pure water, good environment, modern and herbal medicines necessary for our bodies, fibers including silk, hemp, cotton and others. Agriculture brings original environment and culture to every region and this has made our human lives rich and prosperous. Agriculture is harmonization between human beings and other life systems. With this harmonization, it has not only changed the life systems but also given distinctive "software" or heart inside human beings and developed spiritual and social culture. In other words, agriculture is interaction between human beings and the life systems. We must not allow others to destroy agriculture for the sake of short-term profits to exploit nature as an industry to produce food as commodities. To achieve better interaction and harmonization, we will need better equipment and knowledge.

The most vital item of all inputs is agricultural machinery. As the population grows whilst the farming land in the world is limited, the most fundamental undertaking would be an increase of the land productivity. The necessary conditions for this are timely and accurate operations. It is the most important mission of agricultural mechanization.

When agriculture and farmers become affluent in this world, there will be true peace. We should endeavor to harmonize and sustain with the other life systems beautifully by using agricultural machinery for world peace. The efforts of the people associated with AMA are especially crucial and these attempts are the most invaluable acts to help write human history.

Yoshisuke Kishida
Chief Editor

October, 2013

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THEME:

What kind of cooperation do you want from the Japanese government, agricultural industry, agricultural engineering associations, engineers, developers and researchers to promote agricultural mechanization in the developing countries and homeland?

Anticipated Role of Japan Concerning Agricultural Mechanization Issues in Developing World

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Summary

Despite recent advancement in Agricultural Engineering, hunger and poverty is noticeable in the developing countries. Developing countries are facing several issues such as: high cost of farming, lake of resource conservation, and shocking environmental conditions. The objective of this article is to summarize typical problems faced by agricultural sector in developing countries and also to highlight potential cooperation from Japan. Introduction of precision agricultural mechanization techniques and contemporary energy production sources from farm wastes contain reasonable potential. In order to help farmers, Japan may launch a training program for farmers, and farm machinery manufacturers of developing countries regarding efficient use of irrigation water, technology for the treatment and use of waste water, and introduction of precision agriculture techniques. Establishment of material banks and farm machinery renting pool may also demonstrate to be a prospective option.

Resource Conserving Agriculture

Cost of crop production is one of the major challenges faced by farming community of developing countries. Major portion of the cost and resources are wasted upon conventional tillage, over irrigation, inefficient harvesting and wastage of grains during post harvest period and storage. Random and excessive application of nutrients as well as pesticide with poor application techniques are additional concerns (Wall, 2008). Pretty *et al*. (2006) suggested a widespread adoption of resource conserving technologies in the developing countries. Resource conserving technologies combined with other innovations in crop and livestock production would contribute to increased agricultural productivity.

The status, limitation, and critical parameters of sustainable agricultural development are different for different developing countries. Speedy changes in the socio-economic situation of various developing countries are creating new scopes for Precision Agriculture (PA). For example; a joint study of cotton research institute and agricultural mechanization research institute, Pakistan revealed that 50 % of the pesticide applied on the field crops was not reaching the target and this finding was related with faulty spraying equipments and poor pesticide application techniques (Rehman and Khan, 2000). Deviation of pesticide from the target could be a reason for reduced pest control, resulting in low crop yield, and could be a large source of environmental pollution. In comparison, precision pesticide applications technologies in the developed countries suggests potential for better pest control and may decrease the cost of crop production with the extra benefit of environmental protection.

Agricultural Mechanization

Beside importance of input and crop parameters, the role of agricultural mechanization is prominent in promoting conservation and precision agriculture techniques. Modern agricultural mechanization techniques can help efficient handling of field processes, improve at-farm working conditions, and help adjust socio-economic trends. Most recently, Han *et al.* (2013) reported that the contribution of agricultural mechanization to agricultural output is 31.46 % of all factors. They also suggested that increase in agricultural mechanization may extensively contribute to the growth of agricultural output. As an example, minimum tillage, conservation tillage, or sometimes to zero tillage is intelligently practiced in the developed countries and crop yield in most cases is higher than the crop yield in the developing countries.

Importance of mechanization has already been felt while small farmers believe that using a tractor with a few basic implements is farm mechanization. Small, medium and large manufacturers exist in nearly all the developing countries. Generally, large manufacturers give practical importance to research and adaptation of new inventions, while they face competition of product cost with small manufacturers. In many cases, the small manufacturers are generation of old black smiths with little knowledge about metallurgy and set standards of farm machines. However, they have close liaison and already built trust with the small farmers. Considering that small manufacturers has liaison with farmer and they inherently learnt fabrication skills, hence transfer of technology through small and medium manufacturers would be quick and effective. This can be achieved by enhancing the technical knowledge of small and medium farmers and small and medium manufacturers through formal training in their regional languages with the help of local government and non-government organizations. Awareness and availability of certain grades of steels and other materials is a big issue faced by small manufacturers. So, introduction of a concept for material bank at regional level with selected materials may provide successful results of the training in adapting new technologies. Small and medium farmers are also facing financial constraints for the purchase of high-tech farm machine, so introduction of farm machinery pool at regional level could be a feasible solution.

Farm Environment and Energy Potential

Importance of farm wastes has been well recognized in the developed world with its potential of producing energy (Franco and Giannini, 2005; Khan, 2009). Beside recognized prospects of gasification, direct burning of solid agricultural wastes is quite common in the developing countries (Khan *et al.*, 1998). Direct burning is not only an inefficient way to utilize a potential resource but it also causes serious pollution of the environment. Evrendilek and Ertekin (2003) reported that direct burning of biomass has bad impact on air quality, though it is generally considered less harmful than those associated with coal, but more harmful than those associated with natural gas.

Use of domestic and industrial waste water to field crops is common in the developing countries which is a serious concern. Heavy metals are contaminating water resources as well as food chain because of their unique properties. Heavy metals are non-biodegradable, non-thermo-degradable and generally do not leach from the topsoil. Concentrations of heavy metals in wastewater used for irrigation is generally several-fold (3 to <13-fold) higher than the recommended limits (Mapanda *et al.*, 2005).

Soil salinity is another concern and this can be attributed to the use of brackish ground water for irrigation and lack of adequate drainage. Continuous use of brackish water is deteriorating the health of fertile soil. Farmers need technology for solving this issue; though technology exists worldwide for the treatment of brackish water. Farmers of developing countries are either not aware with such technologies, or are not adopting them due to social barriers and lack of education.

Recommendations

- Japanese agricultural industry may develop a joint venture with local manufacturers in the developing countries and institute modern farming techniques.
- Serious deficiency of energy in the developing world is well recognized, so modern technology related with biogas and gasification pictures great potential. Recently developed gasifiers and biogas plants may be introduced in the developing countries. This concept will help efficiently utilize farm waste and also cope with the

energy need at the farm level.

- Japan may coordinate with the developing countries to educate local agricultural engineers, farmers regarding harmful effects of waste water, excessive use of fertilizers, improper use of pesticides and efficient use of water for irrigation. Training should also include an aim to reduce the social barrier for adopting new technologies.
- A pilot project should be launched for the treatment of brackish ground water for irrigation purpose and treatment of saline soil.
- Japanese industry may collaborate with regional stake holders and establish material banks as well as farm machinery renting pools in the different regions of developing countries.

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Which Plow is more Suitable for Tillage Farming in Iraq?

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Tillage farming is an essential operation to prepare agricultural soil. There are two types of plows used widely in agricultural field. The first plow is moldboard plow. The farmers used that plow for a long time. The second plow is chisel plow. There are large numbers of Iraqi farmers that used chisel plow. Which plow is more suitable for tillage farming?

Iraqi farmers don't know where and how to use those pieces of equipment to increase grain yields and decrease fuel consumption. I want to know which plow prepares healthy agricultural environment by reducing the rate of carbon dioxide emission and making the soil healthier during the tillage farming operation in Iraq.

Farmers in Iraq use disk plow for tillage farming. Disk plow causes many problems to the Iraqi soil. The first problem decreases the crop yield specifically the corn and the wheat. The soil becomes unhealthy because the disk plow raises the level of silt in the soil. Tractors and disk plow need more fuel. Iraqi farmers suffer from the prices of diesel fuel because of the high cost for producing diesel fuel in Iraq. The farmers need to find the alternative plow to solve these problems.

According to what I mentioned above I asked myself which is better moldboard or chisel plow for fuel consumption, crop yield and environment effects in Iraq?

I will make a comparison between the two types of plows in order to determine which plow has lower fuel consumption, high crop yield and less impact on environment. After that, I can probably answer my question about which is better.

Aurich, Ken, William and Alfons (2006) undertook an experiment in Canada from 1982 to 2001 to study the impact of moldboard and chisel plows on fuel cost and crop rotation. The study illustrated that the chisel plow was more efficient than the moldboard plow in fuel cost. The researchers found that chisel plow used half of the time to finish the tillage farming operation as compared to moldboard plows. Also, the study mentioned that the long crop rotation increased crop yield more than the short crop rotation. Also, crop yield increased when they used chisel plows instead of moldboard plows in long crop rotation. The researchers concluded that chisel plows were more efficient than the moldboard plows in long crop yield.

Al-Kaisi and Xinhua (2005) carried out an experiment in Iowa from 1998 to 2001. The researchers investigated the effects of plow types on carbon dioxide emission and soil carbon in corn and soybean rotations. The researchers used a randomized complete block design with three replicates as a statistical system to analyze research data. Five plow types that were used were no tillage, strip tillage, deep rip, chisel and moldboard plows. Al-Kaisi and Xinhua found that moldboard plows gave the highest rate of carbon dioxide emission. The researchers found that with chisel plows they got the lowest carbon dioxide emission. Al-Kaisi and Xinhua explained that chisel plow has the ability to leave the crop residue on top of soil.

Chisel plow saves energy compared to moldboard plow. The cost of using the chisel plows is less than the moldboard plows. Chisel plow decreases Carbone dioxide emissions from the soil and improve soil properties. The benefits of using chisel plows are more numerous than using moldboard plows. I recommend the Iraqi farmers could use the chisel plow.

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Agricultural Mechanization Strategy and Japan-Ghana Co-operation

by

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Agriculture is a major source of employment for many Ghanaians and contributes a major part of the Gross Domestic Product of the country. As such to increase the nations GDP and the livelihood of the citizenry, there is the need to increase agricultural production through effective mechanization. As at 2002, only 13.4 % of Ghanaian farmers had access to mechanical power which is the backbone of mechanization (Josiah *et al*., 2008). This shows there is so much to be done to attain a high level of mechanization.

Achieving effective agricultural mechanization not only involves making available equipment but having the framework as well as the technology and well trained personnel to effectively use them. A careful look at the Ghanaian agricultural sector shows that, these have not been properly done, hence the low level of mechanization and minimum home-grown technological methods of farming. Japan on the other hand has been successful in developing a highly mechanized agricultural sector. In the year 1990 Japan had a mechanization capacity of 7 Hp/Ha, a significant rise from the 1968 capacity of 3 Hp/Ha (PCAARRD, 2009). Deductions from Yukumoto (2011), suggest that current methods of mechanizing Japanese agriculture involves the use of robots and the automation of most processes. In addition, Japanese machinery manufactures compete with most of the major machinery manufactures in the world (Farm Machinery Industrial Research Corporation, 1992).

This essay examines the problems facing the realization of an effectively mechanized agricultural sector in Ghana and then most importantly, propose possible co-operations between the stake-holders in the agricultural sector of Ghana and Japan that could aid the attainment of an effective mechanized agricultural sector.

Agricultural mechanization entails the provision of mechanical power for undertaking the various agricultural productions. The amount of mechanical power available affects the level of production as well as productivity. Ghana over the past few years has realized the need for a highly mechanized agricultural sector and this has promoted the introduction of many forms of mechanical power into the agricultural sector. With the most prominent one being the agricultural wheel tractor.

Due to the trend currently in the country, machinery introduction into agriculture have focused on tractor and implements, consequently land preparation is the most mechanized sector of agricultural production in Ghana (Diao *et al*., 2013). The number of operational tractors in the country rose steadily from 2250 tractors in 1964 to 5200 tractors in 2008 whiles the number of operational combine harvesters fluctuated from 20 combine harvesters in 1964 to the highest number of 156 combine harvesters in 1984 and a final number of 9 operational combine harvesters as at 2008 (Mahama and Seidu, 2011). This has left the other equally important agricultural production sectors such as planting, harvesting, and processing to be under-mechanized. Before a highly mechanized agricultural sector can be attained, steps must be taken to provide the appropriate technology for farmers during all their agricultural production endeavors, from field preparation through planting, harvesting, processing, storage etc.

One of the most important aspects of agricultural mechanization is the level of expertise of the personnel available to aid in effective mechanization. Institutions like the Vocational Training Institutes, Technical Institutes, Polytechnics and the Universities all train the different levels of expertise needed for effective mechanization. Ghana like any other developing country has an educational system where the technicians and engineers being trained get involved in their chosen field of study only during their tertiary education level with short periods of internship with industry. This affects their preparedness for a hands-on feel of their chosen career. The institutions in Ghana which train the technical experts to work in the Agricultural sector must make it a point to introduce students to the specific conditions of the work environment in Ghana.

Secondly, the machinery and equipment to aid in mechanization must be made available. The Government of Ghana is the biggest importer of agricultural mechanization equipment however, repair and maintenance in most cases is being done by the informal sector. As such any reduction in government expenditure affects the consistency of service delivery and also affects the level of mechanization anticipated. Many researchers (Jenane *et al*., 2007; Houssou *et al*., 2013; Houssou *et al*., 2012) have shown that government intervention is not efficient, hence the need for private sector involvement. Nonetheless, whether it is the government or private sector the two factors that hinder machinery and implements acquisition are; lack of credit facilities for the farmers to afford the machinery and the unavailability of the equipment suitable for efficient work under the farmers working conditions.

An example of government and private sector intervention in Ghana is the Agricultural Mechanization Centres (AMSEC). These centres provide specialized services to the farmers but a recent study revealed that the AMSECs are operating below their threshold of profitability. Few AMSECs own other machinery either than the tractor since "there is little incentive for an AMSEC to invest its own money in other equipment" (Diao *et al*., 2013). This affects their service delivery for other agricultural practices.

Several studies (Fonteh, 2010; Jenane *et al*., 2007) have shown that the formulation and implementation of an Agricultural Mechanization Strategy is an effective method of attaining high levels of mechanization. A study conducted by Diao *et al*. (2013), that evaluated some of the existing strategies showed that equipment acquisition and the provision of specialized service centres for the farmers who own the machines is the problem with the implementation of the strategy. It was then proposed that, the private sector should be allowed to be major players in the sector un-like the existing system where most of the system was government run.

In light of the preceding points, agricultural mechanization can be improved considerably by servicing equipment and acquiring knowledge and skill required for effective mechanization through the formation of co-operation with other countries. Japan being a major manufacturer and exporter of agricultural equipment would be a country of choice for Ghana. Japan is disposed favourably in supporting developing countries through grants and bilateral financial arrangements which can be used to support agricultural mechanization in Ghana.

Finally sustainability can be ensured when during the design and construction of the agricultural machinery and equipments by the Japanese Manufactures and Developers the Ghanaian conditions as well as research findings on the Ghanaian agricultural sector should be used. Again there should be collaboration between the Ghanaian and Japanese Engineers as well as the researchers so that there will be constant evaluation and improvement in the existing systems.

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■■

Far Sighted Decision

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It is no doubt that the decision taken in 1933 by Yoshikuni Kishida to found SHIN-NORINSHA COMPANY was courageous, far sighted and wise. Courageous, because, it was economically unfeasible to do business in the publishing industry at that time. Far sighted, because, the main publications were in the field of Agricultural Machinery. Wise, because, the publications promoted agricultural mechanization not only in Japan but also in developing countries where it is needed most.

The publications of SHIN-NORINSHA COMPANY, particularly, the "*AMA-Agricultural Mechanization In Asia, Africa, And Latin America*" was unique in the world in a sense that it connected experts around the world which strengthened the international cooperation in promoting the agricultural mechanization in the developing countries. The long list of co-editors appear on the back of AMA from all over the world is a living proof of the numerous international experts involved in achieving the goal for publishing AMA and fulfilling the aim of SHIN-NORINSHA COMPANY.

I congratulate SHIN-NORINSHA COMPANY for its 80th anniversary and wish it further progress towards promoting Agricultural Mechanization in the whole world.

As for the THEME

Developing countries depend highly on agriculture. Agriculture in the developing countries without appropriate agricultural mechanization will not be feasible.

Japan, through the Japanese government, private companies, research centers and universities can help in promoting agricultural mechanization in developing countries through:

1. Identifying problems and bottle necks limiting the use of farm machinery in agriculture production and deal with it accordingly.
2. Helping in training programs on how to operate, maintain and repair the farm machinery.
3. Helping the local industry to manufacture appropriate farm machinery and spare parts with simple technology.
4. Cooperating with local researchers on researches deal with developing farm machinery needed and suitable for the different areas within a particular country of different countries.
5. Providing sufficient funds to help establish private small farm machinery and spare parts industry.
6. Providing funds to establish small private and cooperative farm machinery hiring services.
7. Providing funds to support purchasing appropriate farm machinery that cannot be manufactured locally and it is vitally important for the country such as combine harvesters.
8. Establishing exchange short scientific and training programs.
9. Establishing branches of some Japanese farm machinery producers.

The training on the operation of farm machinery is highly needed and important for the developing countries. Training field schools is highly recommended and need the funding and logistical support that most developing countries are incapable of. Therefore, the Japanese government can help in this regard by providing funds, trainers and training the local trainers.

■■

Role of Japan in Promotion of Agricultural Mechanization in India

by

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Abstract

Indian agricultural equipment market experienced a rapid growth with import of paddy transplanter, sugarcane harvester, cotton pickers, air-assisted sprayers etc. during the last few years. Japan's small agricultural sector is highly mechanised, sophisticated and automated. It has a strong industry with export to whole Asia and other regions of the world. Tractor and implement manufacturers of India may enter into joint ventures with Japanese industry for design, development, up-gradation and manufacturing of high quality durable farm machinery at affordable price. The Japanese model of quality control and efficient after-sales service can be adopted in India for promotion of agricultural mechanization.

Introduction

The contribution of agriculture and allied sector to the Gross Domestic Product (GDP) of India declined from 55.1 % in 1950-51 to 37.6 % in 1981-82 and further to 14.1 % in 2011-12 on account of higher growth in the non-farm sectors. The services sector was the largest contributor to India's GDP in 2011-12 accounting for 52 % while industry contributed 30 %. The working population engaged in agriculture declined from 69.5 % in 1951 to 66.9 % in 1991 and further to 54.6 % in 2011. But agriculture still continued to be the main sector because it provided livelihood to over 58 % of India's population. Agriculture, forestry, and fishing formed the primary sector of the Japanese economy, but together they accounted for only 1.2 % of GDP in 2012 whereas service sector accounted for 71.4 %. In 2011, the labour force engaged in agriculture in Japan and India was 3.9 and 54.6 %, respectively. The two countries, therefore, shared a similar structure, especially with regard to their reliance on the services sector.

Only 12 % of Japan's land is suitable for cultivation and farming is mainly done on terraces in small areas by old age farmers. Japan's small agricultural sector is highly mechanised with about 461 tractors and 237 harvesters per 1000 ha. It is dominated by small, sophisticated and specialised machines and future trend is towards more automation. Japan has a strong industry with export to whole Asia and other regions of the world (Samarakoon, 2013). Agriculture in Japan is also subsidized and protected with government regulations that favour small-scale cultivation instead of large-scale agriculture as practiced in North America. In the late 1980s, 85.5 % of Japan's farmers were part-time farmers and earned most of their income from non-farming activities.

Agricultural mechanization plays a lead role in increasing production, productivity and profitability in agriculture by achieving timeliness in farm operations, precision in placement of inputs, reducing unit cost of production, saving in labour requirement and reduction in human drudgery. The labour saved due to mechanization can be utilized for processing of agricultural produces, marketing of fresh and processed products, manufacturing and sale of improved tools and implements and other allied activities. It is a known fact that the next generation of farmers will not be interested in farming unless it will be profitable and modernized in comparison to alternate opportunities in the society.

Indian agricultural equipment market experiences a rapid growth with expected strong potential for future growth as well. The tractors, power tillers, combine harvesters, threshers and rice transplanters are some of the equipment for which a surge in demand is witnessed over the past few years. The tractors account for the largest share and are followed by threshers and power tillers in the agricultural equipment market. The market for power tillers in India is dominated by VST Tillers and Kerala Agro Machinery Corporation Ltd. (KAMCO) and is mainly concentrated in the eastern and southern parts of the country owing to small land holdings and cultivation of paddy crops. Manufacturers based in Punjab had a strong presence in the combine harvester market growing at CAGR of around 30 % since 2005 and some imported models of combines from Korea and Japan also have limited presence due to high cost. The threshers market in India is highly un-organized and is dominated by large number of small and medium scale enterprises (SMEs). The rotavators are being considered better than the conventional tillage equipment among the Indian farmers. This equipment save considerable amount of fuel and accomplish soil pulverization in short time. The market for rice transplanters in India was almost nil 5-6 years back as the rice transplanting was done manually with women labour. Presently, many small companies are importing rice transplanters from China, Korea and Japan and marketing them in the India. The high subsidies up to 50 % provided by the centre/state governments is expected to encourage large number of paddy farmers to purchase rice transplanters in coming years.

Challenges in Farm Mechanization in India

The farm mechanization sector in India is facing various challenges related to farm machinery and equipment, technology, markets, operations, legislation, policy framework and other related areas. These challenges pose a serious impediment to the growth of the Industry and agriculture. The key challenges faced by the farm mechanization in India are as follows.

1. The average farm size in India and Japan is small (less than 2 ha) as compared to the European Union (14 ha) and the United States (170 ha). Therefore, there will be little mechanization unless machines appropriate for small holdings are made available or substantial farm amalgamation takes place. Due to small size of land holdings, it is difficult for the farmers to own machinery. As a result, the benefits of mechanization are enjoyed by only a section of the farmers who have large farm holdings.
2. The major constraint of increasing agricultural production and productivity is the inadequacy of farm power and machinery with the farmers. The average farm power availability needs to be increased to minimum 2.5 kW/ha to assure timeliness and quality in field operations, undertake heavy field operations like sub soiling, chiseling, deep ploughing and summer ploughing.
3. There is an urgent need to design, develop and test machinery especially suitable to Indian farming conditions such as dryland farming, paddy transplanting, sugarcane harvesting, potato combine, cotton picking, spraying tall plants such as fruit and forest trees etc.
4. The quality and after sales service of farm machinery are the other concerns in India as the majority of farmers are cost conscious. There are inadequate service centers for proper up-keep of the machinery. In addition, the inability of local low cost manufacturers to come up to the levels of standard designs of equipment also pose a big challenge to farm mechanization (Srivastava *et al*., 2013).
5. The knowledge about farm machinery management is insufficient in India. The farmers as well as artisans lack adequate training for efficient usage of the machinery.
6. The high cost and energy efficient farm machinery are capital intensive and majority of Indian farmers are not able to acquire these assets due to shortage of capital with them. Therefore, an arrangement to provide custom hiring service facility for these farm machinery to the farmers by engaging unemployed agricultural graduates will go a long way in meeting the requirements (Srivastava *et al*., 2013).
7. Almost 90 % of tractors are sold in India with the assistance of some financial institution. Sale of farm machinery is driven by factors like financial support, limit of funding (in terms of percentage of the cost), funding/financing institution and the applicant's profile (deciding the credibility of the loanee).
8. There is a need to innovate custom service or a rental model by institutionalization for high cost farm machinery such as combine harvester, sugarcane harvester, paddy transplanter, laser guided land leveler, rotavator etc. and can be adopted by private players or State or Central Organizations in major production hubs.
9. Cropping pattern decides the extent of mechanization required for timely operations and achieving optimum results. The scope of mechanization increases with intensive cropping pattern.
10. The scalability of farm operations is need for economically viable farm mechanization.

Strategy for Mechanization of Indian Agriculture

India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task. An appropriate mechanization technology suiting to the needs of the farmers is required to be adopted. The Japanese experience in this context will be an asset to the country. This may be achieved by following a few points as mentioned below.

1. There is a need of incentives and policy support for the adoption, development and promotion of farm mechanization technologies suitable for dryland farming, horticulture and orchards, hill agriculture, sugarcane harvesting, cotton picking, rice production and processing etc.
2. The rice transplanting operation can be mechanised by introduction of self-propelled walking type rice transplanters on small and medium land holdings. The riding type rice transplanter may be introduced on large size land holding on custom hiring basis (Mehta, 2002).
3. Agricultural cooperatives on the model of Japan may be instituted to cater the need of farmers for mat type paddy seedlings at subsidised prices (Mehta, 2002).
4. Surface covered and environmentally controlled greenhouse cultivation technology using microprocessor controlled systems can be introduced for high value plantation, horticulture, and other cash crops (Mehta, 2002).
5. The high capacity rice combines from Japan may be introduced to paddy growing areas on custom hiring basis. It will help in timely harvesting and better yield of paddy crop.
6. Medium and large scale farmers may be provided with Govt. subsidies to encourage them to buy and to apply advanced medium and high size machinery on their fields.
7. Training may be organised for rural youth and village artisans in repair and maintenance of agricultural machinery, tractors, power tillers, rice transplanters, combines, pumps etc.
8. Provision may be made for special credit support at lower interest rates to rural individuals, venturing into entrepreneurial use of farm machinery through custom hiring.
9. Manufacturing units that are setup in areas with lower mechanization needs to be supported by extending tax and duty sops. This would result in easier reach of the equipment to farmers in those areas. A higher rate of refinance may be extended to loans lent by banks in regions so as to increase the interest of banks to lend to this sector.
10. Banks need to develop hassle free loan origination and disbursement process for tractors and farm machinery on individual ownership basis or custom hiring basis.

Role of Japan in Agricultural Mechanization in India

The Government of both the countries should support the institutions/industry for joint projects for development of customized farm machinery technologies suitable to Indian condition. Policy support should be provided to tractor and implement manufacturers of India to enter into joint ventures with Japanese industry for design, development, up-gradation and testing of farm machinery. Human resource development of Indian researchers, designers and manufacturers of farm machinery may be done in Japan to share advanced knowhow in the area of design, development and manufacturing of sophisticated farm machinery.

Japanese industry has played a key role in the progress of farm mechanization by providing high quality and user friendly machines with efficient after-sales service. This has helped the farmers to use the machines during critical periods of production and processing with minimum failure rate. The Japanese model of quality control and efficient after-sales service can be adopted in India to produce high quality durable machines at affordable price by small and large scale agricultural machinery manufacturing industry. Japanese industry may be encouraged to establish farm machinery manufacturing hub in India to reduce the cost of production of farm machinery. The Government of Japan may assist India by providing modern agricultural equipment to farm machinery bank, and train entrepreneurs to use them to ensure timely land tilling, planting, weeding, chemical spraying, harvesting and threshing for increased crop production and productivity.

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Promotion of Agricultural Mechanization? Case of India

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Efforts to Promote Mechanization in India

India is a largely agrarian economy -with 52.1 % of the population estimated to directly or indirectly employed in agriculture and allied sectors in 2009-10 (Ministry of Agriculture GoVt. of India) The share of agriculture in gross domestic products is 18 % and that of manufacturing and service sectors is 28 % and 54 %, respectively. The mechanization is key to Indian agriculture and that is why Government of India has been giving a lot of emphasis on promotion of mechanization. Indian Council of Agricultural Research (ICAR) and state agricultural universities (SAUs) located in different states of India have full fledged agricultural Engineering Division dealing with the issues related to farm mechanization. Two institutes of the ICAR i.e., Central Institute of Agricultural Engineering (CIAE) and Central Institute of Post Harvest Engineering and Technology (CIPHET) and agricultural Engineering Divisions of the commodity institutes of ICAR on sugarcane, cotton, rice, fodder, horticulture and national institutes on fish, dairy, dry-land agriculture conduct research and development in the areas of farm machinery and post harvest engineering and technology. Farm mechanization research and development is also carried in a coordinated mode through All India Coordinated Research Projects (AICRPs) on Farm Implements and Machinery, Renewal Energy Sources, Utilization of Animal Energy, and Ergonomics and Safety in Agriculture. All these AICRPs have cooperating centers located in different states so as to cater to mechanization needs of different agro-climatic zones. The activities of these institutes and coordinated research projects are planned, supervised and monitored by subject matter Division of Agricultural Engineering located in ICAR head quarter in New Delhi. Federal and State Government Ministries Agriculture and Cooperation, Department of Science and Technology, Food and Agro-Processing, Rural Development, Water Resources and New and Renewable Energy Resources sponsor projects related to agricultural Engineering. The quality control in agricultural machines is the responsibility of Farm Machinery Training & Testing Institutes; four Institutes in Central, North, South and Northeast India. Of late, with an aim to further raise the quality standards of agricultural machines Ministry of Agriculture and cooperation has instituted 29 more testing and training cells in all most all the SAUs and other departments under state Governments to ensure speedy testing of the machines sold by the manufacturers. In addition, seventeen State Agro-Industries Corporations, Joint Sector Companies, have been promoted by the Government of India and by the State Governments concerned to manufacture and distribute agricultural machines and other agri-inputs, promotion and execution of agro based industries and providing technical services and guidance to the farmers and others.Subsidy is provided on tractors and power tillers to those which have been tested at Central Farm Machinery Training and Testing Institute and implement and machinery which has been tested by an institute designated for this purpose.The long-term credit is usually available for the purchase of tractors and farm machines; as such the Reserve Bank of India has mandated banks (both in public and private sector) to provide 18 % of credit to agriculture sector. The credit is available from

National Bank for Agriculture and Rural Development (NABARD). The agricultural implement manufacturing is a very strong industry in India involving a large number of manufacturers with different capabilities and product range. India is the largest manufacture of tractors in small power range uptp 60 horsepower. During the 12th Five Year Plan (2012-17) an ambitious programmes has been launched by the Govt. of India in boosting the mechanisation to new heights which includes various schemes like Skill development scheme, Custom Hiring centre Scheme and Credit Guarantee Scheme. Etc. The agricultural mechanization will record further boost with proper support of different stakeholders and international cooperations.

Cooperation sought from Japanese government, agricultural industry, agricultural engineering associations, engineers, developers and researchers to promote agricultural mechanization in the developing countries and India

1. India has a large number of small and marginal land holdings and the mechanization thereof is a difficult task. There is need of international cooperation from countries like Japan in developing suitable smart powered equipment with reasonable prices affordable by the farmers. Mechanization of hill agriculture with small plot sizes on slopy terrain needs also be addressed.
2. For accelerated dissemination of large number of agricultural machines/ equipment developed at R&D centres, in India and abroad there is a need to have national level display/ demonstration centres of the technologies in north south , east , west and central India.With international cooperation these centres can be established where international technologies can also be displayed for benefits of the farmers.
3. There is need of manufacturers involvement in development of agricultural machines at research stage to reduce the incubation period between research laboratory stages to field adoption. International manufacturers and instituitions may be encouraged to collaborate with Indian R&D instiutions and manufacturers to develop and popularize suitable technologies for mechanizing fruits, horticultural, vegetable, plantation and medicinal crops. The operation like paddy transplanting , paddy direct seeding and cotton picking need to be mechanized at widers scale by providing affordable technologies.
4. The custom hiring centres can be appropriate solution for effective mechanisation in the country as individual ownership is not economical.Technologies developed by research institutions should have “Business plan model” along with potential for commercialisation to facilitate adoption by manufacturers. Agricultural engineering associations can share their expirienecs in this regard.
5. To improve the quality of the products advance manufacturing processes electro discharge making laser beam machining etc. must be introduced both at manufacturers and institutions level. An international assistance and cooperation may be helpful in strengthening the manufacturing capacity of the Indian farm implement industry.
6. International cooperation is also required to develop smart technology of “precision farming , to adapt elements such as seed, fertilizer and pesticide to the varying needs of an individual field. Apart from increasing yield it will save environment by lowering the total amount of pesticides and fertilizers applied to a field.
7. International cooperation from developers and researchers may be helpful in the area of information technologies. Mobile based smart information system is required for sending very quick solution to farmers problems related biotic and abiotic stresses to crops.Technologies for conservation agriculture particularly energy and water saving equipment , protected cultivation, on farm processing, soil enrichment, dry land agriculture and agro-forestry needs to be strengthened through international cooperation.
8. Energy efficient cropping system, equipment and management practice should be promoted with appropriate incentive so as to conserve commercial energies and supplement and substitute theses with new and renewable sources of energy.
9. Mechanism and human resources should be developed for promoting mechanization. R & D should be intensified on energy management for efficiency and economy in agriculture
10. Exchange of M. Tech and Ph D students working in the area of agricultural engineering particularly farm mechanization will prove very productive. Visits of researchers and manufacturers to Japanese manufacturing industries and research and development organizations will prove very beneficial. Role of JICA needs to be redefined to take a holistic approach to agricultural mechanization and energy solutions.

■■

Biogas Technology Transfer as an Important Factor of Rural Development

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The degradation of the natural environment and the need for energy conservation cause that sustainable development worldwide is necessary. One of ways to achieve this purpose is a larger use of energy from renewable resources. Production of biogas is one of examples. Anaerobic digestion of organic residues and wastes is of increasing interest. Production of biogas in agriculture has several good points. It can be a promising approach to decentralized rural development both in developed and developing countries. It has positive effects for:

- environment conservation;
- energy management;
- agriculture;
- Local economy.

Positive aspects of agricultural biogas production for environment consist in farm waste recycling, reduced nitrogen leaching, being a result of the microbiologic digestion in the biogas plant –changing organic nitrogen into inorganic one (Hishinuma *et al*., 2000), which makes it more easily available to the crops and therefore better absorbed by plants. As a result, the crops grow better, and loss of nitrogen to the environment is reduced. Other advantages are: reduction of smell problems, less potential for denitrification, depending on the site-specific conditions, less greenhouse gas emissions (methane and laughter gas). Biogas production can contribute to a solution of the manure problem. Indirectly it brings about an improvement of hygiene and public health.

Production of biogas from farm by-products brings about the energetic advantages. It ensures production of a renewable energy from locally available raw materials, substitution of fossil fuels and increases energetic independence. Methane embodied in biogas can be used for replacement of fossil fuels in both heat and power generation and as a vehicle fuel or for the production of hydrogen which is necessary for fuel cells. In some countries it is mostly used for cooking and lighting. In developed countries it is mainly utilized in engine-based combined heat and power plants (Komiyama *et al*., 2006).

There are also advantages for agriculture. Anaerobic fermentation improves the management of manure and organic wastes. It ensures a better use of the nitrogen contained in animal manure. Homogeneous slurry, received as a result of the process is easily useable for arable farmers and free from weed and disease germs*). The digestate being by-product of biogas production is a valuable fertilizer due to the increased availability of nitrogen and replaces a part of mineral fertilizer. In many developing countries, like in Sub-Saharan Africa, lack of sufficient fertilizing is a reason of low yields of crops (Pawlak *et al*., 2002). Application of the digestat received as a by-product of biogas production could improve the situation.

The economic advantages are directly linked to the relative abundance of potential raw materials for biogas production. These are all organic waste, not only manure, but also organic wastes produced by households, vegetable by-products not useful for food (Umetsu *et al*., 2006) or grass from permanent meadows and pastures, if not used as a forage for farm animals (this is actually a case of some farms in Poland, where animal production has been reduced). Anaerobic digestion of organic residues and wastes in agriculture is based on locally

* if treated in a thermophilic process, above 60 degrees Celsius, disease germs disappear in 6-10 hours.

available row materials. Its product (biogas) and by-product (fertilizer) can be successfully used on farms, not causing logistic problems. This is very important, especially in a case of insulated areas. The use of on-farm digested material as fertilizer is the indispensable element for practical feasibility of investment. Instead, the centralized biogas plant is able to expect the scale merit of a building, but needs to consider original problem of collection of a material, sanitation processing of digested manure, a janitor and so on (Ishikawa *et al*., 2006).

Biogas, if not produced from dedicated energy crops, does not compete directly or indirectly with food production. In a case of biomass production for energy purposes direct competition consists in reduction of area used for food or forage crops. However also in a case of straw used as a fuel there is an indirect form of competition. As a result of burning straw, less of organic matter is given back to the soil. This brings about the deterioration of fertility causing diminution of yields. This is not the case of biogas, because organic matter in form of digestat is used as an organic fertilizer. This is very important for many developing countries, suffering deficit of food. Al this makes production of renewable energy from the biogas more convenient as compared to use dedicated energy crops for this purpose.

Most of developing countries are located in hot climate zones. This is a favorable factor for biogas production, because the methane fermentation needs high temperatures to be efficient.

Above mentioned advantages cause that microbial conversion of manure and other organic wastes to biogas has become one of the most attractive technologies for energy production, resource recovery, and waste treatment. The reason why the existing potential is not sufficiently used is existence of several barriers impeding the implementation of biogas plants. Among the most important are economic barriers:

- inadequate payback of investment inputs –the economics do not justify the enterprise for beneficial use of biogas;
- scarcity of available capital or existence of more pressing needs for limited financial resources;
- small scale of production –supply of raw materials too small to justify a biogas plant project ensuring efficient production.

Also human factors (insufficient level of know-how) should be taken into account. Other barriers: such as legislation and fiscal policies have different nature in particular countries and will not be considered here.

Above-mentioned and other barriers are especially burdensome in countries without advanced experience in biogas production. Therefore, transfer of technology and knowledge is very important. Japanese experience seems to by very useful. In Japan there are biogas plants using manure as a raw material in spite of small size of farms in the country. Most of them produce electricity or electricity and heat (Aoki *et al*., 2006; Li and Koboyashi 2010). High state-of-art and experiences achieved in implementation of agricultural biogas plants under difficult conditions of small size of farms in Japan are crucial from the point of view of developing countries and very useful for Poland, where most of farm is small and only 6.8 % of farms with cows have 20 or more these animals.

Possible cooperation between Japan and beneficiary countries can be carried out on different levels. At the governmental level, the Ministry of Economy, Trade and Industry seem to be the proper institution from the Japanese side. Two divisions of the Ministry could be involved: Environmental Policy Division and Recycling Promotion Division. The nature of cooperation would be mostly policy solutions promoting technology transfer.

Very important is the participation of scientific institutions in the cooperation. The experience of Japanese Universities and Research Institutes can be very useful to overcome different barriers hampering the development of biogas productions. Among such institutions are: the National Institute for Environmental Studies, Obihiro University of Agriculture and Veterinary Medicine (Department of Animal Science), Rakuno Gakuen University (Department of Dairy Science), Agricultural Experiment Station, Miyagi University (Department of Environmental Sciences), Osaka University, University of Yamanashi, National Institute of Advanced Industrial Science and Technology (Research Center for Life Cycle Assessment), Shibaura Institute of Technology and Hokkaido Perfectural Konsen Agricultural Experiment Station. The result of the cooperation could be extension of results of appropriate technologies for the utilization of liquid and solid waste and advisory activity in the field of choice of technologies most convenient under condition of particular co-operating countries.

The Shin-Norinsha Co. Ltd., now celebrating its 80th anniversary, could coordinate above-mentioned cooperation. The Company has magnificent achievements in promotion of agricultural development, especially in the field of farm mechanization, in Japan and developing countries through international exchange and establishing communication network in the world. Besides, the company publishes the scientific journal AMA, being the irreplaceable forum of exchange and dissimulation of knowledge on agricultural engineering, addressed first of all to developing countries, as well as other periodicals, books and scientific materials. The Shin-Norinsha supports also scientific research projects, business consulting, market survey and sponsoring various meetings and events, being very important factors of technology transfer.

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■■

Japanese Industry of Agricultural Machinery, R&D Institutions, Cooperation with Serbia

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Serbian manufacturers of agricultural machinery and equipment, R&D institutions and farmers are strongly interested in cooperation with Japanese partners. This can be realized and supported in few fields, further described.

Industrial Cooperation

Serbia has good agriculture and modest industry of agricultural machinery. It is not easy to imagine equipollent cooperation with Japanese manufacturers, but, it is, in some cases, possible and feasible. The industrial partners from Serbia can be successful component suppliers and can perform assembling of machines for the domestic market and exports in the region. There are also some marketing advantages of Serbia. Serbia has tax free trading agreement with Balkan countries, CEFTA, and same type of agreement with Russia.

The other opportunity offers by European Union declared Danube Strategy, macro region with more than 150 million of inhabitants. This region covers considerable agricultural areas of Europe and is big market for agricultural machinery.

Serbian industry of agricultural machinery and equipment consists, mostly, of small and medium enterprises. They are adaptive to the market requirements and, in cooperation with R&D institutes can relatively easily develop new products, not only for domestic market. Some of them are strongly export oriented. Major markets are countries in the region of Southeastern Europe, Russia and some African countries. Manufacturers are located in villages and small towns. Their activities strongly support development of economically weak rural areas of the country. Most of advanced manufacturers are members of regional clusters of machinery producers.

One of possible cooperation could be with Kubota, now also owner of Kverneland Group, both with high reputation in Serbia.

Joint contribution to developing countries

Serbian R&D institutions are qualified and have experience in development of low cost mechanization for small plots, special crops and specific farming. These, in cooperation with Japanese colleagues, can do productive advancements in many developing countries.

Good example is company Europrima (www.europrima.rs), manufacturer of special machinery and equipment for medicinal and aromatic crops, which exported in more than forty countries, in the region and world wide. Typical example is implementation of mechanized chamomile production in Egypt. This company is owned by former students of Faculty of Technical Sciences, and started with machines developed there.

For the developing countries developments related to environmental protection, and more specific, development of advanced production and utilization of renewable energy sources, especially biomass can be very interesting.

Governmental Support

Japan is well known as significant donor for developing and economically weak countries. Based on Serbian experience, all donations were given without any political or economic stipulation. The only prerequisite for it was to insure that this support will be delivered to jeopardized population.

In the field of agricultural machinery governmental support is very welcome in order to boost international cooperation and support developing countries. Some of activities could be:

1. Study on possible cooperation between Japanese and Serbian industry of agricultural machinery and equipment.
2. Support of cooperation between Japanese and Serbian R&D institution in the filed of agricultural machinery development for developing countries. Participation of Serbian researchers in ongoing and future projects. Scholarships for young researchers and similar measures.
3. Support of programs for on-farm development of machinery for agricultural production, as well as development of production and utilization of renewable energy sources in agriculture and rural areas in developing and underdeveloped countries.

Here mentioned activities are sound with profile and activities of AMA. These can contribute to the food security, fight against poverty and creation of better world in the future.

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EVENT CALENDAR

◆ **8th ISEN '13 Sendai**

—Advanced Science and Technology in Experimental Mechanics in Experimental Mechanics—

November 3–6, 2013, Sendai, JAPAN

http://jsem.jp/ISEM8

◆ **Agrex & Food Korea**

—Jinju International Agriculture & Food Expo 2013—

November 6-10, 2013, Jinju complez Stadium, KOREA

http://jsem.jp/ISEM8

◆ **Worldwide Opportunities in Engineering for Agriculture**

November 7, 2013, Harper Adams, UK

http://www.dbt.org.uk/dbtforum

◆ **AGRITECHNICA 2013**

—World's leading international exhibition for agricultural machinery and equipment—

November 12-16, 2013, Hannover, GERMANY

http://www.agritechnica.com/home-en.html

◆ **AEPAS**

—International Workshop On Agricultural Engineering and Post-harvest Technology for Asia Sustainability—

December 5–6, 2013, Hanoi, VIETNAM

http://www.j-sam.org/events/AEPAS_2013_2nd_Announcement.pdf

◆ **FIMA**

—38 International Fair of Agricultural Machinery—

February 3–6, 2014, Zaragoza, SPAIN

http://www.fima-agricola.es

◆ **42nd International Symposium**

—Actual Tasks on Agricultural Engineering—

February 25-28, 2014, Opatija, CROATIA

http://atae.agr.hr/

◆ **MCG2014**

—4th International Conference on Machine Control and Guidance—

March 18-20, 2014, Braunschweig, GERMANY

www.mcg2014.de

◆ **RHEA-2014**

—Robotics and associated high-technologies and equipment for agriculture and forestry—

March 21-23, 2014, Madrid, SPAIN

http://www.rhea-conference.eu/2014/

◆ **ADAGENG 2014**

—12th International congress on mechanization & Energy in Agriculture—

June 3–6, 2014, Cappadocia, TURKIYE

http://www.adageng2014.com

◆ **DLG-Feldtage 2014**

—One of the largest agricultural machinery exhibition in Germany—

June 17-19, 2014, Hannover, GERMANY

http://www.dlg-feldtage.de/en.html

◆ **AgEng 2014 Zurich**

—Engineering for improving resource efficiency—

July 6–10, 2014, Zurich, SWITZERLAND

http://www.AgEng2014.ch

◆ **Canadian Society of Biosystems Engineers CSBE**

—Joint International Meeting with ASABE—

July 13-16, 2014, Montreal, CANADA

www.asabemeetings.org/

◆ **12th International Congress on Mechanization & Energy in Agriculture**

September 3-6, 2014, Cappadocia, TURKEY

http://www.adageng2014.com/

◆ **18th World Congress of CIGR**

—International Commission of Agricultural and Biosystems Engineering—

September 16–19, 2014, Beijing, CHINA

http://www.cigr2014.org

Promoting Agricultural Mechanization in Nigeria through the Intervention of Japanese Government

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Nigeria, like most developing countries in Africa has an economy strongly dominated by the agriculture sector. Agriculture generates up to 50 percent of gross domestic product (GDP), contributing more than 80 percent of trade in value and more than 50 percent of raw materials to industries. Agriculture provides employment for the majority of the Nigerian people. Despite this domination, it is still grossly underdeveloped. Furthermore, not less than 40 percent of agricultural produce is lost owing to poor post-harvest handling, storage and processing methods. The low level of agro-technological inputs into agriculture has been cited as one of the main constraints hindering the modernization of agriculture and food production systems in Nigeria and Africa as a whole. Yields of maize and other staple cereals have typically remained at about one tone per hectare, which is about a third of the average achieved in Asia and Latin America. Whereas the population is increasing exponentially and this is accompanied by a rural to urban migration (FAO and UNIDO, 2008). Ensuring food security for the entire population is critical. But feeding the increasing urban population cannot be assured by an agricultural system that relies almost entirely on manual labor (Oni, 2011a).

Agricultural mechanization embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting, preparation for storage, storage, and on-farm processing. It includes three main power sources: human, animal, and mechanical. The manufacture, distribution, repair, maintenance, management and utilization of agricultural tools, implements and machines underscores the supply of mechanization inputs to farmers in an efficient and effective manner (www.unapcaem.org). Mechanized agriculture therefore is the process of using agricultural machinery to increase farm productivity. In modern times, powered machinery has replaced many jobs previously executed by men or animals such as oxen, horses and mules (en.wikipedia.org/wiki/Mechanized_agriculture). The history of Nigerian agriculture contains many examples of application of traditional tools like in most other African countries (Oni, 2011b). However, modern day farming is accomplished by the use of computers in conjunction with satellite imagery, Global Positioning Systems (GPS) and Geospacial Information Systems (GIS) guidance to increase yields. Besides improving production efficiency, mechanization encourages large scale production and improves the quality of farm produce. On the other hand, it displaces unskilled farm labor, causes environmental pollution, deforestation and erosion (en.wikipedia.org/wiki/Mechanized_agriculture).

The present state of agricultural mechanization in Nigeria is still far from increasing farm earnings and productivity. This is because mechanization policy has not been formulated following a well designed, reliable and thorough analysis (Nwoko, 1990). A study conducted in Nigeria (Olaoye and Rotimi, 2010) revealed that low production efficiency, drudgery, under utilization of mechanical power, and uses of old tractors with attendant periodic breakdowns during operation, contributed to low level of mechanization with level varying between 27.6 % and 40.3 %. The study further revealed a productivity of 0.0951 ha/kWhr on a farm size of 520 hectares and a productivity of 0.0115 ha/kWhr on a farm size of 88 hectares, respectively. An average physical productivity (crop yield) varying between 1.2 and 1.7 tones per hectare for maize and between 11 and 13 tones per hectare for cassava was also underscored.

Although mechanization can clearly influence production and the evolution of agricultural systems, its role in national development strategies has often been poorly defined. Nigeria is rated amongst the world's poorest countries (IMF, 1994 and UNESCO, 1991) despite her abundant natural and human resources. This is based on low gross national product (GNP), high unemployment rate, low income per capita, crippling national debt and high inflation rate. The overdependence on one product (crude oil) which is subject to the vagaries of international markets coupled with unstable political situation in the country has continued to make the future more bleak and precarious. Without proper development of engineering practice for enhanced mechanized agriculture, Nigeria cannot expect to effectively develop its economy, or improve the standard of living of its people.

With Nigeria's low level of agricultural mechanization practice it is doubtful if it would be able to meet its future demands if her agricultural mechanization level remains in the rudimentary state. Japan with her fast developing technologies in the area of agricultural mechanization can contribute to uplifting Nigerian agriculture through well articulated and sustainable developmental policies in agricultural mechanization. There are presently several Japanese companies that are into research and development and manufacture of agricultural tractors and implements for home use and international markets. Several developing countries including Nigeria have benefited from technologies imported from Japan through bilateral cooperation such as JICA (Japan International Cooperation Agency). This would continually alleviate farmers from the tedium of use of hand hoes and cutlasses.

Nigeria in her present state would also appreciate the cooperation of Japanese government in setting up tractors and implements manufacturing companies in Nigeria which would further empower young Nigerians and thereby reduce the high poverty and unemployment rates prevailing in the country today. This would also be in perfect agreement with the Nigerian government's Agricultural Transformation Agenda currently being driven by its Federal Ministry of Agriculture and Rural Development. With the setting up of these manufacturing companies in Nigeria, the country also stands the chance of increasing her agricultural mechanization level through the involvement of tractorization in every part of the country. Moreso, most of the problems faced with the non-availability of tractor and implement spare parts in Nigeria would be solved as these companies would make available the tractor and implement spare parts. The cooperation of the Japanese government in helping to boost the level of agricultural mechanization practice through its journal outlet of AMA published by Shin-Norinsha Co., Ltd in Japan has remained a veritable source of agro-technological information and innovations that has transformed agricultural practices in most countries of Africa, Asia and Latin America. It would probably remain so for several years to come.

As Shin-Norinsha Co., Ltd of Japan celebrates 80th anniversary, the Nigerian contributors to AMA salute the President and Editor-in-Chief, and indeed the entire staff of the Company for the milestone it has recorded in the transformation of world-wide agriculture through the activities of the company and technical information dissemination by AMA.

Congratulations!

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Successful Mechanization of Smallholder Agriculture –Opportunities for Cooperation and Partnership between Africa and Japan

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Introduction

This is an auspicious and opportune time to put a spot light on Africa's economic relationship with Japan, and there are several good reasons to do so. As I am writing this article in the last week of May 2013, African leaders are meeting in Kyoto with their Japanese counterparts to discuss existing and economic ties. Over the decades, Japan has maintained a friendly economic relationship with Africa and African countries. The works of Japan's international development agencies and organisations such as JICA and Sasakawa Africa Foundation are widely recognized for their efforts in promoting scientific cooperation and trade, and the adoption of modern agricultural technology in many African countries. The anniversary of the 80th anniversary of Shin-Norinsha Co. Ltd, a truly global and formidable key role player in agricultural mechanization machinery appropriate for countries in Asia, Africa and Latin, is also a time to celebrate and recognise the critical role of agricultural engineering and mechanization in sustainable agricultural and economic development.

Surprisingly, the African continent (the least developed region of the world) and Japan (a modernized, developed and industrialized economy) have a lot in common, at least historically, when it comes to the challenges of agricultural development. Many researchers and observers alike have blamed the predominance of small-scale agriculture as a major obstacle to the introduction of modern agricultural technologies such as mechanization into African agriculture. While it is true that smallholder agriculture in Africa needs to be transformed into industrial agribusinesses in efforts to tackle widespread poverty and rampant food insecurity, the Japanese experience in transforming its smallholder agriculture into knowledge intensive mechanized enterprises is of particular interest to Africa. Until the 1970s, Japan's agriculture was dominated by small-scale family farms, often less than 2 ha per household. Through a combination of targeted and favourable agricultural development policies coupled with investments in new knowledge and technological innovation, the yield of staple crops (mainly rice, wheat and barley) and overall productivity of land and farming inputs increased dramatically. Consequently, rural agricultural Japan was mainstreamed into the national economy. By the 1970s into the 1980s, through widespread adoption of mechanization and other improved agricultural technologies, drudgery was removed from farming and all operations could be completed on time and more efficiently, thereby allowing more members of rural farming families to take up more financially lucrative off-farm employment in the urban areas.

Smallholder Agricultural Mechanization in Japan –A Success Story

The fascinating and remarkable success of the modernization of its smallholder family farms is a true reflection of the major changes undergone by Japan agriculture during the past half-century, with the biggest change occurring in efficiency of operations. The development, adaptation and application of new scientific and technological innovations have made Japanese agriculture among the most productive in the world. Mechanization and automation, widespread use of agrichemicals such as pesticides and fertilizers, novel environmental and soil management practices, and industrialization of agriculture have made it possible to achieve high crop yields and increase production at small, intermediate and large scale farms. From an African perspective, the successful and profitable mechanisation of small scale agriculture in Japan, especially rice paddy, is particular interest given the predominance of smallholder agriculture in Africa.

A look at the state of agriculture and economic development in Sub-Saharan Africa (SSA) paints strikingly different pathway and outcome. The region still accounts for the majority of global underdevelopment statistics: from food insecurity and malnutrition to infant mortality, from high incidence of infectious diseases and death due to malaria and HIV/AIDS to low human development index and widespread poverty. The majority of Africans still live in rural areas practising agriculture for their livelihood. While agriculture remains the main source of employment and income for the majority of people in SSA and the region accounts for over 60 % of global uncultivated agricultural land, it also records the lowest crop yield and productivity compared to other parts of the world. This is particularly unsurprising given that, to date, African agriculture has barely benefited from the modern technological innovations that have turned agricultural productivity around in upward trend in Japan and other developed countries.

Although many researchers and development experts have deplored the state of African smallholder farmers and the prevalence of poverty among them, and offered various reasons for this situation, the truth of the matter is that they have remained agriculturally undeveloped while the rest of the economy have transformed in some measures in response to the changing socio-economic aspirations of the people. Some development practitioners have talked about the apparent high output per input of smallholder farmers compared with large scale industrial farmers, and the unique and wonderful values of smallholder farmers as repositories of indigenous agricultural knowledge. Be these as they may, these values do not offer much help to the rural resource-poor farmer confronted with the complex problems of climate change, global competition, rapidly declining soil fertility, new and emerging pests and diseases, high incidence of postharvest food losses, rising urbanisation and impacts on farm labour scarcity, and public concerns about environmental protection and resource conservation.

The successful mechanization of its agriculture –including small, intermediate and large farms– is arguably one of the most internationally recognised stories of Japanese agriculture and industrial revolution which occurred during the past 50 years. This occasion of the 80th anniversary of Shin-Norinsha Co. Ltd., the parent company of Farm Machinery Industrial Research Corporation –publisher of Agricultural Mechanization in Asia, Africa and Latin America (AMA)– is an opportune moment to acknowledge and celebrate both the success of Japanese agricultural mechanization endeavour and the company in particular. While researching, producing and marketing a wide range of innovative machinery to support agricultural mechanization in Japan and around the world, the publication and global circulation of AMA provided a unique and special international forum for the dissemination and promotion of novel ideas and technologies on agricultural mechanization. Latest information on the status and trends in agricultural machinery in Japan and the regular and incisive editorials of Mr Yoshisuke Kishisda (AMA Chief Editor) always provide much needed fact, inspiration and hope for researchers and practitioners of agricultural mechanization for sustainable agricultural development.

Agricultural Mechanization for Food Security in Africa –Opportunities for Cooperation and Partnership

As we celebrate these successes and usher in another half century of continuing success for Shin-Norinsha Co. Ltd and AMA, it is also time to reflect on the opportunities that lie ahead for collaboration and partnership between Japan and Africa in the areas of agricultural mechanization for sustainable economic development. So much has been talked about Africa's abundant natural resources –especially agricultural land and fresh water – which need to be sustainably exploited to achieve food security and reduce poverty in the continent. In contrast to the not-long-ago view of Africa as a hopeless dark continent, there is now widespread global optimism and recognition among the private sector and governments around the world of Africa as the "rising continent", which offers tremendous high rates of return in investment and which also has the potential to feed the growing world population. Similarly, African leaders expound the philosophy and vision of the "African Renaissance", a continent that is open for business. In support of this vision of a new Africa and new agriculture, African leaders have committed to invest at least 10 % of their country GDPs to agriculture development. During the past decade, millions of dollars have been invested by global food chains and foreign governments to bring hundreds of thousands of new agricultural land into production in Africa. Surely, these new large scale agriculture enterprises will not depend on the same simple hand tools employed by millions of smallholder farmers. Successful agricultural intensification and cultivation of new large areas will require investments in new knowledge and technological innovations, including agricultural machinery.

While the new optimism about Africa and African agriculture by both the public and private sectors are most welcome, I should hasten to add that like other continents (and countries) that have already gone through this path, Africa's economic development and related efforts to reduce poverty will remain a mirage if agriculture remains undeveloped and does not undergo major structural and technological reform. The mechanization of agriculture **at all levels** –while not the panacea for all challenges limiting the realisation of Africa's green revolution– must be viewed and implemented as a necessary condition for success. As Africa's predominantly rural farming population age fast and urban population continues to grown unabated with the potential to exceed rural population in many countries in the next decade, a new and bold approach is needed to address the looming agricultural labour shortages and decline in food production. Related to these also is the need to create employment opportunities in the new agriculture for the millions of educated but unemployed African youth. Africa needs to create new jobs for it burgeoning youth population. The development and promotion of knowledge intensive agriculture, which includes appropriate use of modern agricultural machinery to remove drudgery and enhance productivity, is certainly part of the solution.

It is estimated that the global agricultural machinery industry generated more than US$ 56 billion in 2010, and the market is projected to grow at about 8 % annually through 2015 to reach almost US$ 81 billion. With rising global population, mainly in SSA and other least developed regions, it is also expected that economic growth and rising disposable income will require major increases in food production to meet future demand. Rising disposable incomes and improvements in living standards are known to heighten demand for protein-rich foods and spur the need for more and new agricultural food products. To increase food production to meet future demand in Africa and around the world, it will be necessary to reduce postharvest food losses and waste, intensify production on existing land and to cultivate additional agricultural land, especially in SSA where most of global uncultivated farm land exists. Both last two approaches to increasing food production will require investment in new agricultural machinery, including tractors.

A brief look at the status of agricultural machinery and irrigation technology in Africa reveals the huge deficit and tremendous potential that lies ahead. Analysis show that the number of tractors (per 1000 ha) is lowest in Africa (28) compared to the average (241) in nine developing countries in other regions (**Table 1**). Like the time of our forbears centuries back, the human muscle remains the main source of power in African agriculture, accounting for over 65 %. While other developing regions have invested in the application of improved engine (tractor) power to promote and accelerate agricultural development, the increase in tractor numbers in Africa between 1961 and 2000 was

Table 2 Growth in numbers of tractor in Africa and other developing regions (1961-2000)

Region	Increase (%)
Sub-Saharan Africa	28
Latin America and Caribbean	469
Asia	500
North Africa and Near East	1350

Source: FAO, 2004, Agricultural Mechanization in sub-Saharan Africa.

Table 1 Status of agricultural mechanization and cereal yield in Africa compared to other developing regions

	Power source (%)			Tractors (per 1000 ha)	Irrigation (% of arable land)	Fertilizer use (kg/ha)	Region cereal yield (kg/ha)
	Engine	Animal	Hand				
Africa/SSA	10[&]	25[&]	65[&]	28[*]	5[*]	13[*]	1040[*]
Average of selected countries	50[**]	25[**]	25[**]	241[#]	38[#]	208[#]	3348[#]

[&]SSA; [*]Africa less Egypt and Mauritius; [#]Bangladesh, Brazil, China, India, Pakistan, Philippines, Republic of Korea, Thailand, Viet Nam; [**]3 other developing regions –Asia, Near East and North Africa, Latin America and Caribbean. Sources: World Bank, World Development Indicators, 2007 (Table 32); FAO, 2005, World Agriculture, Towards 2015/2030 (Table 4.16).

only 28 % compared with 500 % in Asia (**Table 2**). The cocktail of inadequate and inefficient farm power and machinery sources with the lack or very limited use of yield- and productivity-enhancing inputs such as fertilizer and irrigation contribute to the low crop yield prevalent in many parts of Sub Saharan Africa (**Table 1**). Given the huge deficit in agricultural machinery application in African agriculture, it is expected that the agricultural machinery market growth in Africa and other developing countries will make up for slowing growth in developed countries in the years ahead.

Africa and Japan have a lot to gain from cooperation and partnership in the ongoing Africa's green revolution journey. This includes bilateral activities on specific issues addressing the policy frameworks for developing a lucrative agricultural industry that employs modern technology to create new value in agricultural products and services as well as provide employment opportunities. African bureaucrats will benefit from deeper understanding of Japanese experiences on key policy initiatives such as those which supported agricultural mechanization, development of the machinery industry, and the widely acclaimed national agricultural cooperative network which enabled farmers to access market for their products. SSA is still the only predominantly agricultural region which lacks functional and robust agricultural machinery testing centres, where the performance of technological innovations in agricultural mechanisation can be rigorously evaluated and standards can be established based on scientific evidence.

Conclusion

The development and promotion of an agricultural technological innovation system, which includes agricultural mechanization and agro-processing as important elements, is needed to ensure the development of new knowledge to address the multi-faceted challenges facing agriculture in Africa and globally. African countries and Japan as well as their private sectors and professional associations should deepen and strengthen their engagements and dialogue to identify and implement joint projects of mutual interest to promote the development and adoption of technological innovations to improve agricultural productivity and value chains in an ever increasingly climate sensitive and environmental sustainable world. The recently formed African Network of Agricultural Engineers (AfroAgEng) provides a timely platform for dialogue and networking with similar agricultural engineering associations and other engineers in Japan during this exciting time in Africa. Let us cooperate in partnership to advance agricultural mechanization and related agricultural engineering technologies as instruments to banish poverty and hunger and promote sustainable economic development in Africa.

As we celebrate the global success and impact of Shin-Norinsha Co. Ltd on agricultural mechanization against the backdrop of Japan's remarkable achievement of successfully transforming its traditional small scale family farms to usher in a modern, diversified industrialised country, may we also toast Africa's green revolution in our life time with some credit to the cooperation and partnership between Africa and Japan.

■■

Assistance in Promotion of Agricultural Mechanization in Developing Countries

by

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Abstract

The economy of almost all developing countries and their huge amount of population depend on agricultural products. The implementation of machinery for agriculture in developing countries should increase gross agricultural production. Agricultural land is not sufficiently cultivated to a sufficient extent and quality. This is due to the fact that farmers cultivate in a primitive way. There is amount of land that because of low yields per hectare is not enough to cover the minimum food requirements of the population. Insufficient is also the level of post-harvest processing. This paper highlights the importance of modern farming mechanization in agriculture and the subsequent agricultural production and processing, including preparation of manpower.

Introduction

World population is still growing. Population growth means a growing demand for food. This is especially true in developing countries, where the largest population growth is expected. One of management problem of developing countries is first of all wrong priority setting. In many of developing countries, head of states come to power by state coup which leads to inappropriate management of the government and give priority to “a tank than a tractor”. The budget is dependent partially on foreign aid and often creating a misallocation in the field of science and technology especially in the modernization of agricultural production for subsistence population. Unfortunately these problems still continue in the 21st century.

Importance of Mechanization for Agriculture

The implementation of machinery for agriculture in developing countries should increase gross agricultural production. Many developing countries have enough suitable land for growing grain, which is the basis of subsistence of the population. There is amount of land that because of low yields per hectare is not able to cover the minimum food requirements of the population. Agricultural land is not sufficiently cultivated to a sufficient extent and quality. This is due to the fact that farmers cultivate in a primitive way.

Since the beginning of industrial development, replacement of human labour and draught animals in agriculture with machinery has occurred worldwide, but there is a big gap between industrialized and developing countries in this respect. Agricultural mechanization includes three main power sources: human, animal, and mechanical. The manufacture, distribution, repair, maintenance, management, and utilization of agricultural tools, implements, and machines is covered under this discipline with regard to how to supply mechanization inputs to the farmer in an efficient and effective manner (Stout *et al*., 1999).

In many developing countries, agricultural production and food security are adversely affected because of insufficient use of farm power, low labour productivity, or labour scarcity. The need to improve agricultural labour productivity is increasingly recognized. In this context, three principal purposes of mechanization may be summarized: to increase labour productivity, to increase land productivity and to decrease cost of production (Stout *et al*., 1999).

Agriculture will have to supply not only food, but also other materials such as bio-fuels, organic feedstock for secondary industries of destruction, and others. Furthermore, new agricultural technology is also expected to help reduce environmental destruction. Agricultural technologies are especially important in developing regions of the world where the demand for food and feedstock will need boosting in parallel with the population growth and the rise of living standards (Kitani, 1999).

There is a certain discrepancy between the trend in the design and manufacture of agricultural machinery on the one hand and the size of farms in developing countries on the other side. The larger machine has usually higher efficiency and lower specific costs. The size of farms in developing countries can differ, but generally, the majority of farms include very small farms, usually with average size less than one hectare.

Based on recent results and findings, Shambu and Jha (2012) formed a conclusion that the main constraint in farm mechanization was lack of an extension programme, farm road, and availability of implements and consolidation of land holdings. If this were improved through joint efforts it could be a boom for larger extant of adoption of farm machinery and implements and, simultaneously, help in increasing the farm mechanization process.

Importance of Postharvest Technology and Food Processing

Very important role plays in agriculture postharvest technology and processing. Postharvest treatment largely determines final quality. According to Gustavsson *et al.* (2011) about one third of produced food is not consumed.

In developing countries, most food losses occur during the harvest and storage. For this reason, improving postharvest technologies in developing countries represents a priority area for improvement the situation in the whole food production chain. Food losses are often caused by nonsufficient post harvest operations such as drying, storage and processing. The not sufficient level is also in the logistics, like transport, handling and products distribution.

Extension Service and Pilot Projects

The application of agricultural mechanization in developing countries has been sometimes criticized because it often has failed to be effective and has been blamed for exacerbating rural unemployment and causing other adverse social effects. This was largely the result of experiences from the 1960s until the early 1980s, when large quantities of tractors were supplied to developing countries either as gift from donors or in very advantageous loan terms.

In particular, projects that were designed to provide tractor services through government agencies had a miserable record. These experiences often combined with a very narrow perception and lack of knowledge about mechanization. At the same time there are many examples in which mechanization has been very successful (Stout *et al*., 1999).

The essence and the main direction of the solution that boosts the mechanization in agriculture field have to focus on sample firms. The firms are significant in terms of modernization of agricultural technology and scientific knowledge which represents prototypes of the state for agricultural production. These companies should simultaneously be a training centre for workers of all similar professions. Mechanization of work in field production provides users many advantages, but in developing countries also considerable concern with the maintenance of machineries in working condition. Another problem is the use of technology in field's leads to very rapid depreciation of equipment and reduced lifetime. It is primarily due to the lack of prevention. There is less equipment in workshops; low-skilled personnel cannot eliminate complex failure. Unqualified level personnel and lack of spare parts leads to premature depreciation of machinery and tractors.

The main aim of a pilot project is to introduce suitable modern technology of agricultural machinery and equipment as a sample and operate other pilot projects through different parts of the regions. In the case of the machine or equipment successful application will be extended by extension agencies. This can facilitate that these trainers would then conduct national training courses for front-line extension workers. This can make it possible to adapt content to national and local conditions and to train the extension staff.

Education and Man Power Preparation

The case for low level of agriculture is the low level of skill of personnel. Developing countries have lack of skilled workers-the labourers, high school students and engineering professionals in the field of mechanization of agriculture.

Technical condition of agricultural equipment and its changes through time significantly affects two categories of workers. Primarily, the workers who operate on machinery during its operation, which means –operators, drivers and similar professions. The other group of people directly active with machinery is staffs that ensures the maintenance and renewal of the technical conditions, i.e. handyman, service workers and repairers.

The qualification of operators, working on the machines is different, i.e. average or very low.

Trainings are generated on short-term and various courses. Technical tradition in developing countries is very weak, so obtained knowledge are often shallow. This means, during the operation it could lead to interruptions, and thus reduce the quality and efficiency of work and reducing the life of machinery and high failure rate.

The basic concept of personnel training and consideration of priorities should be based on the following considerations. Experiences of many developing countries show that the need to pay close attention to the problems what should be qualification of qualified labourer –high school student/University student; to whom should be given a priority in solving (at which level and where to begin) and in what forms to be achieved.

Graduates and high school students, even assuming that the gain qualifications are in direct production activities are very difficult to fully exercise as low standard of professional workers. The university graduate or high school graduate itself usually does not have enough practical experience and artisanal craftsmanship.

Perfect knowledge of blue-collar workers cannot be replaced by other means. Ideas about that, for example, an engineer must operate perfectly all the knowledge of lower-secondary school categories of workers and labourers have their skills and professional habits are currently completely naive and outdated. Each category has its indispensable position.

Excellent engineer without qualified worker is unlikely to good use. It has, therefore, to consider whether it would be expedient to secure for the mechanization of agriculture in general, for the maintenances, diagnosis and repair separately education mainly blue-collar workers.

Conclusions and Recommendations

There are many important tasks to solve in the agricultural mechanization in developing countries in the future. Main important problems for the development in developing countries are mechanization technology and equipment used for main local crops, irrigation, protected cultivation, constructions for livestock production and postharvest technologies.

Important role of developed countries should be in help to enhance the education, especially in the form of practically oriented vocational education and training for apprentice focused on the area of agricultural technology. New application of knowledge should be verified in pilot projects on which should primarily teach practical knowledge and further expand in the country in the form of extension service.

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What does this have to Do with Agricultural Engineers and this Magazine, AMA?

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I am privileged to live in one of the world's wealthiest countries. Yet I am learning that, on average, Australian youth today are unlikely to have as long a lifespan as their parents. Their lives will not last as long as the present generation. The reason: (it is embarrassing to admit) we in Australia have an obesity epidemic; we are not eating sensibly. Now what does this have to do with agricultural engineers and this worthy magazine, AMA?

A great deal, as a matter of fact. Good farm machinery engineering is all about efficiency. And the same factors that govern efficiency, durability and economics in machinery apply to our bodies, the most wonderful machines of all.

I want to unashamedly state that the rule to good health, long life, the counter to obesity and the key to agricultural resource efficiency and environmental sustainability is: moderation and the vegetarian lifestyle.

Vegetarians avoid eating meat. We don't need it. Eating red meat in particular isn't good for you. And as for efficiency, consider this: growing animals for meat is an unwholesome business for individuals and for the planet.

We have finite land, water and energy resources. We need to manage these resources in the best possible way. Lifestyle changes are necessary, especially in affluent "Western" societies. At the same time, we need proven and appropriate technologies and suitable machinery to make the most efficient use our food-producing limited capital: land, water, energy. The vegetarian alternative –a plant-based diet– not only prolongs life but is crucial for agricultural sustainability and every other aspect of our environment.

My wife and I have been vegetarian for over fifty years. It's been an economical lifestyle too! What is disappointing is to see the short-sighted Westerners and meat promoters pushing bad choices on people, especially the youth, in developing economies. Where there are poor people they don't need meat! That's a complete fabrication. There is absolutely no excuse for promoting meat consumption in places where crops like soybeans and protein-rich leguminous plants, seeds or nuts can be grown. Growing leguminous crops can take less than one-tenth of the land, water and energy that it takes to produce the same amount of protein through animals.

To cap it off, large scale vegetarian lifestyle adoption would make an enormous contribution to solving the "obesity crisis" and to reducing spiraling national healthcare costs everywhere.

You can read about three societies –the Seventh-day Adventists of Loma Linda, the Sardinians and the Okinawans –societies with the world's highest proportion of centenarians– in National Geographic, November 2005 and in the book "*The Blue Zones: Lessons for Living Longer From the People Who've Lived the Longest (2008)*" that was a sequel to that issue of NG.

The Seventh-day Adventist movement –of which Dr Quick is a member– promotes the vegetarian lifestyle and considers good health as the "right arm" of their program. Adventists operate health clinics and lifestyle programs globally and run businesses producing vegetarian foods on all continents. Dr Quick is a co-editor of AMA also the cofounder of the Asian Agricultural Engineering Association, now lives in his home country Australia. He was for six years the leader of IRRI's agricultural engineering division in Los Banos, Philippines.

■■

Need of Public and Private Partnership for Sustainable Agriculture in Developing Countries

by
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It is my pleasure to contribute in the celebration of the 80th anniversary of the Shin Norinsha Company's existence as a leading manufacturer and distributor of agricultural machines.This company has been on the fore front in propagating the new technologies in Asia, Africa and Latin America through the publication of the AMA journal. As we have entered the 21st century, the world has seen the turmoil/suffering of the human race not only due to war and terrorism but also due to erratic climate changes, resulting from global warming. So today's scientists and engineers do not have to only produce enough food, fibre and biomass for ever increasing population but see that the environment we live in is clean and remain clean for years to come.

The responsibility lies with the governments and the private entities to work together so that the productivity of the land and labour get enhanced to meet the demand of an ever increasing population. In order to achieve that objective innovative technical input in agriculture is needed more so among the developing countries. The energy input in agriculture is very much limited in many developing countries, which limits the realization of the full potential of the land and labour alike. One should also realize that the industries must invest in the establishment of skill training centres, so that the technicians/engineers have the right training to meet the future demand. It is estimated that by 2050 the world population may cross the 9 billion mark and feeding them would be a big challenge to the governments and non-government agencies throughout the world. Another thing the governments in the developing countries can do is to exempt taxes on imported agricultural equipment for subsistence farmers in those countries. I have seen the subsistence farmers in Swaziland and Papua New Guinea struggling with old hand tools and animal drawn equipment and it is a back breaking farm work. The related agencies must see that the safety of workers engaged in agriculture is taken care.

In addition to the production, processing of crops, storage, distribution and marketing are becoming more important than ever before and therefore, regulations observed by the government agencies must be appropriate, safeguarding the health of general public. The public needs agriculture and agriculture cannot develop without the application of proper science. For example, mold contamination during storage of all edible cereals, legumes, oil seeds and ready to eat food products must be thoroughly studied and guidelines adhered to. This should be done in all the countries as far as possible for the sake of the consumers. I am sure industries and governments shall take such responsibilities seriously, in the public interest and Shin Norinsha as a company will strive for it as it has done in the past.

■■

Industrialization and Tourism as Strategies for Promoting Agricultural and Fisheries Mechanization in the Philippines

by
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Agricultural mechanization in the Philippines has long been the subject of debates among sociologists, economists and engineers who however, agree that agricultural mechanization is needed for agricultural productivity and increased production. The overriding reason against pushing mechanization is its labor-displacing consequences, particularly in rice farming.

Thus, the Philippine government has treated agricultural mechanization with laissez faire attitude and has let mechanization proceed under its own course to be influenced only by market forces. Nevertheless, the government has supported institutions and programs like the Agricultural Mechanization Development Program (AMDP), the Agricultural Machinery Testing and Evaluation Center (AMTEC), the Philippine Center for Postharvest Development and Mechanization (PhilMech), the Rice Engineering and Mechanization Division of the Philippine Rice Research Institute and the Agricultural Engineering Division of the Bureau of Plant Industry. Yet, the Department of Agriculture is planning to create the Bureau of Agriculture and Fisheries Engineering. The government has also supported machinery design and mechanization research projects in agricultural state colleges and universities as well as inventions and creative science projects related to agriculture and fisheries.

From 1970 to 1995, the small-scale machinery fabricators produced the first commercial prototypes of machines designed by the Agricultural Engineering Division of the International Rice Research Institute (IRRI). Among such prototypes were the power tiller and the axial-flow thresher, which have become popular in the rice-producing countries. From 1979 to 1991, the Philippine government had hosted in Los Baños the headquarters of the Regional Network for Agricultural Machinery (RNAM), a UNDP-supported project initially by eight Asian countries and executed by UNESCAP. RNAM was instrumental in the exchange of technical information on many aspects of agricultural mechanization among the participating countries. RNAM evolved into the present UN Asian and Pacific Center for Agricultural Machinery and Engineering (UN-APCAME) based in Beijing.

The lack of an industrialization policy and strategy, particularly manufacturing, which will create employment in the rural areas, has induced traders to supply farmers with imported machinery and power units. The establishment of an engine manufacturing industry however, has never been in the plans of the importers for their tired reasons of lack of market and incapacity to compete with established companies in Japan, US and Europe. Importing them was easier, more lucrative and less risky for traders but hardly created jobs directly in the rural areas.

Being first in Southeast Asia, the pioneering pilot manufacture of a 10-hp diesel engine was started in the mid-1970s by a private company in collaboration with a Japanese car manufacturer, which provided technical backstopping. An initial 10 units of tested working prototypes were produced. The initiative had full support of the government, which then had vision of industrialization patterned after Japan. Unfortunately, the production stopped when a new government took over in 1986. In the meantime, neighbouring countries have been producing engines in collaboration with Japanese manufacturers and the Philippines has been a lucrative market for them, proof that belies the reasons given by the supposed leaders of the agricultural machinery manufacturing industry. In fact, an engine manufacturing industry could have spurred the manufacture of motorcycles of which the Philippines has imported more than one million units from the neighbouring countries.

The rationale behind the cool treatment for industrialization has been that agriculture, in the minds of policy and decision makers, takes precedence over industry since the Philippines is basically an agricultural country rich in natural resources. However, they ignored the recurring weather calamities and the risks involved in agriculture, which could be mitigated with mechanization, local manufacture of machinery and all-out support for the manufacturing industry to support agriculture. They argued that agriculture should be developed first before industry and made as employment sink of the mass of unskilled rural workers. They also argued that the buying power of the farmers and rural workers must be enhanced through agricultural production to purchase the outputs of industries. Thus, manufacturing industry initiatives in general have been pushed to the backburner.

The expectations of the economic planners and decision makers however, were not to be realized for several decades. Quite the reverse happened. Poverty and the poorest of the poor have always been highest among farming families and fisher folks in the rural areas as a result of being destined to work in agriculture and fisheries. Rice self-sufficiency has been an elusive goal although the few token exports during the few years of good-weather harvest served to extend political mileage. Rice shortage always meant political career disaster.

Unlike in the other industrialized and industrializing countries, the manufacturing industry in the Philippines has not developed as comprehensively as it should in spite of the fact that among the Southeast Asian countries it pioneered in industrialization. In 1948 or three years after WWII, the president of the republic pushed for industrialization which placed the Philippines as an economic power second only to Japan in Asia and had high quality education by the mid-1950s and early 1960s. In just two years into his term, basic manufacturing industries produced oil, chemical, cement, jute, iron and steel, textiles, glass, nail, incandescent bulbs, toilet soap, rubber tires, plywood, kettles, tableware, pencils, etc., which were common items but were imported during those years. By the last year of his term in 1953, an additional 165 tax-exempt factories had begun manufacturing articles that were formerly imported. Importers naturally opposed such show of support for local manufacture. Demolition media supported by importers and traders succeeded in his not getting re-elected as president.

Although modest by today's variety of goods, the industrial production then was a boost to the economy. The manufacturing industries provided employment to the yet sparse population and there was relative prosperity compared to other Asian countries. Unfortunately, the envisioned industrialization was not pursued by the succeeding administrations which were distracted by agrarian unrest, peace and order, corruption and food security political issues, among other concerns in governance precisely because of the high rate of unemployment. Thus, the setting up of industries lagged behind the other Asian countries, which ironically probably used the Philippines' initial success as model. In the meantime, the burgeoning population could not be employed locally. Many skilled and knowledge workers sought employment abroad but majority of rural labor either remained jobless or were destined to be low-waged farm workers yet expensive for farmers who hire them because of their low productivity.

Finally, the passage of Republic Act No. 10601 or the Agricultural and Fisheries Mechanization (AF-Mech Law) on June 5, 2013 is expected to simultaneously change the landscape of agriculture production areas with mechanization and that of the countryside with manufacturing industries.

Lessons from the industrialized countries in East Asia and from the highly mechanized rice agriculture of a least developed country in South Asia: their industries were meant to support agriculture –not the other way around

Up until the early 1960s, Japan as well as the Philippines and the other Asian countries used manual labor and animal power in agriculture. Japan however, bolted forward ahead of the pack because of its industrial development background. Japan started industrializing in the 1870s when it embraced the industrial revolution. During the Meiji period, it had a massive program of sending Japanese students for technical studies in UK and US and hired Westerners to teach modern science, mathematics, technology and foreign languages. The Philippines had undergone similar development activities under the American education heritage. Unfortunately, that heritage did not provide a Filipino culture for industrialization and full development of related technical and engineering knowledge and skills and instead encouraged the "soft" industries like law profession that formulated debilitating bureaucratic procedures and requirements as well as trade and business that benefited mostly only the professionals and the highly educated.

It was only in 1948 that the leadership envisioned an industrialized country similar to the US and this was started vigorously amidst the short-sighted political opposition and probably American influence that provided for developing agriculture first instead of simultaneously with industry.

Japan's initial industrial outputs of engines, vehicles, airplanes, ships, weapons and other war materiel were used to support its WWII campaign during the early 1940s. After WWII, Japan utilized the engines it had developed for the military to power irrigation pumps, rice threshers and rice mills, giving it an edge over the Asian countries.

During the mid-1960s, Japan started to support its agriculture by locally manufacturing power tillers and other machinery through adaptive design and development of technologies from industrialized countries. For example, the power tiller, which replaced horses and cattle in small paddy field farming, was initially adapted from the original bulky rotary tiller, called "Rotavator" from UK and later improved by adaptations from the small garden tractor, called "Merry Tiller" from the US. The Japanese did not mind the criticism of initially producing low quality goods but after gaining manufacturing experience through copying and adapting, became proud of the label, "Made in Japan." Further development of farm mechanization supported by industry resulted in the scarcity of farm labor leaving behind the elderly and women to tend the small-scale farms. Some younger office employees had to work their own farms part-time.

Japan's steel industry included the basic smelting plants for which the iron ore feedstock had to be imported probably from the Philippines that would import back the processed iron ingots. By the mid-1960s Japan was manufacturing cars, electronic and other high-technology items and most importantly, agricultural machinery to support its agriculture.

Quite the opposite of South Korea and Taiwan, which essentially followed the footsteps of Japan in industrialization and agricultural mechanization to develop its agriculture and be food secure, the Philippines did not pursue agricultural mechanization because depriving the large farm labor force of work would mean political ruin for the leaders. The break for Korea was the rehabilitation of the huge integrated iron and steel complex that was established during the early 1970s through a consortium of some industrialized countries and with technical assistance from the United Nations Industrial Development Organization or UNIDO. This rehabilitation enabled Korea to manufacture cars and vehicles, tools, electronic gadgets, computers and agricultural machinery among other industrial products. Such industries propelled Korea to be a fast industrializing country. In contrast, the Philippines were ahead of Korea in establishing a steel mill in 1960 but lacked further government support.

The Taiwan agricultural machinery industry mass produced the Philippine-designed flat-bed drier much ahead of the cut-and-weld machinery fabricators in the Philippines. It also produced laptops among computer hardware products, which the Philippines did not care about manufacturing. Like in Japan, industrialization in Taiwan caused a shortage of farm labor and boosted agricultural mechanization. It had to abandon its labor-intensive but successful multiple cropping system because it was difficult to mechanize using a system designed for monoculture farming system.

In 1949 after the revolution, China started establishing manufactories of agricultural machinery, at least one in each province, to support agricultural mechanization and to provide employment to the rural people as matter of policy. Such factories however, became economic liabilities under the commune system. When China opened its economy during the late 1970s and after accumulating foreign exchange through tourism, such factories were modernized by transfer of technology from the US. China's agriculture flourished because of mechanization and machinery manufacturing industry.

Bangladesh, a least developed country (LDC) by UNDP classification, is considered to have the most mechanized rice farming system in South Asia. Almost every farmer owns a power tiller because the indigenous foundry industry supports the production of high quality but low-cost spare parts for the cheap engines imported after the devastating cyclones that hit Bangladesh in 1988 and 1990, which resulted in about 300,000 human deaths and decimation of work animals. The president decided to import the cheap engines against the lobby of importers because more engines could be purchased with the limited budget thus, more area could be prepared for the direly needed rice planting for the critical season. The issue of low quality could be addressed later after the people survived the looming famine. It turned out that the decision gave a boon to the indigenous parts manufacturing industry, which directly employed more than 100,000 people and more in the downstream industries.

The Philippines has gone for the soft industries, like trading and importing, services such as business process outsourcing or BPO and information technology that developed naturally because they are quick-profit centers but benefited only the professionals. The government has remained cool to the heavy and hard industries like metals-based manufacturing of machinery and items that would utilize the mass of jobless low-educated youth.

When education in computing was in the initial stages, the emphasis was on programming or software development. The manufacture of computer hardware and other electronic gadgets like cell phone, radio, television, discs, etc., which could be carried out simultaneously with software development, has been ignored in spite of the large demand for such gadgets and the Philippines being a leading exporter of memory chips and other electronic parts. The few, if not lack of manufacturing industries, which would have employed workers in the rural areas, constrained thousands of skilled and knowledgeable Filipinos to work abroad where they are sought after. Their foreign exchange remittances have become major lifeblood of the Philippine economy, to be best spent perhaps in investments in manufacturing.

Strategy for the promotion of agricultural and fisheries mechanization in the Philippines

The proposed strategy is an "out-of-the-box" approach of sorts. Industrialization has been the tried-and-true path taken by the economically progressive and developed countries and has led to their advanced agricultural mechanization, which enabled the modern agricultural technologies to be applied in the field closely simulating the laboratory techniques that developed them thus, narrowing the yield gaps between the lab and the land.

Thus, the two approaches are industrialization and tourism. They will create jobs in the countryside and attract farm labor to such industries. Farmers will be constrained to mechanize and labor displacement will no longer be an issue.

The principle behind the strategy of promoting agricultural mechanization considers the "pull" or technology-adoption factor towards agriculture in reaction to the opposite and larger "pull" or labor-attraction factor towards industry. On the farmer's side, the adoption forces consist of the motivations to mechanize but are being negated by guilt feelings of depriving the laborers of farm jobs or by facing sabotage of agricultural machinery. On the industry side, labor is attracted by higher wages, better working conditions and non-seasonality of jobs. The opportunities for high production and productivity leading to competitiveness, fast turnaround time, timeliness of operations, avoidance of drudgery and tediousness, are foregone by the social problems like poverty in the rural areas due to joblessness. Lacking alternative employment, they turn to agriculture, which is affected by the low productivity and high cost of manual labor.

In the present system, the poor farm worker is an employee of sorts by the poor farmer employer who takes the production risks. This poverty vicious circle however, should be broken or spun off to a system that gives opportunities for a better quality of life to both the farmer and the farm worker. Industrialization will break that cycle as proven in the neighbouring countries. The manufacture of a 10-hp single-cylinder diesel engine is a starting point. Massive industrialization however, is needed to make a dent on the 8 percent unemployment rate and spur agricultural and fisheries mechanization.

A deliberate industrialization thrust started in 1992 when industrial zones and estates to attract foreign investments were established and just about when the going appeared well, the Asian financial crisis hit them in 1997. No equally enthusiastic revival attempts or promotions have been made so far by the succeeding administrations.

Among the recent manufacture-oriented initiatives of foreign investors are the establishment of a modern blast furnace and the modernizing of a copper beneficiation plant to integrate with the mining industry instead of exporting the raw copper ores.

The passage of the Agricultural and Fisheries Mechanization (AF-Mech) Law, which will finally chart the direction of agricultural mechanization, is expected to boost the manufacturing industry, if political will is stronger in fighting against the powerful lobby of importers trying to hinder it.

Assistance from Japan and collaboration with the Japanese industrialists and investors

1. Technical and financial assistance/partnership in setting up ore beneficiation plants in the mining areas to integrate manufacturing operations with those of mining.
2. Assistance and collaboration from Japan in development of land consolidation/clustering, farm layout and land forming for contiguous farming system of which Japan has extensive experiences in increasing land, labor and crop productivity.
3. Collaboration through partnerships or joint ventures between Filipino and Japanese industrialists if only to start with the manufacture of a single-cylinder, light-weight 10-hp diesel engine to be used as workhorse by farmers and

fisher folks. Being designed by Filipino and Japanese mechanical engineers for the tropics and manufactured in the Philippines, the engine will have a global competitive edge in Asia and other rice producing countries in Africa and Latin America.

4. Relocating idle or underutilized smelting plants in Japan to mining areas in the Philippines. This will make manufacturing competitive because of local access to raw materials. The Japanese and Filipino industrialist partners can set up an integrated metals-based on-site manufacturing industry with reduced investment costs for the relocated ready-to-run facilities.
5. Promotion of innovative language tourism among Japanese families wishing to learn the English language at much lower cost than in Japan. Travel and tour companies in Japan and the Philippines collaborate in providing services to Japanese family groups touring the Philippines.

Aside from visiting the tourist destinations for fun and sightseeing the beautiful Philippine beaches, landscapes and tropical island sceneries as well as engaging in diving, golf and other sports, they may enrol their preschool children with ages ranging from two to four years in private preschools to learn English quickly, effortlessly and enjoyably as mother language, which is not lost or forgotten even when they go back to Japan.

Older children and adults may learn English by attending language classes in private schools like what many Korean tourists do at present. Private-to-private collaboration with government support in facilitating visits of families from China, Taiwan, Korea and Thailand for language tourism in the Philippines may be organized. The Philippines is the most experienced country in this novel form of tourism. For the English immersion needed for language learning, the Philippines are the only suitable place nearest the East Asian countries.

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Agricultural Mechanization in Vietnam and How to Develop the Cooperation with Japan

by
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Vietnam Agricultural Mechnization

Generally, in developing countries and particularly, in Vietnam, agricultural mechanization has allowed an increase to the plant area, and contributed towards enhance yields and quality of farming products. Planting, caring, tending and harvesting a crop requires not only significant amount of power but also needs a suitable range of tools, equipment and farm machines. Indeed, most farmers in developing countries and also in Vietnam experience a greater annual expenditure on farm power inputs than on fertilizer, seeds or agrochemicals. Vietnam, for example, mapping the geographical distribution of tractors and farming machines draws out a general pattern. Here, there are two regions emerge in which the soil and topography were suitable for growing rice, one in the north called Red river field and the other in the south called Mekong delta. Most residents participated in the north region with a larger population provided more manpower while farms were smaller. In the opposite prevailed: the people were generally worked by owners, the population was not dense and scattered, compared to the total acreage under cultivation, and farms were larger. Therefore, the agricultural mechanization in Vietnam mostly develops in the Mekong delta regions. However, the agricultural mechanization is also still at the low level, not synchronous, and imperfectly such as:

- The farm power equips average about 1.3 HP per hectare which is very low comparing to the other regions in Asia.
- Farm machines mainly used for land preparation such as plough and rake, rice smash and transportation, and rice milling and processing. The mechanization level of harvesting is below 30 % and the manpower takes over 70 % for this stage. The other stages of cultivating such as planting, caring, and fertilizer feeding… have implemented commonly by manpower.
- There is a little farmer might equip tractor and farm machines by himself due to low income from agriculture sector, and lack of the subsidy policy from central government.
- The ability and strength of Vietnam manufacturing factories which respond for agricultural devices, tools, and equipments are still not enough resource to produce quality products in order to make suitable machines for agriculture sector.
- The training system for agricultural engineering also has some problems like out of date program, lack of facilities for practicum, and slowly update new technology or new equipments,
- There is a gap on connecting the people from industry, research institutions, and farming. Therefore, technology transfer to final point-famers- is not easy.

And What can We Operate together?

Regarding the situation of Vietnam agricultural mechanization, the cooperative works need to be done in agricultural mechanization between Japan and Vietnam might focus on the following aspects:

- What is now increasingly important is to encourage sustainable private sector development that can offer farmers the right choice of technology at the right price to increase agricultural productivity, provide food security and reduce post-harvest losses. Japan might help Vietnamese farmers develop agricultural business for themselves.

- Improving the ability of manufacturing agricultural machines by transfer technology and manufactured techniques from Japan to Vietnam Enterprises so that the tools and equipments made in Vietnam can be used for long time with low cost. Some machines might be highlights are harvesters, plant caring machines, spraying machines and fertilizer machines, and processing machines for agricultural products.
- Agricultural mechanization is not an isolated activity. Besides agronomic, technical and social aspects there is also an important role played by institutional aspects such as agricultural education, extension and research. Therefore, it is well if both Japan and Vietnam operate a joint project to develop these aspects.
- Enhancements the technology transfer in agricultural engineering to famers directly and on time, especially in rice production and short-term industrial crops via short courses training operated by both Japan and Vietnam.

Vietnam is still the agricultural country in which nearly 70 % of population are working and living in rural areas so that Agricultural Engineering would be played as an important role for economy developing. The cooperation between Japan and Vietnam in agricultural mechanization would promise more chances to be carried out.

NEWS

"Bharat Ratna Dr. C. Subramanium Award 2012"
Dr. Indra Mani

Congraturations!!

Indra Mani was awarded "Bharat Ratna Dr C. Subramanium Outstanding Teacher award 2012" of Indian Council of Agricultural Research (ICAR) for his out standing contributions in Post Graduate Teaching in the area of Agricultural Engineering. He has been doing teaching with innovations during last about 20 years. One of his aim has been to inculcate value and ethics in his students. This prestigious and coveted award was presented by Shri Sharad Pawar Union Ministry of Agriculture, Goverment of India and Shri Tariq Anwar Minister of State for Agriculture on 16th July 2013. This day is the Foundation Day of ICAR.

And also this year in January during ISAE convention at Hyderabad he was conferred with ISAE fellowship.

National Modernization cannot be Realized without the Development and Diffusion of Agricultural Mechanization

by
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AAA Co-operating Editor
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AMA started to be published as a quarterly journal in English by the late President Yosikuni Kishida of the Shin-Norinsha Co., Ltd. in Tokyo in 1971, so as to promote farm mechanization in countries in the world, and it is a matter for congratulations that President Yoshisuke Kishida, his son and successor, has been continuing his work more globally & successfully.

Farmer Population

Countries	(1,000)	%
UK	480	1.5
USA	2,562	1.6
Germany	691	1.6
France	601	2.1
Japan	1 517	2.4
Netherlands	219	2.5
Italy	881	3.4
Finland	102	3.7
Spain	1,055	4.7
Korea	1,350	5.6
Russia	6,392	8.3
Portugal	533	9.4
Greece	657	12.5
North Korea	3,099	23.9
Philippines	13,336	34.3
Indonesia	49,513	42.1
Bangladesh	32,220	46.3
Thailand	19,494	49.3
India	266,751	54.9
China	502,691	61.5
Vietnam	29,302	63.6

The principle for the development of a nation is how to realize it by activation on all the necessary industries in the country.

In such a case, it is very impor tant that the modernization of agriculture as a primary industry through farm mechanization is the base to support the development of all other domestic industries.

The reason is that agricultural modernization through farm mechanization leads to a decrease in the farming population by promoting the efficiency of labor on farms and increases working population in the second and third industries.

The table bellow shows the percentage of the farming population to the total labor population in some main countries in the world at the end of 2009 reported by the STAT in FAO.

This statistic clearly shows that most Asian countries except Japan and Korea are developing countries with more than 30 % of farming population, and that China and India, overpopulated big countries, are still among the developing countries, because more than 50 % of the working people are farmers.

Therefore, this statistic suggests that we should have much consideration in keeping up with their countries.

The ratios of farming population to the total labor population in most of the Euoro-American countries are usually small percentages.

Accordingly, most of their count ries have become developed countries, in which almost all the necessary industries have developed well.

The reason why most Asian countries are still developing countries is that national modernization by the diffusion of farm mechanization is insufficient.

Most of these Asian countries were once the colonies of European countries mainly having dry field farming of little annual rainfall, about 500 mm, and stock raising without water-paddy field farming, except California, where many Japanese immigrants reside, and a part of Italy.

Therefore, Euro-American farm machinery specialists can hardly understand how to lead the mechanization of water-paddy-field farming in Asian countries with annual rainfall over 1000 mm.

Frankly to say, there have been very few Euro-American specialists who are teaching and assisting the development of farm mechanization in Asian countries. Actually, when I had to go to a certain paddy field for the exhibition or demonstration of farm machines, the trouble was that there were no farm roads, though national and village roads were complete.

So, many times, the tractors had to be driven across other fields and ridges between rice fields before reaching the designated field.

In dry land farming in Europe and America, farm-roads will be naturally made, by the removal of stones, trees, and weeds, and by setting up irrigation facilities.

But rice-paddy fields in Asian countries must be perfectly flat (less than 2.5 cm flat level per. one field, JAS) in principle, becoming small. fields enclosed by ridges.

Moreover, the diffusion of civil engineering works for setting irrigation and drainage facilities is necessary, in order to make the field dry in the mid-season of young paddy ears being formed.

Therefore, in the latter half of the 20th century, the progress and diffusion of civil engineering works were made in Japan, so as to increase the yield of rice and solve the postwar food shortage.

That is to say, the civil engineer ing works for basic structural reform in paddy fields having both functions of irrigation and drainage were established initiatively by the Ministry of Agriculture in more than two thousand farming areas all over Japan every year.

However, in almost all Asian countries, such civil engineering projects in farm areas have not yet been actively performed.

There is another thing worrying me. That is the disappearance of “suki” (Japan plow) cultivation and suki companies, as a result of the diffusion of rotor and rotary cultivation with two-wheeled and four-wheel tractors. In most Asian countries except Japan and Korea, animal-plow-farming is still seen. It is difficult for Japanese to teach and lead the mechanization of their farming without knowing well about their plow cultivation.

It is necessary that Japan’s public service personnel and people in companies related in agricultural engineering should know that the exclusive admiration for European and American specialists in dryfield plow-farming will not be generally accepted in the field of agricultural mechanization project in Asian countries today.

It is very important that all the developed countries in the world should cope with developing and low-developed countries of paddy field farming deliberately, for the aim of peaceful coexistence.

I appreciate for Shin-Norinsha Company giving me chances to write 25 articles in Kikaika-Nougyou journals and also 25 articles in English in AMA.

Last but not least, I send my congratulations on the 80th anniversary of the foundation of Shin-Norinsha Co. and hope for more development of the company and the activities of all the stuff.

■■

Global Problems in Agricultural Mechanization System of Russian Federation

by
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Introduction

The most important problem for Russian Agriculture is to recreate the Agricultural Machinery Fleet to 2020 and for this it is necessary to put innovations in industry, to design more efficient machinery which answers the requirements of harmonized International standards and testing procedure. The Russian Academy of Agricultural Sciences supports the prognosis to increase considerably (in 3.5-6 folds) the fleet of main types of agricultural machinery from present crucial state (2012) to 2020 as follows:

- wheeled and crawler tractors from 276.2 thous. units to 900 thous. units;
- grain harvester from 72.3 thous. units to 250 thous. units;
- forage harvester from 17.6 thous. units to 60 thous.units;
- sugar-beet harvester from 2.8 thous.units to 20 thous.units;
- potato harvester from 2.7 thous. units to 30 thous. units;
- mineral fertilizer distributors from 16.3 thous.units to 60 thous.units;
- ploughs from 76.3 thous.units to 400-500 thous.units;
- drills from 115.4 thous. units to 500-600 thous. units and so on.

Accordingly with above it is necessary to increase also the production of the many types and many thousand units of other agricultural machines and equipments for plant production, meadows and pastures improvement, animal production, vegetables, fruits, e.t.c.

In reality the production of the key agricultural machines in 2012 was on the very low level:

- domestic production of agricultural tractors was 459 units; imported from Republic of Belarus –26153 units, including the assembled in Russia from Belarus components
- 14800 tractors; for export –369 units (314 wheeled and 55 track laying tractors);
- production of grain harvesters was 5940 units, but from this number 1937 units wasn't sold to agricultural farms.

Also it is necessary to take into account that at present time in the Agricultural Machinery Fleet of Russian Agriculture there are about:

~35 % of tractors of 10-17 years old;
~65-70 % of Grain and Forage Harvesters of 10-12 years old;
~60 % of Sugar-beet Harvesters (domestic production) of 8 years old;
~80 % of Potato Harvesters (domestic production) of 10 years old. Concerning the imported Harvesters it is necessary to point out that ~50 % of them are above 10 years old and the level of localization of the assembled in Russia Harvesters is not more than 5-20 %.

It means that we need fulfill several main tasks:

- to design, manufacturing and annually testing of the hundreds of new machines for all over the country which should be acceptable for the new different types of farming (agricultural enterprises, private farms, small size of population plots);
- to certify the imported machines to choose the suitable one for every from 40-60 regions of Russia with different soil-climatic conditions;
- to spend the huge material, industrial and labor resources for industrial production of the new machinery and to recreate the components base in Russia;
- to recreate the professional system of preparing the high qualified tractors and harvesters operators and services for maintenance and repairing of the technique;
- to support the agro and bioengineering sciences and designing structures in Russia and develop the efficient cooperation with our neighbours (Belarus and Ukraine,

Kazakhstan, China, India, Japan and others).

By the way in 1996-1998 we worked out the special programs in the frame of Agro-Business Commission of Technical-Economical cooperation of Russia and USA (Gore-Chernomyrdin) and Russia and Japan (Eltzin –Hoshimoto) in Agriculture and Industry. As a result there were offered some proposals for organization of the joint venture for the production of agricultural machinery in Russia which were supported on the governmental level.

For example for realization some projects were invited the several agricultural machinery firms as follows: from USA –“Deere and Company”, “Detroit Diesel”, “Case”; from Japan– “Farm Machinery Research Corporation and Shin-Norinsha L.t.d.”, “Morooka”, “Niplo”, “Sugano” and others. For the more the Presidents of Japan corporations “Shin-Norinsha Ltd.” and “Morooka” had visited Russia and had meeting with the Leaderships of some regions of Far East: Amur region, Khabarovsk region, Primorsky region and also had discussion with the Leaderships of machinery building plants in towns: Khabarovsk, Birobidzhan, Blagoveszhensk, Belogorsk, Arsentiev and others.

As a positive result Ministry of Agriculture and Food of Russian Federation, Rosselkhozacademy together with representatives of Leaderships of Interregional Association of Economical Cooperation of Far East and Baikal regions had issued the order № 343/01-2-1200/79 from 9 June 1998 about the realization of Russia –Japan Program for development of cooperation in the field of Agriculture and Agricultural Industry.

However the reforms that were carried out in Russia for the last ten years didn’t allow putting in reality also the proposals of Russia-Japan cooperation. You may see at the beginning of article the results of these reforms: crucial state of agricultural machinery fleet at present time (data on the end of 2012).

As far as the agricultural farms of different types and sizes were install also appeared the problems for supplying them with acceptable technique and technology. The parameters of existing forms of farming and main indicators of technical provision of them are shown in **Table 1**.

As a results of reforms we have forced to import now more than 50 % of the food and 60-70 % of agricultural technique. Compare with 1991 we did not use now more than 40 mln. hectares of arable land. Practically more than 2/3 of them were covered with tussocks, bushes and trees. So, there is a big problem to return them to use again because of huge State expenditure and time.

The specialists know that the key types of agricultural machines are the agricultural tractors which fulfill the main technological operations and required about 6-7 worker’s places around the machine-tractors aggregates for different jobs, including services, repairing and maintenance.

That is why we will consider first the main data of agricultural tractors fleet in Russian Agriculture. In 1991 in Russian Agriculture there were 1300 thous. units of tractors of different sizes but to the end of 2012 tractor fleet has decreased up to 276.2 thous. units. Also there were drastically decreasing the rural population especially in regions of Far East and Siberia.

Russian Academy of Agricultural Sciences has substantiated necessary increasing the optimal tractor fleet for Russian Agriculture up to 900 thous. units in order to fulfill a real renovation of the tractors fleet to 2020 and also increase the annual usage of 110 mln. hectares of arable land instead of 76.7 mln. hectares now.

But the Federal program of Russian Federation has planned to increase the tractor fleet for Russian Agriculture only up to 329.1 thous. tractors to 2020 and it is more realistic because practically most part of tractor plants in Russia is lost their potential. For example, Volgogradsky, Vladimirsky and Altaysky tractor plants are totally ceased production. The other tractor plants decreased much their production. The same situation is also with small machinery building plants which produce small party of different ag-

Table 1 Main indicators of Russian Agriculture (types of farms and their efficiency, tractors and motobloks fleet)

Types and numbers of Farms	Main indicators of Agricultural production on the end of 2012				Main indicators of Agricultural production, prognosis to the end of 2020			
	Arable land, mln. hectares	Total agricultural product, %	Tractor Fleet		Arable land, mln. hectares	Total agricultural product, %	Tractor Fleet	
			thous. units	Average power, kW			thous. units	Average power, kW
Agricultural Enterprises, 25,000	56.7	46.7	276.2	73	90.0	77.7	900/329.1	88-92
Private farms, 240,000	16.5	8.5	70.0	72.8	15.0	7.0	~400	66
Families plots, ~17 mln. families	3.5	44.8	412.0	2-5	5.0	15.3	2000 motobloks	12
Total:	76.7	100	758.2	~46	110.0	100	1300 + 2000 motobloks	

ricultural machines on the regional level.

The main technical indicators of crawler tractors in Russian tractor fleet are shown in **Table 2** and of wheeled tractors –in **Table 3**.

There is only one real way to put innovations and increase the production of tractors in Russia. This way is attraction of the foreign partners and investments to create the joint ventures in Russia for production of modern design tractors, including also tractors of Japanese corporations, for example “Morooka”. The technical data of “Morooka” rubber track tractors are shown in **Table 5**.

Comparison of indicators of crawler tractors of Russia, Ukraine, Belarus in **Table 4** and Japan (Morooka) in **Table 5** shows that realization of power for tractive force (kN/kW) is more efficient for Morooka tractors (1.02-0.54) when for Russia (0.73-0.42), Ukraine (0,33) and for Belarus (0.19-0.32). It is necessary to take into account also the working speed of Morooka tractors –for 1st diapason 0…9 km/h with tractive force from 100 up to 135 kN and for 2nd diapason 0…16 km/h with tractive force 50-67.5 kN when working speed is practically twice more than for others tractors.

Concerning the specific tractive force (kN/t) there are large advantages of Morooka tractors for 1st diapason of working speed (14.2-10.9) but for 2nd diapason specific tractive force (kN/t) much less (5.4-6.3). For Russian tractors specific tractive force is a very even (6.42-6.47) for the different power. For Ukraine –6.48, for Belarus tractor–much less 2.78-4.63.

The Morooka tractors have much less specific mass (kg/kW) from 71.5 for small power and 43.5-37.5 for high power when Russian tractors have much more specific mass −112 kg/kW for small power of

Table 2 Technical indicators of crawler tractors in Russian tractor fleet

Traction class	Tractive force, kN	Power of basic models, kW	Mass of basic models, kg	Main PTO power / front PTO power, kW		Front mounted system force, kN	Main mounted system force, kN
8	78	280	16,000	150	-	75	120
6	59	220	12,000	120	-	60	100
5	49	185	10,000	105	-	55	90
4	39	140	8,000	85	-	45	80
3	29	110	6,000	85	-	35	70
2	20	70	4,000	40	-	30	60

Table 3 Technical indicators of wheeled tractors in Russian tractor fleet

Traction class	Tractive force, кN	Power of basic models, kW	Mass of basic models, kg	Main PTO power/ front PTO power, kW	PTO power/ Engine power, %	Front mounted system force, kN	Main mounted system force, kN
8	74	340	19,000	210/-	61.8/-	90	140
6	60	260	15,400	150/-	57.7/-	70	120
5	50	230	12,800	135/50	58.7/21.8	65	110
4	40	180	10,300	105/40	58.4/22.3	55	90
3	30	130	7,700	75/30	57.7/23.1	45	80
2	20	110	5,100	60/20	54.6/18.2	40	65
1.4	14	70	3,600	40/15	57.2/21.5	30	50
0.9	9	40	2,300	24/-	60/-	25	40
0.6	9	25	2,300	15/-	60/-	20	30
0.2	2	10	500	8/-	80/-	-	8
0.1	-	5	100	5/-	100/-	-	-

Table 4 Comparison of technical indicators of some crawler tractors of Russia, Ukraine and Belarus

Models	ДТ-75*	ВТ-100*	Т-4А1*	ХТЗ-181**	МТЗ-2102	Т-250*	Т-500*
Mass, kg (t)	6180	7580	8870	9050	10800	12700	12000
Power, kW	55.15	88.24	95.6	175.7	155.9	183.8	186
Tractive force, kN	40	49	57	58.6	30-50	82	77.6
Specific mass, kg/kW	112	85.9	92.8	51.5	69.3	69.1	64.5
Specific tractive force, kN/t	6.47	6.46	6.42	6.48	2.78-4.63	6.46	6.47
Tractive efficiency, kN/kW	0.73	0.56	0.6	0.33	0.19-0.32	0.45	0.42

Working speed of Russia* and Ukraine** tractors is 5 - 8 km/h and of Belarus tractor MTZ- 2102 with tracks equipped with rubber-metal pivots up to 10-12 km/h and for transportation –up to 30 km/h.

Table 5 Technical indicators of the rubber track tractors of "Morooka" corporation

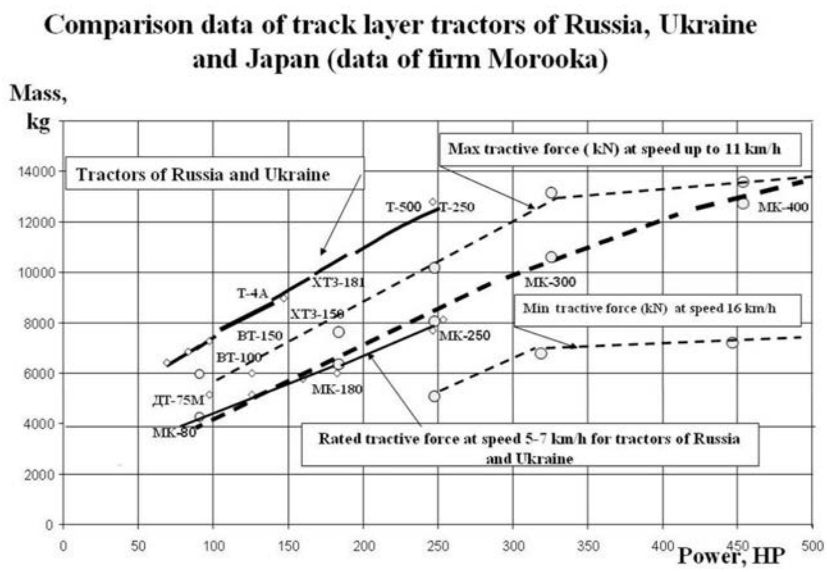
Models	MK-80	MK-180	MK-250	MK-300	MK-400
Mass, kg (t)	4290 (4.29)	6300 (6.3)	8000 (8.0)	10500 (10.5)	12400 (12.4)
Power, kW	60	132.4	183,8	239	331
Tractive force, kN	61	75	100/50*	135/67.5*	135/67.5*
Specific mass, kg/kW	71.5	47.6	43.5	43.9	37.5
Specific tractive force, kN/t	14.2	11.9	12.5/6.3*	12.9/6.4*	10.9/5.4*
Tractive efficiency, kN/kW	1.02	0.57	0.54/0.27*	0.56/0.28*	0.41/0.2*

Data of Morooka tractors: for MK-250, MK-300 и MK-400 working speed:
- 1st diapason –0…9 km/h and tractive force 100 and 135 kN;
- 2nd diapason –0…16 km/h and tractive force 50 and 67.5 kN*

tractors and 64.5-69.1 kg/kW for powerful tractors or practically 1.5-1.8 times more. So, we can take a conclusion that Morooka tractors are more efficient.

The advantages of Morooka tractors in comparison with Russia, Ukraine and Belarus tractors are shown on **Fig. 1**.

Fig 1. Tractor "Morooka -250" –Japan Firm "Morooka"



Comparison of main technical reqierements of the Agricultural tractors of Foreign and Domestic production and Perspective tractors is shown in **Table 6**.

The new forms of farming in Russia required paying more attention to small type's tractors for private farms, population's plots, for gardening, selection, seeds and vegetables production. For this we prepared together with our Italian partners the special programs to organize the Joint venture for small tractors production, as follows': for gardening "BASE 20" of power 16 kW, "ASTER 45" of power 32 kW, "ENERGY 80" of power 55 kW and others.

We also have special interest to small self-propelled crawler robot "Dargreen 45H" of French firm "DARIO" with engine power 33 kW, electric powered transmission and radio distant managing in radius up to 150 m which can have very wide specter of usage.

New Types of Machinery for New Forms of Farming in Russia

Now we need to pay more attention to small type's tractors for private farms, population's plots, for gardening, selection, seeds and vegetables production. For this we prepared together with our Italian partners the special programs to organize the Joint venture for small tractors production, as follows': for gardening "BASE 20" of power 16 kW, "ASTER 45" of power 32 kW, "ENERGY 80" of power 55 kW and others.

We also have special interest to small self-propelled crawler robot "Dargreen 45H" of French firm "DARIO" with engine power 33 kW, electric powered transmission and radio distant managing in radius up to 150 m which can have very wide specter of application in all types of Farms.

Table 6 Comparison of technical level of tractors: Foreign and Domestic production on 2012, Perspective models to 2020

Main indicators of technical level	Foreign tractors	Domestic tractors	Perspective tractors
Diapason of power, kW	5 …..440	15…257	5…400
Specific fuel consumption, g/kW in hour	107	120…130	125…135
Spare of tractor engine Moment, %	40…50	20…25	50…60
Time up to simple damage of engine, moto-hours	1500…2000	250…400	600…900
Resource of engine, thous.hours	15000…20000	6000…10000	15000…16000
Level of sound in cabin, dBA	70…75	80…85	70…75
Introduction of ecological requirements	Euro-3 … Euro-4	Euro-1	Euro-1 … Euro-3
Diapason of main working speed, kM/h	Up to 40	Up to 15	Up to 20
Diapason of main maximum transport speed, kM/h	50…60	30…40	40…50
Specific energy per ton of tractor mass, kW/t	17…21	13…18	16…18
Specific mass of tractors (without class 0.6), kg/kW:			
-crawler tractors	50...54	54…68	50...54
-wheeled tractors	38…60	46…70	38…63
Electronically system of tractor control	Wide spread	Restricted	Restricted
Type of the transmission of tractors	Hydrostatic, double flow (cvt), electrical	Mechanical, synchronized	Hydrostatic, double flow (cvt), electrical
Average pressure on soil, kPa: -crawler tractors -wheeled tractors	42…50 80…120	42…55 100…145	40…50 80…120

Conclusion

Strategy of Support of the Food Security in Russian Federation

1. To decide the problem of food security to 2020 the Russian Federation should first of all to start a real innovative rehabilitation of the industry on the base of high technological and technical levels in order to fill the machine-tractor fleet with the new machinery: 900 thous. tractors, 250 thous. grain harvesters, 60 thous. forage harvesters, 20 thous.units of sugar-beet harvesters and 30 thous.units of potato harvesters also many other machines (it will be enough for annually using of about 100 mln. hectares (from the total amount of 133 mln.ha of arable land). Also we need to improve 10-15 mln.ha of grasslands and pastures (totally we have ~20 mln. ha of the natural grasslands and ~ 60 mln.ha of the natural pastures);
2. However, the Russian Federation, in spite of the fact that there are the huge land resources, has tried to solve the food security problems by importing of more than 50 % of food, above 70 % of tractors, 40-50 % of grain and forage harvesters, 95 % of sugar-beet harvesters and many other agricultural machinery and equipment because of low domestic industrial, agro-technological and material-technical provision;

Fig 2. New types of machinery for new forms of farming in Russia

The Main Energetic indices of Technical Supplement of Russian Agriculture

1. The specific power per one hectare of arable land (kW/ha) including the total power of tractors, self-propelled harvesters and auto tracks used in Agriculture now is about 0.96 kW/ha. For tractor fleet only at the average power of one tractor 78 kW specific power is now about 0.4 kW/ha. It is not enough for successful Agriculture.
2. So, for the perspective fleet for 2020 a specific power of total fleet per one hectare of arable land (110 mln. Hectares) should be about 2.5 kW/ha but for the perspective tractor fleet only at the average power of one tractor 100 kW the specific power may be ~1.2 kW/ha.

The Most Economical Way to Go out from Critical Situation in Russian Agriculture

1. For Russia it is absolutely necessary to increase the domestic industrial production of the key machinery not less than in 3.5-6 folds. Only this way can support the development of productive and competitive agriculture as exclusive measure for increasing employment and income.

■■

Comparison Computerized Object Recognition Systems


by
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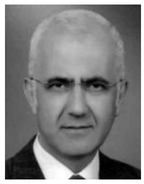
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Abstract

Nowadays, object recognition automation systems are used in many sectors. Structure of the object recognition system is important for producing correct and rapid results. In this study, object detection systems are designed to classify Starking and Granny Smith type apples and these are compared with each other. Both designed systems are based on the pattern recognition principles. Outputs of object recognition systems are compared with the actual results and it has been observed that suggested system produces high success rate object recognition results. According to this result, it has been determined that the success of MATLAB Simulink object recognition system is 95 percent and success of Harpia object recognition system is 80 percent. Therefore, the MATLAB-based object recognition system produces more stable and clear results.

Introduction

In everyday life objects are recognized and classified by people or automatic recognition systems in many places. If this process is done by people, it may be slow and errors can be seen. For example, in an apple packing plant, a worker who classifies the apples according to their types will get tired after some time of work and will need to rest. In addition, for reasons such as lack of attention will cause wrong classification of the apples. Therefore, the need for automated systems is increasing over time in the factories where the object recognition system is used.

As the technology develops, computers begin to handle object recognition process. Object recognition process is carried out through computers using image-processing techniques. Image processing software leads to successful results at getting images from a computer connected software and evaluating them.

The apple recognition process is classifying apples according to their colors and separating them quickly by using image processing techniques (Liu *et al.*, 2007). Object recognition systems are becoming popular as they can separate many objects using this technique (Peng, 2003).

As the apples are grown in many parts of the world, these fruits are frequently seen in shopping centers and greengrocers. These products are one of the most imported and sold around the world . Thus, they need to be classified in warehouses .

In this study, two different types of object recognition systems are designed to distinguish between apples of Granny Smith (GS) and Starking (St), using image processing techniques based on object recognition system. First object recognition system to be presented is designed using MATLAB and the second one is designed with Harpia Software that uses OpenCV libraries. Performance results of the designed systems are discussed.

Materials and Methods

It is possible to obtain high-speed and efficient results by replacing traditional object recognition process with the procedure that performed in computer environment. In this study, the systems designed for object recognition is compared for making results more clear and accurate.

The current image recognition systems are divided in three groups: statistical image recognition, structural image recognition, and intelligent image recognition systems. Structural image recognition benefits from formal features of the image being studied. Designed system includes structural image processing steps. Identification process is carried out by using the color features of the image (Turkoglu *et al*., 2003).

MATLAB Based Object Recognition System

Object recognition system working with MATLAB software based on structural pattern recognition system is seen in **Fig. 1**. Through the Simulink blocks in the MATLAB software, the system can perform the process of object recognition by processing the recorded images (Sert, 2010).

The "Picture 1" labeled block in **Fig. 1**, is used to get recorded picture files, and "Conversion 1"

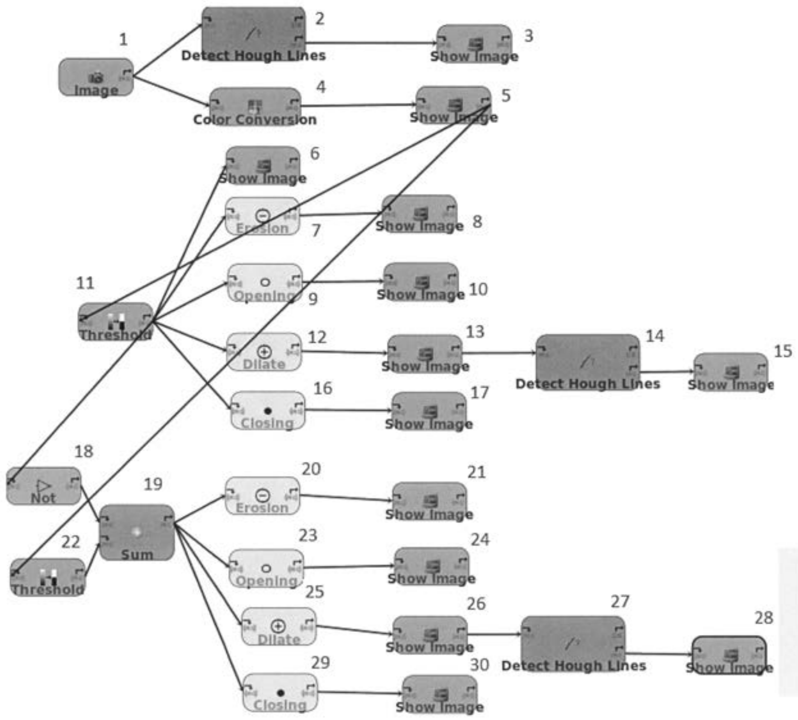


Fig. 2 Harpia object recognition system

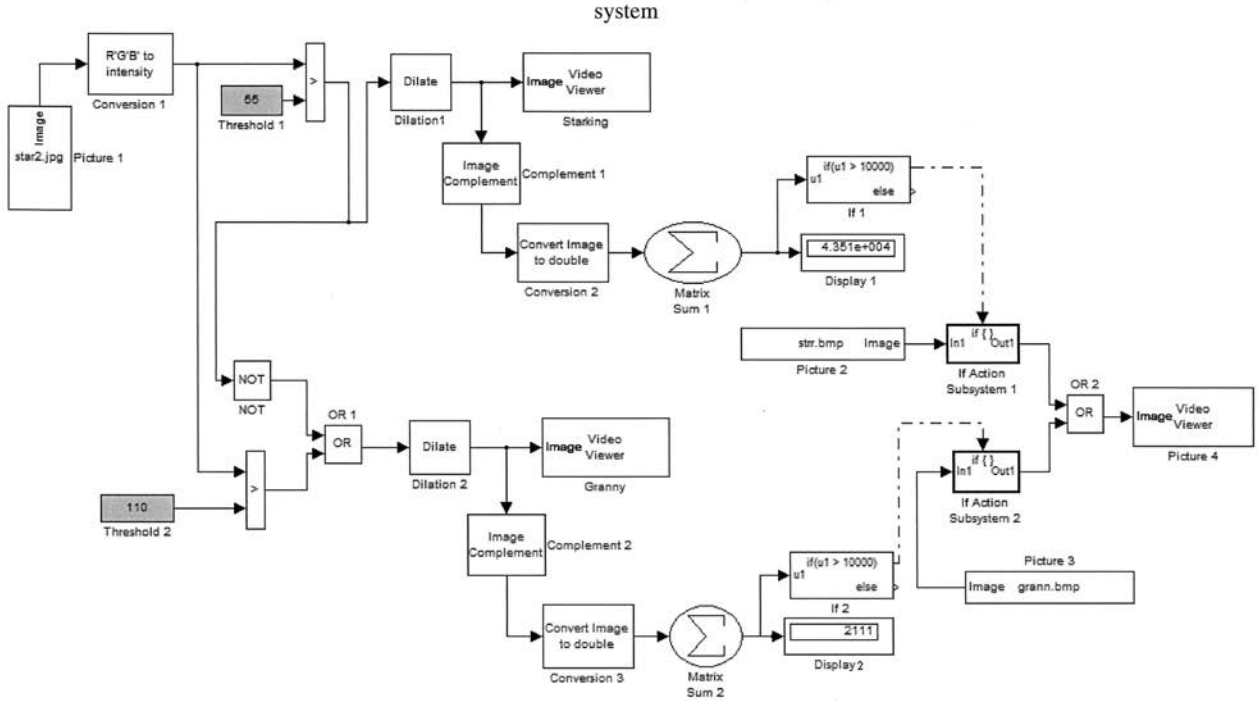


Fig. 1 Circuit of MATLAB Simulink object recognition system

system

labeled block is used to make conversion between image formats and these are seen. “Conversion 1” block provides conversion from RGB to Gray format. “Threshold 1” and “Threshold 2” labeled blocks at **Fig. 1**. are used to convert gray tone image into binary image. The shades of gray are converted to binary values by using the following formula (Nobisa *et al*., 2005; Pichon, et. al., 2003):

$$I_{bin}(p) = \begin{cases} if \rightarrow I_{grey}(p) \geq d = 1 \\ if\ not = 0 \end{cases}$$

Here, ***d*** is a certain threshold value and this value is a critical point for conversion (Threshold).

“Dilation 1” and “Dilation 2” labeled blocks at **Fig. 1** are expansion filters. The expansion process, in contrast to the process of erosion, is used to soften the black areas (Louverdis *et al*., 2002) . Binary dilation process of A through B is defined by installation of $A + B = \{Z|(\hat{B})_Z \cap A \neq \emptyset\}$ (Gonzalez *et al*., 2009).

Gray-scale dilation form of A(x,y) is defined through B(x, y) as: $(A + B)\ (x, y) = max\ \{A\ (x - x', y - y') + B\ (x', y')\ |\ (x', y') \in D_B\}$ (Gonzalez and Woods, 2009; Haralick *et al*., 1992).

Gates are the fundamental building blocks of digital logic circuitry. These devices have opening and closing functions to admit or reject the transition of a gotten signal.

Basic logic gates are AND, OR, NOT, XOR. A basic OR gate consists of two inputs and an output. The output is 1 when one input, or the other, or both are 1. The OR gate output is 0 only when both inputs are 0. An even simpler gate is the NOT gate. It has only one input and one output.The output is always the opposite (or negation) of the input (Patton, 1998).

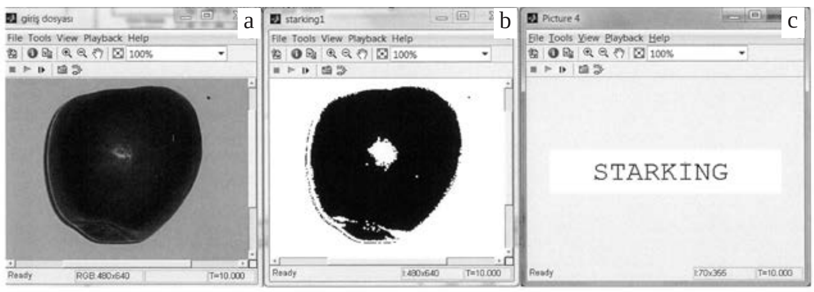
“Complement 1” and “Complement 2” labeled blocks at **Fig. 1** are “Image Complement” block and are used to get the complement of the picture that was converted into binary form. “Conversion 2 “ and “Conversion 3” labeled blocks In **Fig. 1** are used to change the data type of image file that is applied to the input. “MatrixSum 1” and “MatrixSum 2” labeled blocks at **Fig. 1** collect elements of the matrix coming to the input and transfer these to the output. “If 1” and “If 2” labeled blocks at **Fig. 1** send the active signal to the output when the conditions are provided. “If Action Subsystem 1” and “If Action Subsystem 2” labeled blocks at **Fig. 1** transfer the signal from “In1” input to “out1” when the active signal comes to if input. “Starking”, “Granny”, and “Picture 4” named blocks are used to show the image file at the input.

“Picture 1” labeled block in **Fig. 1**, can read the image file, and the image is converted from RGB to gray by “Conversion 1” labeled block. “Threshold 1” block at **Fig. 1** is adjusted to level 55 and so enabled to show only St kind apple at “Starking” named block. There is binary information that represents apple in two dimensional matrix at the output of “Dilation 1” labeled block in **Fig. 1**. As the binary response for black areas is 0 and white areas is 1 in apple picture at the output of “Starking” labeled block, in **Fig. 1**. “Complement 1” labeled block enabled to change the values of black areas that show the area of

Table 1 Test results of MATLAB object recognition system

Tested apple type	Display 1 output	Display 2 output	System output (picture 4 block output)
St	46,210	07,081	Starking

Fig. 3 Block out images of MATLAB object recognition system:

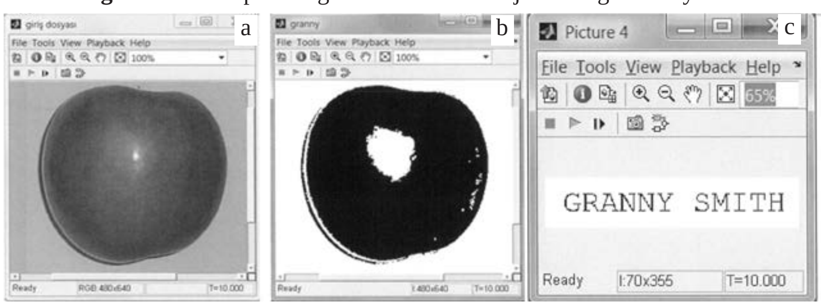


a) “Picture 1” labeled block output, b) “Starking” labeled block output,
c) “Picture 4” output labeled block output

Table 2 Test results of MATLAB object recognition system

Tested apple type	Display 1 output	Display 2 output	System output (picture 4 block output)
GS	00028	64050	Granny Smith

Fig. 4 Block output images of MATLAB object recognition system:



a) “Picture 1” labeled block output, b) “Granny” labeled block output
c) “Picture 4” labeled block output

apple converted from 0 to 1. Then, these 1's are added by "MatrixSum 1" labeled block in **Fig. 1**. If this total is more than 10,000, "If 1" named block in **Fig. 1**, will send active signal. So, it will be determined that the kind of the object is a St kind apple.

NOT operation was applied to the output of "Threshold 1" labeled element in **Fig. 1**. As the threshold level that GS apples show would be 110, "Conversion 1" labeled block output has been passed through "Threshold 2" which has value level of 110. The outputs of "Not" and "Threshold 2" elements have been applied OR process by "OR 1" labeled element and the output has been passed through dilate filter. For the transformation of the areas that show the apple in image matrix to level 1, the complement of the picture have been taken with Complement 2" labeled block in **Fig. 1**. and by the help of "Conversion 3" labeled block, the binary information of the picture has been converted into double. "MatrixSum 2" labeled block add content of the matrix coming own inputs. If the collected information is more than 10,000, it is understood that the kind of object is GS apple and so the type of apple is shown.

Open-Cv Based Object Recognition System

The object recognition system prepared by OpenCV based Harpia software is seen in **Fig. 2**. So this object recognition system has been designed and object recognition system is carried out in a similar way with the system in **Fig. 1**. The difference is that it doesn't determine the numerical value of the area that the apple covers and thus, conditional representation is not used. The threshold level of block 11 has been adjusted to 48 and block 22's to 110 in **Fig. 2**. If the taken image is a ***St*** kind of apple that taken by 1 numbered block in **Fig. 2**, the binary image of the apple will be shown in block 15 but not in block 28. GS kind of apple will not be shown in block 15 but instead of block 28.

Results

Running of Matlab Based Object Recognition System

When St kind of apple seen in **Fig. 3a** is loaded into "Picture 1" labeled block in **Fig. 1**, the picture in **Fig. 3b** will occur in "Starking" labeled block in **Fig. 1** and the picture

Fig. 5 Flow diagram of object recognition system

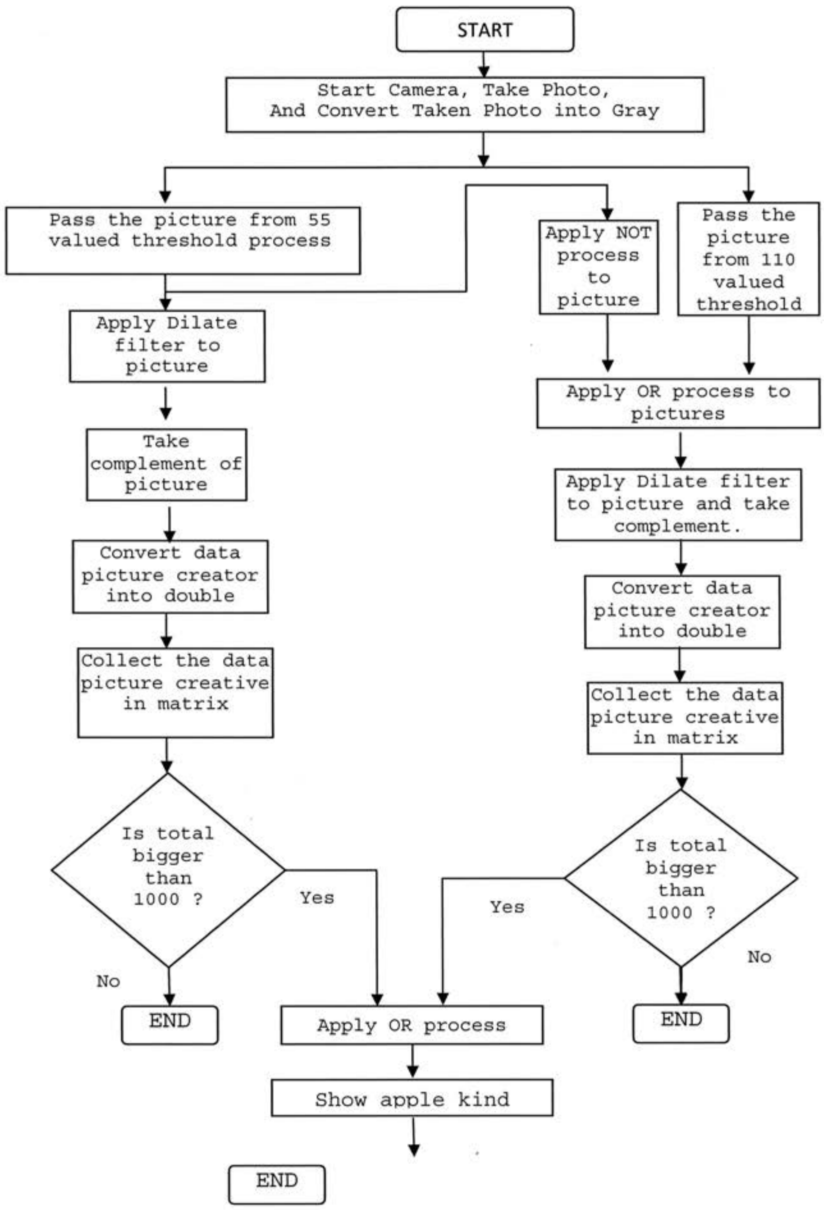


Fig. 6 The symbol of apple sizes

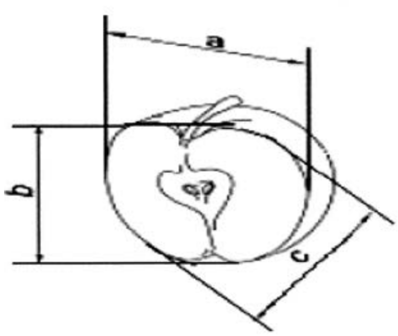


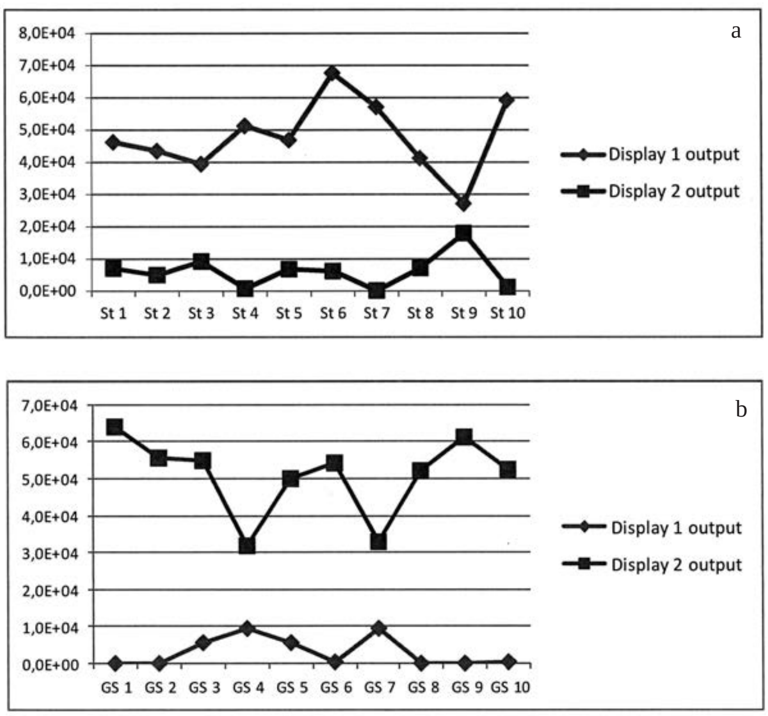
Table 3 Test results of MATLAB Simulink object recognition system

Tested kind of apple	Display 1 output	Display 2 output	System output (picture 4 block output)
St 1	46210	07081	Starking
St 2	43510	05000	Starking
St 3	39420	09214	Starking
St 4	51250	00808	Starking
St 5	46840	06854	Starking
St 6	67581	06214	Starking
St 7	57100	00105	Starking
St 8	41210	07152	Starking
St 9	27110	17960	Output Error
St 10	59120	01278	Starking
GS 1	00028	64050	Granny Smith
GS 2	00078	55520	Granny Smith
GS 3	05453	54790	Granny Smith
GS 4	09285	31750	Granny Smith
GS 5	05485	49870	Granny Smith
GS 6	00178	54120	Granny Smith
GS 7	09521	32780	Granny Smith
GS 8	00091	52100	Granny Smith
GS 9	00128	61120	Granny Smith
GS 10	00485	52451	Granny Smith

Table 4 Minimum and maximum size of apples

Kinds	Apple sizes					
	a		b		c	
	Min	Max	Min	Max	Min	Max
St	60	85	57	80	62	90
GS	80	90	72	92	77	97

Fig. 7 Test result graphics of MATLAB Simulink object recognition system:



a) Result graphic for St kind apple, b) Result graphic for GS kind apple

in **Fig. 3c** will occur in "Picture 4" labeled block in **Fig. 1**. At the end of the test, the outputs of MATLAB object recognition system are shown in **Table 1**.

When the image of "GS" kind of apple seen in **Fig. 4a**. is loaded into "Picture 1" labeled block **Fig. 1**, the picture in **Fig. 4b** will occur in "Granny" labeled block **Fig. 1** and the picture in **Fig. 4c** will occur in "Picture 4" labeled block in **Fig. 1**. At the end of the test, the outputs of MATLAB object recognition system are shown in **Table 2**.

In **Fig. 5**, the flow diagram of MATLAB-based object recognition system is seen.

The object recognition system in **Fig. 1** has been tested with apples in different forms and hardware output results have been presented in **Table 3**.

Minimum and maximum sizes of St and GS kind of apples used for test and they are shown at **Table 4**. The a, b and c view sizes of apples are seen at **Fig. 6**. The sizes of apples have been found by measurement finding software prepared.

In the result of 20 tests process, the output error has been seen only in one test. Therefore, the results of the designed object recognition system on 20 tests work with 95 % success.

Depending on **Table 3**, Display 1 and Display 2 labeled Hardware outputs found in **Fig. 1**. and they are graphically given in **Fig. 7**.

In **Table 3** the results of Display 2 for the first 10 tests have been tested by Duncan's Multiple Comparison analysis. In the result of the analysis, 10 different classes have been found. In **Table 3** the results of Display 1 for the last 10 tests have been tested by Duncan's Multiple Comparison analysis and in the result of the analysis, 10 different classes have been found.

In **Table 3**, the statistical correlation process of analysis results has been carried out. For the first 10 tests, the correlation between Display 1 and Display 2 has been shown in **Fig. 8a**. For the last10 tests, the correlation between Display 1 and Display 2 has been shown in **Fig. 8b**.

Running Of Open-Cv Based Object Recognition System

In Harpia object recognition system (**Fig. 2**), when St kind of apple picture is loaded to 1 numbered Image block the 8, 10, 13, 15 and 17 numbered outputs will be obtained as in **Fig. 9**.

In Harpia object recognition system (**Fig. 2**), when GS kind of apple picture is loaded to 1 numbered Image block the 21, 24, 26, 28 and 30 numbered outputs will be as in **Fig. 10**.

When **Fig. 9**. and **Fig. 10**. are analyzed, St kind of apple has been shown as binary in 8, 10, 13, 15, 17 numbered blocks; but GS apple has been shown as binary in 21, 24, 26, 28, 30 numbered blocks. Thus, the object recognition process has been realized. In Harpia-based object recognition system the effect of filter types has been seen through related output blocks.

Harpia and MATLAB object recognition systems have been tested with 20 pieces of apple pictures and the results of both systems are shown in **Table 5**.

According to **Table 5**, it can be said that object-recognition system designed with MATLAB operates with 95 % success, but object recognition system designed with Harpia OpenCV-based works with 80 % success.

Fig. 8 Correlation graphics for test results of MATLAB Simulink object recognition system: a) Correlation for the first 10 tests, b) Correlation for the last 10 tests

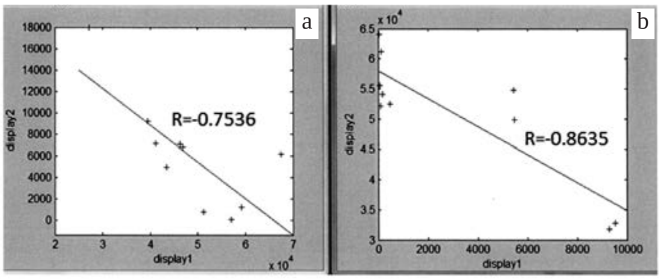
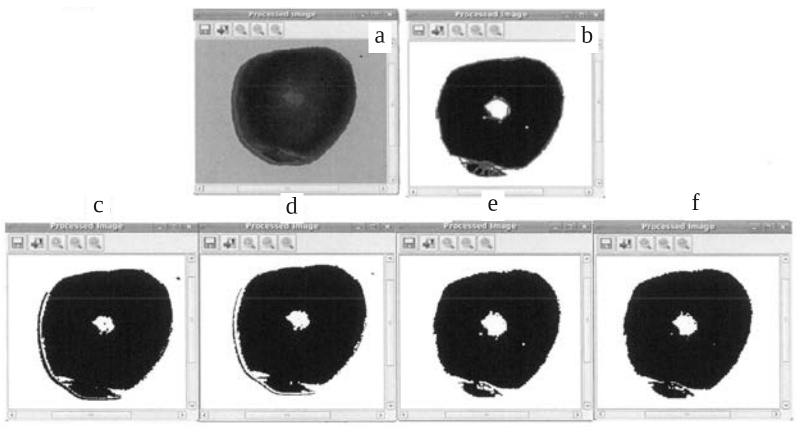
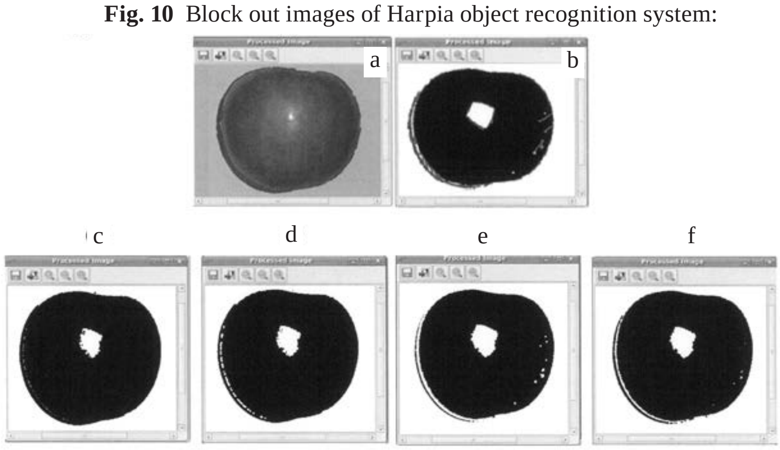


Fig. 9 Block out images of Harpia object recognition system:



a) 3 numbered block output, b)15 numbered block output, c) 8 numbered block output, d) 10 numbered block output, e) 13 numbered block output, f) 17 numbered block output

Fig. 10 Block out images of Harpia object recognition system:



a) 3 numbered block output, b)15 numbered block output, c) 8 numbered block output, d) 10 numbered block output, e) 13 numbered block output, f) 17 numbered block output

Discussion

The St and GS kind of apples, which have different sizes, have been used to test for the performance of MATLAB and Harpia object recognition systems. When object recognition system prepared MATLAB used to test with apples at **Table 3**, there has been mistaken result at 9 numbered test. In this test the gotten result of 17,960 level since exceeding 10,000 level in “Display 2” depending on the color of St kind of apple, it is considered that such a mistake has occurred. In **Table 3**, the highest measured level in “Display 1” for the first 10 test processes is at test number 6 and the highest measured level in “Display 2” for the last 10 test processes is at test number 1. It is considered that these highest gotten results have oc-

Table 5 Test results of MATLAB and Harpia object recognition systems

The tested apple kind	The result of MATLAB object recognotion system	The result of Harpia object recognotion system
St 1	Starking	Starking
St 2	Starking	Starking
St 3	Starking	Output Error
St 4	Starking	Starking
St 5	Starking	Starking
St 6	Starking	Starking
St 7	Starking	Starking
St 8	Starking	Starking
St 9	Output Error	Output Error
St 10	Starking	Starking
GS 1	Granny Smith	Granny Smith
GS 2	Granny Smith	Granny Smith
GS 3	Granny Smith	Granny Smith
GS 4	Granny Smith	Output Error
GS 5	Granny Smith	Granny Smith
GS 6	Granny Smith	Granny Smith
GS 7	Granny Smith	Output Error
GS 8	Granny Smith	Granny Smith
GS 9	Granny Smith	Granny Smith
GS 10	Granny Smith	Granny Smith

curred depending on the color kind of apples.

As seen in **Fig. 9** and **Fig. 10**, Harpia object recognition system firstly extracts objects from background and determines type of apple. After, it is seen that surrounding of the apple has been drawn with red line according to its type like in blocks 15 or 28. The reason of mistaken outputs of the tests numbered 3, 9, 14 and 17 in Table 5 of Harpia object recognition system is thought to arise from the kinds of apple-color and circuit design.

Conclusions

In this study, two object recognition systems have been designed that are needed for in industry. The usage of these systems is expected to become widespread since their usage actively in industry for object classification and object recognition.

Proposed object recognition system eliminates a major deficit in agricultural field. By this object recognition system, recognition process of fruit will be realized in sooner time using less manpower. After the usage of object recognition system being common the more work will be done with less economic expenses. In this case, in local sense it will contribute the development of institutions and in global sense the development of the countries.

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Design of a Mechanical Device to Applique the Direction of Cross-Section on Rural Road Projects

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Abstract

The prism is used with the method of rectangular coordinates of the direction of cross-section on a road project. It is difficult to apply the direction of the cross-section in the intermediate point of curve by prism. Currently, the use of an electronic distance measuring to determine the direction of a cross-section both on the horizontal curve and at the alignment is considered to be more accurate and faster in relation to the other available instruments. However, electronic distances measuring are expensive. A simple mechanical device has been designed to apply the direction of the cross- section both in the intermediate point of curve and at the alignment as precise as that in prism. The structure of the mechanical device and its usage has been explained in this study. In addition the precision of the vertical direction was determinated experimentally, a case study concerning with subject has been included.

Introduction

Generally in a road project, after marking the definite road axis the road axis on area, the longitudinal profile is applied first, then cross section is carried out on marked points of the longitudinal profile. The cross-section is applied to the direction of perpendicular of the at alignment, but the cross section is applied in radial direction to the axis of the road at the curve of the road. At the beginning of the cross-section, the application of a perpendicular direction is needed to alignment direction on the point of road axis of alignment, but the application of radial direction on the point of curve axis of the road must be done (Anonymous, 2004; Brockenbrough, *et al*., 2004).

To determine the direction of cross-section on a road project generally leveling instruments are employed such as the classic or electronic distance meter used at the alignment; the prism and classic or electronic distance measuring which is used on the horizontal curve (*Ince, 2000*). Currently, the use of an electronic distance measuring to determine the direction of a cross-section both on the horizontal curve and at the alignment is considered to be more accurate and faster in relation to the other available instruments. However, the electronic distance measuring is much more expensive than the leveling instrument and prism.

This paper reports on the creation of a simple mechanical device which is almost as accurate as the prism and not as expensive which can be used to determine the direction of the cross-section both in the horizontal curve and at the alignment. This application provides effective and fast measurement and will be useful for local governments to adopt for use with road projects.

In this study the structure of the designed device, its usage and the determination of the accuracy of the device have been explained. The practice about the task has been made and obtaining experiences have been discussed and suggestions about them have been presented.

Experimental Methods

The Construction of the Device

The construction of the triangle of cross-section is consisted of three main parts (**Fig. 1**):

1. The base headgear,
2. The orientation hands,
3. The special range pole and the tripod of its.

The base headgear is cylindrical from the front aspect. There are three orientation hands (2) intersecting the center of the base headgear. These orientation hands are on the side surface of the base headgear. The orientation hands are made of stainless steel and have a grooved mechanical bearing (16) under the base headgear where the special range pole (3) is fitted and there is a observation mark (5) with a sharp point. A screw (8) fixes the direction of the orientation hands to specific direction. To ensure a perfect fix on the determined direction, small piece of rubber is attached to the extremity of the fixing screw.

The length of the steel orientation hands is 50 centimeters, the diameter is 6 millimeters. There is a fixing bolt (8) under the base head gear which positions the orientation hands in a perpendicular direction.

The special range pole of the device is made of stainless steel. Steel with its length ranging between 50 cm, 100 cm and 150 cm. The top (surface) is level and the base is a sharp point. This range pole is established as perpendicular on the determined the point by the tripod (4) and bubble level (9) (**Fig. 1**).

Use of the Device

Preparation of the Device

Firstly an isosceles right-angled triangle that has sides of 3 - 4 m is constructed on level ground. Then a range pole is placed vertically at the definite point (R) in right corner of the isosceles triangle, after marking, a theodolite is set up at this point and the length of the right edge in the definite direction is measured with mm precision and the corner point (P_1) of the triangle is determined. The right angle starting at the RP_1 direction is applied sensitively and the other edge length at this direction is measured by millimeter precision and the other corner point (P_2) of the right angle triangle is marked. The P_1 and P_2 points are marked accurately with a range pole (**Fig. 2**).

Preparation of the device can be done by two methods according to quantity of theodolite instruments.

I Method

If two theodolite instruments are available, preparation of the device can be done as follows:

1. The special range pole is established at the R point and a theodoloite instrument is set up at each of the P_1 and P_2 points. Then the range pole's vertical orientation is first generally established by a bubble level then fine-tuned with the theodolite instruments.
2. The base headgear of the device is placed on the top of the special range pole with the orientation hands attached to the base headgear are loose. The A and B directing hands of the device are oriented to the theodolite instrument at the P_1 point.
3. The theodolite instrument at P_1 is oriented to the O observation mark and thus the P_1R (or P_1O) line is formed. The fixing screw on the base headgear is loosened. The operator uses a line of sight from P_1 point towards a second operative near the R point un-

Fig. 1 General appearance of triangle of cross-section and associated components

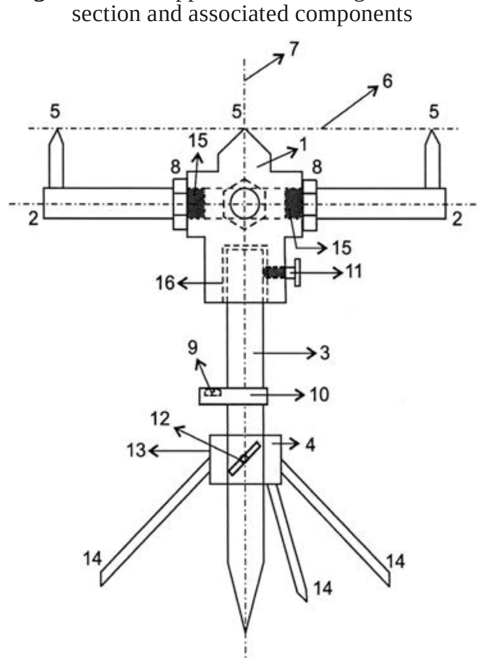
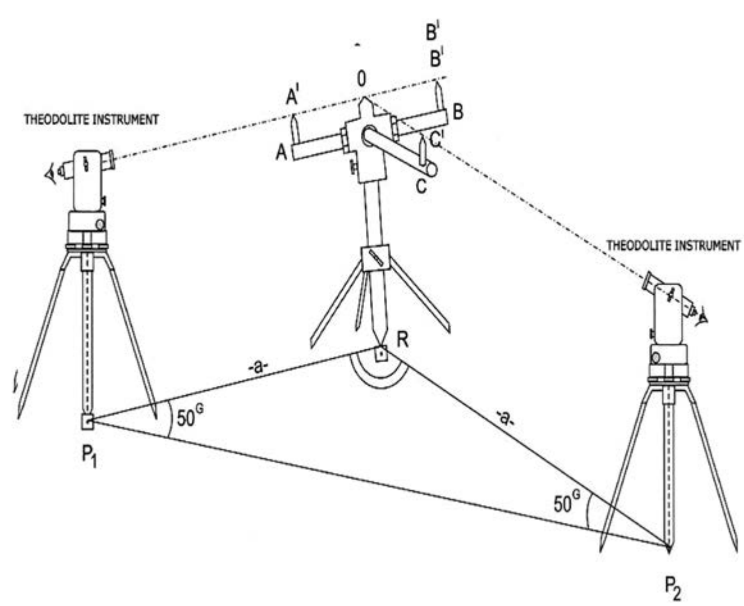


Fig. 2 Adjusting the horizontal direction and vertical angles of the axes of the view finder of the device with two theodolites



1. Base headgear, 2. Orientation hands, 3. Special range pole, 4. Device tripod 5. Observation mark, 6. Orientation axes, 7. Principal vertical line, 8. Fixing bolt, 9. Bubble level, 10. Protective cover for bubble level, 11. Fixing screw, 12. Tripod fixing screw, 13. Metal ring, 14. Legs supporting the device, 15, Grooved bearing, 16, No grooved bearing

til AO and BO hands with their observation marks are directed to the P_1O direction. When AO and BO hands are pointing to the P_1O line then the fixing screw is tightened. Until the P_1A' and P_1B' directions are in coincide with the P_1O direction, the concerning observation marks is rotated slightly to the right or left according to orientation axis. When the observation marks are perfectly aligned, the fixing bolt under the base headgear is tightened to ensure that there is no change of the position of the observation marks (**Fig. 2**).

4. The theodolite set up on the P_2 point is aligned with the O point then the position of A′ and B′ view finders of the device are adjusted. If the OC′ orientation axis is perfectly vertical in position to the other orientation axes, then the C′ point is coincided by direction of P_2O If there is no coincided then, C′ observation mark that as if it coincided by direction of P_2O, is rotated by a small amount to the right or left according to OC orientation axis by the second operative which by holding C′ observation mark. When the C′ observation mark is perfectly aligned in the desired direction, the fixing bolt that is connecting to base headgear is tightened. Thus the triangle of cross-section is ready for the measurement.

The fixing screw in the base headgear is loosened and the base headgear is removed from the top of the range pole taking care not to disturb the orientation hands and it is placed in special box. The device is carried by protection box at the points on the field.

II Method

If two theodolites are not available, then an isosceles right angle triangle with sides of 3–4 m can be created by aided one theodolite and a plumb bob. The range pole is placed at the corner point (O) where the right angle of triangle is located and it is erected in a vertical position and the plumb bob is suspended in the corner points (P_1, P_2) of the right triangle at stable situation (**Fig. 3**). The A and B orientation hands of the device are oriented to hanging plumb line by surveyor near the O point. Once the A′ and B′ observation marks are aligned to the OP_1 direction they are fixed by tightening the fixing bolt and the fixing screw to maintain the positions of the related orientation axes. Then the theodolite is directed towards the plumb line at the P_2 point and the C′ view finder is turned to suitable direction until the OC′ orientation axis is coincided with OP_2 direction and the fixing bolt is tightened. So the device is ready to measure.

Using the Device on Alignment

The special range pole is set up at the starting point (P_1) indicated by a range pole while the longitudinal profile is taking on alignment and the base headgear is placed on the top of the range pole. A range pole is set up at the P_2 point on the road axis, at a distance far from P_1 point. The OC orientation hand of the base headgear is directed to P_2 point. When the OC orientation hand of the base headgear is aligned perfectly with the P_2 point perfectly, fixing screw is tightened. The A′B′ line shows the direction of cross-section at a vertical position to the P_1 P_2 direction in this case (**Fig. 4**). One B″ point is marked on the A′B′ direction behind the A′ observation mark. Similarly an A″ point is marked on the B′A′ direction behind the B′ observation mark. The outside points of road are marked on the ground taking of the width as the road semi platform or the distance from the

Fig. 3 Adjusting the horizontal direction and vertical angles of the axes of the view finder of the device with a theodolite and a plumb line

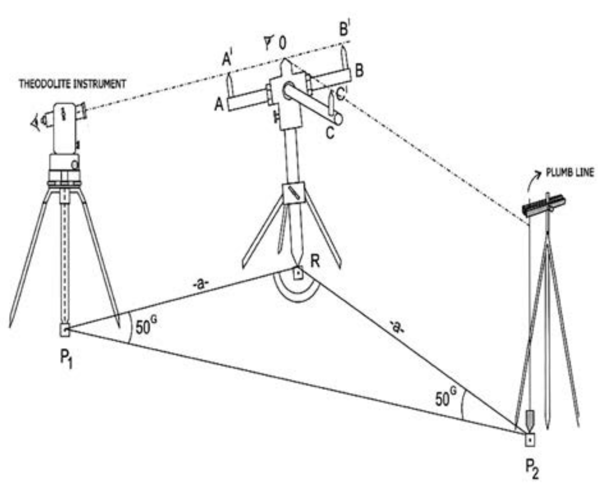
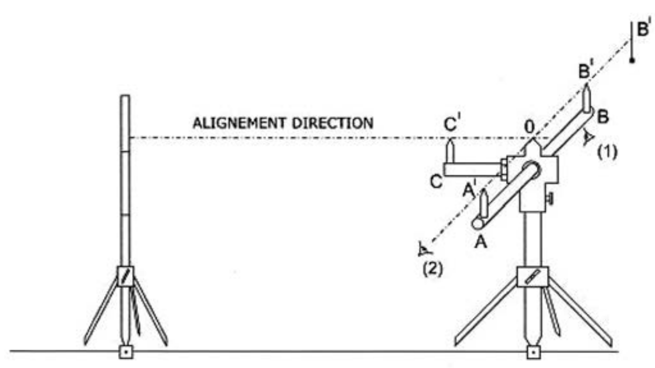


Fig. 4 Using the triangle of cross-section for alignment



road axis to stake on the slope in the direction of the previously marked A″ and B″ points beginning from P_1. A similar procedure is applied to other points.

Using the Device on a Horizontal Curve

To use the triangle of a cross-section on a horizontal curve, the constituted curve intermediate points obtained by dividing curve at the equal arc interval, must be marked on the ground according to chosen application method (Anderson *et al.*, 1997; Bannister *et al.*, 1992; Tüdeş, 1995; Wolf *et al.*, 2002). The direction of the cross section on the origin of curve is perpendicular position to alignment. Therefore, the triangle of the cross-section which is established on the origin of curve is oriented to one point of the road axis from behind the alignment and the procedure is made as explained on alignment. The method to determine the vertical direction from the common intermediate point of curve is to use the chord of left of its and the chord of right of its, at the application of direction of cross-section on the intermediate points of the curve (Ince, 2000; Ozgen, 1984). The triangle of the cross section is set up at the first intermediate point (P_1) of curve, a range pole is placed in front (P_2) of P_1 and at the back (Φ) of P_1 (**Fig. 5**). The OC′ orientation hand of the device is aligned to Φ point and the fixing screw is tightened when the direction is found. Then, the A′B′ orientation axis of the device is in a vertical direction to the P_1Φ direction. A surveyor looking from behind the A′ observation mark is aligned to the second surveyor in the direction of A′B′, then one D point that measuring as far as the defined distance (a) of cross-section at this direction starting at P_1 is marked. Then the fixing screw of the device is loosened and OC′ orientation hand is oriented to the P_2 point and when the full alignment is achieved the fixing screw is tightened. A surveyor looking from behind the A′ observation mark is aligned to the second surveyor in the direction of A′B′, then one E point that measuring as far as the defined distance (a) of the cross-section in this direction starting from P_1 is marked. A middle point (F) is determined by measuring the DE distance with a tape, the FP_1 direction is cross-section at the P_1 point. The extended part of the FP_1 direction is taken into the curve center to determine the direction of the cross-section on the other side of the road axis. A similar procedure is carried out on the other intermediate points of the curve.

Accuracy Determination of the Device

The precise position of the point found by the triangle of cross-section is affected by the direction of the vertical of special range pole and by the accuracy of the horizontal and vertical directions of the orientation hands on the base headgear.

Vertical Precision of the Special Range Pole

The vertical aspect of the special range pole is established by a plumb line in the terrain. If there is a deviation from the vertical line of the special range pole then this error can appear when using a theodolite. The special range pole is placed vertically on the O point which is marked at a distance of 3 to 5 m from the P station point and since the thickness of the plumb line affects the accuracy of the measurements various thicknesses of the plumb line are used (**Fig. 6**). The direction angle of the principal axis (VO) is measured by looking at the sharp point of the special range pole set located on the O point, by the theodolite established on the P

Fig. 5 Obtaining the direction of the cross-section at the intermediate point of curve by the triangle of cross-section

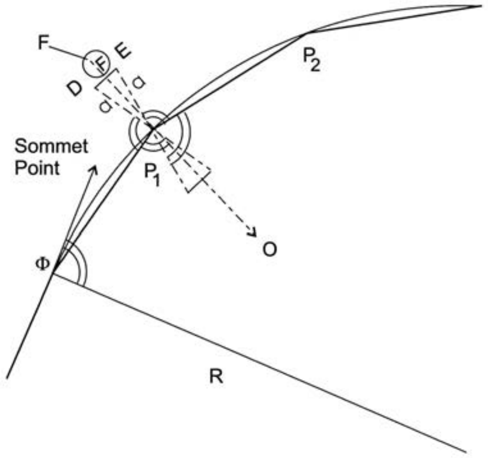
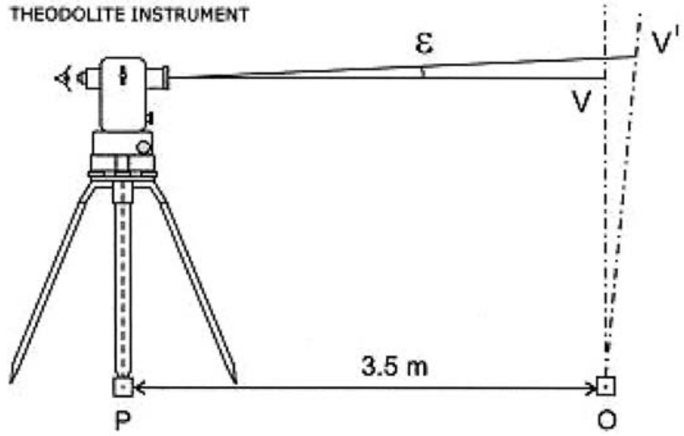


Fig. 6 Adjustment of the vertical alignment of the special range pole by plumb line



point and by looking at the top of the special range pole by telescope of the theodolite as moving to up and down. If the special range pole has achieved a true vertical then the stadia vertical line of the theodolite that coincides with the middle of the point (V) of the top of special range pole, is seen as a deviation from the VO principal axis since the special range pole has not achieved a true vertical by the plumb line. The stadia vertical line of the theodolite is aligned to the V' point by moving the fixing screw of horizontal little movie to definite of this amount of deviation and the direction angle is read and recorded. The difference (dε) between the measurements of the direction angles is explained by the deviation angle of special range pole according to station point. The amount of crosswise deviation (VV′) from vertical direction of the special range pole is obtained by the following equation, according to PO distance and dε shown in **Fig. 6**.

$VV' = (d\varepsilon / \rho)\ PO$ .... (1)

Accuracy of Horizontal and Vertical Directions Between the Target Axes at the Device

Although the calibration of the vertical and horizontal directions is having been made between target axes of the device, because the fixing screw is not completely tightened, the amount of deviation in both directions that are possible can be calculated as follows.

After the P_1A' and P_1B' view finder axes are coincided by the theodolite on the P_1 point which was created on the isosceles right angle triangle as shown in section Preparation of the Device. The theodolite instrument set up on the P_2 point is directed at the O point of the base headgear and at C′ view finder and direction angles are read (**Fig. 7**). If the C′ view finder coincides with the P_2O direction, then the reading direction angles are equal at each other, if there is no coincidence then the amount of deviation (dε) from defined direction is obtained from the difference between the direction angles. The amount of deviation (dγ2) from vertical direction between OC′ and OA′ view finder axes is obtained by the relationship according to P_2C' and C′C″ distances.

$P_2C' = P_2O - OC'$..................... (2)

$C'C'' = (d\varepsilon / \rho)\ P_2C'$ .... (3)

$d\gamma 2 = C'C'' / OC'\ \rho$ .... (4)

Position Precision of the Applied Point

If the amount of deviation from the perpendicular of the special range pole not to take into consideration to application then the right angle is obtained from O′ point instead of O (**Fig. 8**). This factor is effected to the position of the applied point as a constantly.

The error (M′M″) of the vertical of the vertical orientation hand of the device is affected by the corresponding vertical length. The total effect of the MM′ is expressed as follows;

$M'M'' = d\gamma / \rho\ OM$ .... (5)

$MM'' = OO' + M'M''$ .... (6)

Fig. 7 Use of a direct measuring method in at the (adjustment) of the horizontal and vertical directions on the target hands of the device

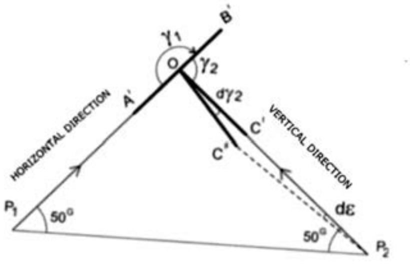
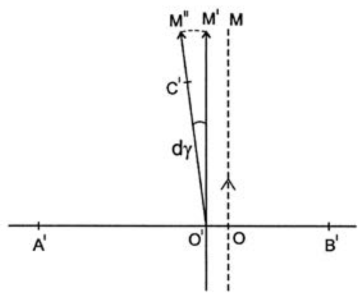


Fig. 8 Of the vertical direction error (OO′) of the special range pole and vertical direction error of orientation hand is affection to position of point at the application done by the special range pole



Results and Discussion

To definite the vertical precision of the special range pole, and the accuracy of the horizontal and perpendicular direction of the orientation axis of the device, an isosceles right angle triangle was created that cathetus is 3.50 m at the application field. If cathetus is less than 3 m in isosceles right angle triangle which will be constructed, the clarification of observed points get difficult when observation that will be made by theodolite instrument. First, the accuracy of the perpendicular orientation of the special range pole achieved by a bubble level as given in section Vertical Precision of the Special Range Pole.

According to the station point, the angular deviation in the line of sight in a vertical direction and the breadth deviation is shown at **Table 1**. These measurements were repeated 10 times.

For the determination of the accuracy of the horizontal and vertical directions, the measurements were carried out as shown **Fig. 7** and the following results were obtained (**Table 2**).

The breadth deviation errors at the P_1 and P_2 points (VV_1', VV_2') calculated by **Eqn. 1**, take into consideration OP = 3.5 − 0.5 = 3000 mm and for dε as given in **Table 1**.

$VV_1' = (0.035 \times 3000) / 63.6620 = 0.164933$ mm

$VV_2' = (0.030 \times 3000) / 63.6620 = 0.141372$ mm

The deviation error ($d\gamma_1$) from both the horizontal direction of the device at the O point and the deviation error ($d\gamma_2$) from vertical direction were calculated taking into consideration the related breadth

Table 1 Angle deviation (dε) from vertical of the special range pole

Deviation of angle from vertical: dε (^{gon})	
Variation Interval	Average
± 0.015 − ± 0.035	± 0.025

Table 2 The horizontal and vertical direction precision values of the device obtained from P1 and P2 points

Results obtained (^{gon})	Deviation from horizontal direction at P_1 point	Deviation from horizontal direction at P_2 point
Average deviations error (dε)	± 0.0035	± 0.0030

deviation errors and the orientation hand length of 500 mm.

$d\gamma_1 = 0.164933 \times 63.6620 \div 500 = \pm 0.021^{gon}$

$d\gamma_2 = 0.141372 \times 63.6620 \div 500 = \pm 0.018^{gon}$

These obtained values for $d\gamma_1$ and $d\gamma_2$ are accepted as normal error value. These errors can be risen from the work done in lathe and milling machine when the application right angle which made in grooved bearing of orientation hands at the base headgear of the device. There is a ± 0.025^{gon} perpendicular error (amount of deviation from vertical direction) also in prism which is used for application of right angles and these errors are risen from the production.

When the vertical precision of the device is found to be in the range of ± 0.01^{gon} and ± 0.05^{gon} the application of the cross-section direction can be carried out on the road; the breadth deviation errors (theoretical position errors) according to various vertical lengths are shown in **Fig. 9**.

It can be seen that from the measurement obtained by the device that when the perpendicular error increased, the breadth deviation error also increased. It can be seen that when the perpendicular error was equal ± 0.05^{gon} and a ± 1 cm breadth deviation error was found at a perpendicular length of 15 m. Thus the device can be used in a road application.

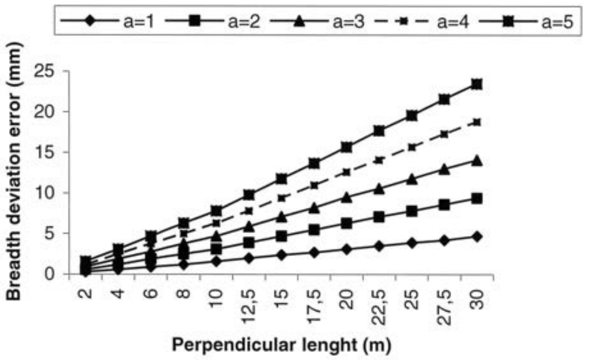


Fig. 9 The variation of the breadth deviation error according to various perpendicular errors (a)and perpendicular lengths(a: minute of arc in unit grad)

Conclusions

The following conclusions may be drawn from the present study:

- The application of cross-section on a rural road project is possible by the proposed device which is less expensive than a prism. It can be easily manufactured with a lathe and milling machine. This device can be used by local governments for all types of urban and rural roads.
- It has been shown that obtaining a cross-section direction at the curve intermediate points which marked in the equal arc intervals with this device is easier than using a prism.
- When a right angle is obtained by a prism because of the application point is not visible a position error is constituted. This error is greater than the deviation error from vertical direction of the special range pole obtained by the proposed device. It can be said that the point position precision provided by the device is better than the precision of prism.

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Predicting Tractor Power Requirements Using Decision Support System —A Tool for Farm Machinery Management

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Abstract

The adoption of information and communication technologies for knowledge-based agricultural production is becoming necessary tool in order to respond to numerous challenges of agricultural sector. The importance and needs of developing decision support systems for farm management have already been recognized by the policy makers and by the end users i.e. the farmers also. A decision support system PAU_TRACPWR has been developed using a detailed data information on crop production parameters for major crops being grown in India, tractor prices, crop values, labour charges, cropwise adoption level of various farm technologies. The critical tractor power requirements would increase to 56.22 million kW by 2025.The adoption of improved technologies in tillage and sowing, new harvesting equipment like tractor operated cotton picker, sugarcane harvesters, crop residue managing equipment would help in bringing down the total tractor power requirements in the region with immediate interventions by farmers, developers and policy makers.

Introduction

Knowledge has remained core strength of the life since ages and there is an ongoing change towards knowledge-based societies and economies in which research and innovations are the major components. The adoption of information and communication technologies for knowledge-based agricultural production is becoming necessary tool in order to respond to numerous challenges of agricultural sector. Consumer demands on food safety and security, sustainable development, environmental protection, sustainability of farmers' revenues and a competitive advantage and power in both domestic and global markets are the thrust areas for making agriculture a significant contributor in Indian economy. The adoption of information and communication technologies as a unique challenge in rural areas has long been a specific public concern with regional, national and international strategic significance. Farm and crop management integrated with information systems will allow farmers not only to maximize profits or minimize input costs, but also to deal with issues surrounding quality and the value of production.

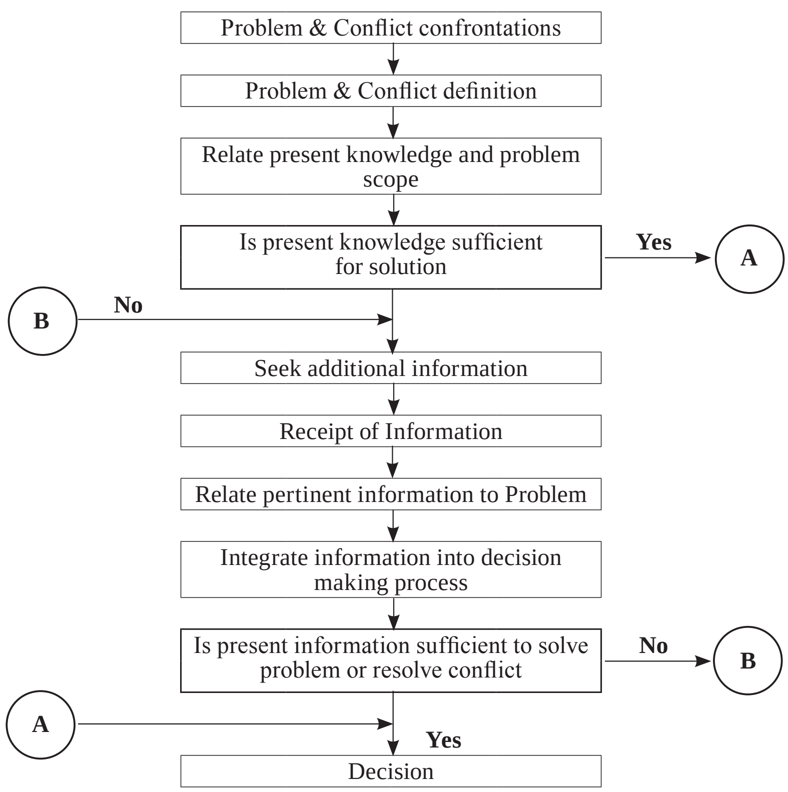
Agriculture continues to remain

a significant sector of the Indian economy, which contributes 18 percent of GDP, provides 65 percent of employment and continued to be the primary source of living for 70 percent of the population in India. Out of an estimated 142.4 m ha net cultivated area in India only, more than 50 m ha are under double cropping. About 60 % of the Indian agriculture is rain fed which contributes 44 % production of total farm output of country and is prone to vagaries of monsoonal aberrations like drought. The progress of agricultural mechanization has been closely linked with the overall development in production agriculture. Till 1950, very few farmers possessed prime movers like tractors, engines and motors. Heavy agricultural tractors and machinery were imported by government organizations mainly for land reclamation and development of large government farms.

Availability of adequate farm power is very crucial for timely farm operations for increasing production and productivity and handling the crop produce to reduce losses. Agricultural labour, draught animals, tractors, power tillers, diesel engines and electric motors are the major sources of power used for farm operations. Tractorisation, as backbone of farm mechanization, has played a pivotal role in bringing green revolution in the country. Diverse utilization and adoption of tractor power in the country is due to varying sizes of farm holdings (average farm holding size 1.6 ha) and socio-economic disparities. The contribution of animate power and tractor power to total power available (0.40 hp/ha) was 65.4 % and 7.6 % respectively in 1971-72. As the usage of tractors in Indian agriculture accelerated, the animate power contribution reduced to 14 % by 2007-08. The contribution of tractor power increased to 40.0 % in 2007-08. However, the total power availability at farm increased to 1.60 kW/ha in 2007-08. An interesting feature of increase in farm power availability and consequent enhanced mechanization in India is that the quantum of power availability and the proportion of mix of animate and mechanical power have, however, been different in various parts of the country and over time.

The importance and needs of developing decision support systems for farm management have already been recognized by the policy makers and by the end users i.e the farmers also. Several decision support systems have been developed for management of agricultural production system. Butani and Singh (1994) developed a DSS for optimization of farm machinery system with the flexibility to incorporate regional variations in crops and cropping practices, farm characteristics, sizes of farm equipment and costs of the resources and outputs. Lazzari and Mazzetto (1994) developed a farm machinery selection and management model as a decision support system (DSS) for farmers and extension services. Ismail (1998) developed a Crop Production Machinery System (CPMS) to predict the size of tractors and implements required to complete the farm operations during a specified duration of time. The machinery cost analysis model was able to evaluate machinery costs to determine the most profitable combination of crops in relations and to evaluate different farming alternatives either to up-scale or down-scale farm operations. Panesar and Fluck (2001) developed a framework for regional energy planning of agricultural production system using GIS. Sidhu (2001) developed a system dynamics simulation model to assess the energy requirements in crop production system in Punjab for the period from 1980 to 2010. Jaskaran (2001) developed a decision support system (DSS) for farm machinery and energy management in spatially changing and complex crop produc-

Fig. 1 Use of information in the decision making process



tion system.

Keeping in view the needs of timely decisions to be taken on farm power requirements in crop production systems for making it not only sustainable but also a profitable venture as one of the significant contributor on country's economy, a Decision Support System was developed.

Materials and Methods

Decision-making is an activity common to all levels of management, and often considered to be management itself. Within both the planning and the controlling processes, the planner or manager is required to make decisions. The quality of decision is related to the information available to the decision maker. Decision may also be regarded as a 'choice', representing a course of behaviour selected from a number of (more than one) possible alternatives. An orderly process of arriving at a decision contains a series of steps to be followed as shown in **Fig. 1**. These decision supports systems have become necessary for today's agricultural crop production system mainly due to fast computation, enhanced productivity, data transmission, better decisions and competitive edge. Decision Support System (DSS) provides support for decision-makers in mainly semi-structured and unstructured situation by bringing together human judgments and computerized information at almost every level of decision-making required by individuals or groups.

To understand the current status of different farm power sources and their relative usage in crop production system, the information in form of secondary data was collected from statistical abstracts of Punjab and India, tractor and farm machinery manufacturing organizations, government reports and ICAR data books. Various departments mainly, Department of Soils, Agronomy, Economics & Sociology etc were visited personally to have experienced suggestions regarding the facts collection and utilization in required decision support system. Wherever the approximation was used it was framed in consultation with the relevant experienced faculty from the concerned departments of the PAU Ludhiana.

After the conceptualization of a decision support system, for predicting total tractor power requirements of a particular region, the study was undertaken to determine the tractor power requirements of India. Since the power availability i.e. the size of tractor power was not considered to be the constraint or limiting factor for the period under study, the variation of soil types in the region considered were classified broadly in three types i.e. light, medium & heavy soils. The total cropped area on yearly basis by utilizing the net sown area suitable for agricultural purposes was recorded since 1990-91 onwards to have trend of land utilization pattern of country. The distribution of net sown area in three major soil types i.e. Light, Medium & Heavy soils was also recorded to determine the multiple passes of farm equipment usage for various farm operations using tractor as power source. Keeping in view the present scenario of Indian agriculture, eight major crops i.e. wheat, paddy, maize, oilseeds, pulses, cotton, potato and sugarcane were considered. The all oilseeds crops and pulses were collectively considered as oilseeds and pulses respectively. The crop parameters mainly, area under crops, yield and production were recorded on yearly basis from 1990-91 to 2005-06. The extent of use of different farm implements and its multiple passes depending upon the soil conditions were determined. Further, year-wise, and crop-wise tractor operated area was also estimated.

Labour shortage and its uncertainty for timely availability, natural resource conservation, need for eco friendly farm technologies were observed to be significant factors for varied level of different farm technologies being used/preferred by the farmers in different regions. The extent of use of advanced farm equipment was considered to be most significant factor towards the total tractor power requirements in present scenario of a region and prediction of its future requirements. Tillage and sowing had been considered to be the major farm operation among all the operations consuming most of the energy. Conventional tillage and sowing using traditional tractor operated implements like MB plough, disc harrow and planker and drills were the most adopted technology. But with the advancement of technologies, improved tillage and minimum tillage technologies had also been observed to be increasing for better profitability and timely operations. Managing previous crop residue by simple means of burning was the traditional method in the past but introduction of residue management technologies and implements like baler, straw combine etc the use of tractors has also increased. Interculture and plant protection equipment like tractor operated weeders, earthing up equipment and sprayers had also been picking up. Combination of tractor operated reapers and threshers have also observed to be increasing in various crops enhancing total power requirement of any region for timely completion of farm operations.

Timeliness of farming operations were considered to be the most significant characteristic of agriculture and various farm implements to be used in a fixed time period of its growing season right from residue management of previous crop, land preparation and sowing to harvesting and threshing and then timely transportation of farm produce to reach market avoiding any loss. A detailed farm calendar of various farm operations for crops taken into considerations in the present study and intended to be grown in regions was framed for the country. This farm calendar was prepared to determine the critical period of farming operations in India where the multiple farming operations are to be carried out simultaneously requiring the total tractor power for timely field operations. The use of tractor operated farm implements in particular fortnight or month of an year under various technologies, i.e residue management, tillage and sowing, plant protection, harvesting & threshing, transportation was defined the country. Two critical periods in Kharif and Rabi season each were framed as May 1 to July 30 and October to December. Since crops like paddy, maize, oilseeds, pulses, potato and sugarcane which were scheduled to be grown in more than one season in a year, the percentage area to be grown in each season out of total crop area under these crops was also estimated to determine the critical tractor power requirements. Multiplicity of cropping systems had been considered to be the one of the main features of the Indian agriculture.

A computer based Decision Support System PAU_TRACPWR was developed in 2009 for making decision on technology interventions by the user with full of information in the form of historical database files on various variables involved. A user-friendly interface was also developed for making future predictions. The DSS was developed in Visual FoxPro at the front end and all data files were managed in Dbase. The decision support system PAU_TRACPWR was designed to get the outcome as total tractor power requirement for all the farm operations to be carried out while growing each crop considered under the study for a particular region. Provision was also made to get the output as tractor power requirements in a particular month or selected time frame or critical time period considering the multiple farm operations for multiple crops to be grown in that period. To have the user intervention and provide some guidelines to feed the realistic values on various input variables as contributing factors for determining the tractor power requirements of a region, a detailed data help line in the form of data files along with trends on various crop production parameters were also made available in the decision support system PAU_TRACPWR accessible at any time of its use. These data files act as a guiding tool for a user to make best use of the decision support system developed.

Results and Discussion

Predicting Tractor Power in India using Pau_tracpwr

Based on the existing data, interaction with economists, agronomists, engineers working and associated with crop production system and government policies and priorities, a future projected/estimated values for crops and tractor related parameters were established in details for major crops presently being grown on tractor operated in India (**Tables 1** to **3**). These values were used in the DSS PAU_TRACPWR

Table 1 Year-wise estimated crop area, production & yield of major crops grown in India

Crop	Area under crop (000 ha)				Area under crop out of net area sown (Percent)				Crop production (million tonnes)				Crop yield (q/ha)			
	2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025
Wheat	27,779	28,580	29,381	3,0182	19.8	20.4	21.0	21.6	79.18	84.42	89.65	94.89	28.50	29.54	30.51	31.44
Paddy	43,755	43,974	44,192	44,411	31.2	31.4	31.6	31.7	145.27	155.02	164.76	174.50	33.20	35.25	37.28	39.29
Maize	7,768	8,289	8,809	9,330	5.5	5.9	6.3	6.7	16.36	18.41	20.47	22.52	21.06	22.21	23.23	24.14
Oilseeds	24,063	23,528	22,993	22,458	17.1	16.8	16.4	16.0	24.88	26.20	27.53	28.86	10.34	11.14	11.97	12.85
Pulses	21,084	20,492	19,901	19,309	15.0	14.6	14.2	13.8	13.09	13.04	12.99	12.94	6.21	6.36	6.53	6.70
Cotton	8,932	9,203	9,473	9,743	6.4	6.6	6.8	7.0	3.98	4.49	4.99	5.50	4.46	4.88	5.27	5.64
Potato	1,527	1,659	1,790	1,922	1.1	1.2	1.3	1.4	28.68	31.88	35.08	38.27	187.83	192.19	195.91	199.12
Sugarcane	4,314	4,417	4,520	4,623	3.1	3.1	3.2	3.3	291.22	300.53	309.84	319.14	675.05	680.36	685.43	690.28

Table 2 Year-wise estimated crop price, tractor price, labour charges

Year	Crop price (Rs/q)								Tractor Price, Rs/kW	Labour Charges, Rs/h
	Wheat	Paddy	Maize	Oilseeds	Pulses	Cotton	Potato	Sugarcane		
2010-11	1,200	850	800	2,500	3,000	2,500	800	150	13,000	15.0
2015-16	1,450	1,100	1,000	3,000	3,700	3,000	1,500	200	15,000	20.0
2020-21	1,700	1,300	1,200	3,500	4,500	4,000	2,000	250	17,000	40.0
2025-26	2,000	1,500	1,500	4,000	5,000	5,000	2,500	300	20,000	60.0

to predict tractor requirements for India during the years 2010-11, 1015-16, 2020-21 & 2025-26. Keeping in view the food requirements of growing population, it was estimated to maintain the level of net sown area of 140.0 million ha in India by 2025. In India, area under wheat was estimated to grow and reach up to 30,182 thousand ha producing 94.89 million tonnes of wheat by 2025. Paddy will remain one of the leading food grain crops in Indian agriculture, so the area under paddy was estimated to reach 44,411 thousand ha by 2025. The overall production of paddy was estimated to be 174.5 million tonnes by 2025. The area under maize was estimated to grow up to 9,330 thousand ha with overall production of 22.52 million tonnes. The declining trends of oilseeds crops estimated to go down to 22,458 thousand ha with 28.86 million tonnes of production. The area under pulses was also estimated to be around 19,309 thousand ha producing 12.94 million tonnes by 2025. The area under cotton may reach 9,743 thousand ha with production level of 5.50 million tonnes by 2025. Potato and sugarcane would also cover 1,922 and 4,623 thousand ha area respectively by 2025 with production of 38.27 million tonnes and 319.14 million tonnes respectively (**Table 1**).

Relatively better market price in comparison to total crop production costs are the key factors among the farmers to opt for crops to be grown by them in a region. Presently, wheat, paddy, maize, cotton and sugarcane produce are picked up by the government agencies directly at minimum support prices, helping farmers to get assured income. But due to open market and global econ-

Table 3 Year-wise estimated % tractor operated area and technology adoption level for major crops grown in India

Crop	Year	Area under cultivation using tractor as power source, %	Area under different tractor operated farm technologies (%)							
			Residue management	Conventional tillage & sowing	Improved tillage & sowing	Minimum tillage & sowing	Tillage combine	Plant protection	Harvesting	Threshing
Wheat	2010-11	85	20.0	89.5	1.0	5.0	2.0	0.0	12.5	12.5
	2015-16	87	25.0	79.0	5.0	10.0	5.0	0.0	15.0	15.0
	2020-21	89	30.0	63.0	10.0	15.0	7.5	0.0	17.5	17.5
	2025-26	90	35.0	50.0	20.0	20.0	10.0	0.0	20.0	20.0
Paddy	2010-11	62	0.5	99.0	1.0	0.0	0.0	0.0	12.5	12.5
	2015-16	65	2.0	95.0	5.0	0.0	0.0	0.0	15.0	15.0
	2020-21	67	5.0	90.0	10.0	0.0	0.0	0.0	17.5	17.5
	2025-26	70	10.0	80.0	20.0	0.0	0.0	0.0	20.0	20.0
Maize	2010-11	70	0.0	99.0	1.0	0.0	0.0	1.0	0.0	35.0
	2015-16	72	0.0	95.0	5.0	0.0	0.0	2.5	0.0	40.0
	2020-21	74	0.0	90.0	10.0	0.0	0.0	5.0	0.0	45.0
	2025-26	75	0.0	80.0	20.0	0.0	0.0	7.5	0.0	50.0
Oil Seeds	2010-11	67	0.0	99.0	1.0	0.0	0.0	0.0	5.0	5.0
	2015-16	70	0.0	95.0	5.0	0.0	0.0	0.0	7.5	7.5
	2020-21	72	0.0	90.0	10.0	0.0	0.0	0.0	10.0	10.0
	2025-26	75	0.0	80.0	20.0	0.0	0.0	0.0	15.0	15.0
Pulses	2010-11	67	0.0	99.0	1.0	0.0	0.0	0.0	5.0	5.0
	2015-16	70	0.0	95.0	5.0	0.0	0.0	0.0	7.5	7.5
	2020-21	72	0.0	90.0	10.0	0.0	0.0	0.0	10.0	10.0
	2025-26	75	0.0	80.0	20.0	0.0	0.0	0.0	15.0	15.0
Cotton	2010-11	55	0.0	99.0	1.0	0.0	0.0	92.5	0.0	0.0
	2015-16	60	1.0	95.0	5.0	0.0	0.0	95.0	1.0	0.0
	2020-21	65	2.0	90.0	10.0	0.0	0.0	97.5	5.0	0.0
	2025-26	70	5.0	80.0	20.0	0.0	0.0	100.0	10.0	0.0
Potato	2010-11	70	0.0	99.0	1.0	0.0	0.0	0.0	50.0	0.0
	2015-16	75	0.0	95.0	5.0	0.0	0.0	0.0	55.0	0.0
	2020-21	80	0.0	90.0	10.0	0.0	0.0	0.0	60.0	0.0
	2025-26	85	0.0	80.0	20.0	0.0	0.0	0.0	65.0	0.0
Sugar Cane	2010-11	60	0.0	99.0	1.0	0.0	0.0	0.0	0.0	0.0
	2015-16	70	2.0	95.0	5.0	0.0	0.0	0.0	1.0	0.0
	2020-21	80	5.0	90.0	10.0	0.0	0.0	0.0	5.0	0.0
	2025-26	90	10.0	80.0	20.0	0.0	0.0	0.0	10.0	0.0

omy these days, the crop prices of Indian produce is estimated to grow continuously. The crop prices (Rs/q) of wheat, paddy, maize, oilseeds and pulses are estimated to reach around 2000, 1500, 1500, 4000 and 5000 respectively by 2025. Whereas, the cash crops like cotton, potato and sugarcane are expected to get comparatively higher market returns in global market and reach to increased level of around 5000, 2500 and 300 Rs/q respectively. Similarly the tractor prices in terms of price per unit power are also estimated to grow up to Rs. 20,000 per kW. The shortage and timely availability of farm labour in future is big threat in agricultural production system. This may increase the labour charges to level of Rs. 60 per hour by 2025 (**Table 2**).

Tractorization is considered to be backbone of farm mechanization for increasing the overall production level of agricultural sector contributing to Indian economy. Crop- wise tractor operated area is estimated to grow around 90, 70, 75, 75, 75, 70, 85 and 90 % by 2025 (**Table 3**). Presently, conventional tillage and animal-drawn implements are being used mostly in various regions of the country. However, the farmers have also preferred improved technologies in their crop production systems. Use of improved tillage technologies like rotavator in crop production is estimated to cover almost 20 % area. Minimum tillage and tillage combine using zero-till drills and roto-tilll drills for wheat is also estimated to cover about 30 % of area under crop (**Table 3**). Adoption of advanced farm technologies would help in reducing the total tractor power requirement in crop resulting into lowering the overall tractor power requirement of any region. This would also help in reducing the total cost of crop production due to economical use of tractor power by the farmers in a region through sharing resources and cooperative farming facilities.

Keeping in view the estimated values of area under various crops, their production levels using advanced farm technologies/ implements and price values in the market, the tractor power requirements are predicted for both the seasons i.e. Kharif and Rabi using DSS PAU_TRACPWR for the years 2010-11, 2015-16, 2020-21 and 2025-26. The maximum tractor power requirements out of these two seasons were recorded as critical tractor power requirement of India. This would increase the critical tractor power requirements of India for the crops considered under this study to 55.82, 58.66 and 59.19 million kW by 2010-11, 2015-16 and 2020-21 respectively. This will go down to 56.22 million kW in 2025-26 which would be lower than the requirements of 2020-21 mainly due to desired shift of tractor power utilization and use of energy conservation technologies. The number of tractors would increase to almost 2.15, 2.26, 2.28 and then reduce to 2.16 million for the major crops considered under this study during 2010-11, 2015-16, 2020-21 and 2025-26 respectively (**Table 4**).

Table 4 Tractor power predicted using PAU_TRACPWR for major crops under study in India

Tractor Power	2010-11	2015-16	2020-21	2025-26
Rabi, million kW	55.82	58.66	59.19	56.22
Kharif, million kW	41.22	45.1	47.16	46.28
Critical Power of Region, million kW	55.82	58.66	59.19	56.22
Number of Tractors, million	2.147	2.256	2.277	2.162

The tractor power requirements for conventional tillage and sowing would be reducing continuously and reach to level of 41.73, 67.05, 74.05, 64.69, 52.99, 54.03, 43.07 and 75.55 % and for improved tillage and sowing operations would increase to 16.38, 17.65, 15.19, 17.39, 14.24, 10.71, 11.19 and 19.62 % for wheat, paddy, maize, oilseeds, pulses, cotton, potato and sugarcane respectively by the year 2025. Tractor operated harvesting equipment would also contribute at higher rate in total tractor power requirements with 18.25, 11.84, 17.89, 32.73, 2.88, 45.62 and 4.43 % for wheat, paddy, oilseeds, pulses, cotton, potato and sugarcane respectively by 2025.

Hence, the tractor power utilization as discussed above revealed that adoption of improved technologies in tillage and sowing, new harvesting equipment like tractor operated cotton picker, sugarcane harvesters, crop residue managing equipment would help in bringing down the total tractor power requirements in country. The tractor power requirement would be increasing initially, but definitely by adopting such planned farm input resources in terms of tractor power utilization in crop production system would help Indian farmers also to see the desired reverse trend/shift of lower tractor power requirements by the year 2025.

Conclusions

In India, the critical tractor power requirements would increase to 55.82, 58.66 and 59.19 million kW by 2010-11, 2015-16 and 2020-21 respectively, but further reduce to 56.22 million kW by 2025-26 due to use of advanced farm technologies. The number of tractors for crops selected under study would increase to almost 2.15, 2.26, and 2.28 million by 2010-11, 2015-16 and 2020-21 respectively and then reduce to

2.16 million by 025-26. The tractor power requirements for conventional tillage and sowing would be reducing continuously and reach to level of 41.73, 67.05, 74.05, 64.69, 52.99, 54.03, 43.07 and 75.55 % and for improved tillage and sowing operations would increase to 16.38, 17.65, 15.19, 17.39, 14.24, 10.71, 11.19 and 19.62 % for wheat, paddy, maize, oilseeds, pulses, cotton, potato and sugarcane respectively by the year 2025.

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Influence of Pad Configuration on Evaporative Cooling System Effectiveness Inside a Wind Tunnel

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Abstract

The investigation has been conducted to study the influence of pad configuration on the evaporative cooling effectiveness inside a wind tunnel. Three different configurations of pad were designed and these were expressed in terms of vertical, horizontal and multi-horizontal. As well as, the influence of both pad thickness and pad-face air velocity was investigated. A developed wind tunnel was employed as pad-fan evaporative cooling system to fulfill the objectives of study. The experimental results revealed that the multi-horizontal pad configuration has achieved the highest values of cooling potential if it is compared with the other two pad configurations during the whole period of operation. The highest average cooled air temperature inside the wind tunnel was found at pad thickness of 15cm and pad-face air velocity of 1m/s for the multi-horizontal pad configuration. For multi-horizontal pad configuration and 1m/s pad-face air velocity, the mean cooling potential was raised from 7.46 to 11.78 ºC (+57.91 %) by increasing pad thickness from 3 to 15cm. The highest mean values of cooling potential were found at pad thickness of 15cm and pad-face air velocity of 1 m/s for the multi-horizontal pad configuration. Saturation efficiency was dramatically raised by increasing the thickness of pad especially for multi-horizontal pad configuration. The required airflow rate was raised by increasing both of pad thickness and pad-face air velocity for all configurations of pad. It has been reached its maximum values when applying the multi-horizontal pad configuration because of the rapid fluctuations taken place in airflow resistance. By increasing pad thickness from 3 to 15 cm, for multi-horizontal pad configuration and pad-face air velocity of 1m/s, the static pressure drop across the pad was raised from 31.39 to 70.63 Pa (+125 %).

Introduction

Evaporative cooling is an adiabatic process (no gain or loss of heat) which lowers the dry-bulb temperature while increasing dew point temperature of an air and water vapor mixture (Hahn and Wiersme, 1972). It has numerous applications of environment control in agriculture, which require more cooling than can be provided by ventilation alone (Albright, 1990). In Egypt, the pad-fan evaporative cooling system is considered as the most common way in reducing heat stress. Efficient cooler performance is highly dependent upon the pad performance. There are no available engineering knowledge about the relationship between the pad configuration and its material type and the evaporative cooler performance. Therefore, it is necessary to pay attention to the configuration of pad and its effect on the investigated system. Generally, meeting pad design requirements to some reasonable or acceptable levels of agriculture is relatively simple. Defining requirements for a high level of performance over a wide range of conditions is difficult. An increase in pad thickness directly increases the resistance to airflow while increasing the contact time of air traversing the pad. However, as air passes through additional thickness of pad, the vapor pressure different decreases. This results in a decrease in the evaporation rate giving element as it continues its path through the pad. The precise relationship is not well known. Increasing pad density enhances overall porosity or capillarity providing more uniform distribution of water. Air velocity through the pads varies at different points within the pad and it is difficult to measure. The velocity entering or exiting from the pad, referred to as pad-face air velocity, is much easier to measure and is commonly used to define pad velocity. It is a basic design parameter used for calculating pad area (Hellickson and walker, 1983). Utilization of rice straw and palm leaf fibers (Kerina) as pad materials in an evaporative cooling system can contribute in solving the accumulation of some agricultural residues such as rice straw. Also, it can play a fundamental role in the environmental dimension. Temperature reduction for all rice straw treatments was higher than that for Kerina by about 15.467 % (Darwish, 2006). A wind tunnel is a device for producing a controlled stream of air in order to study the effects of movement through air or the resistance to moving air for aircraft, buildings, and other objects. In recent years, many agricultural experiments have involved the simulation of natural environments. Therefore, it is of practical interest to produce a temperature, humidity, and velocity controlled environment using a wind tunnel for agricultural experiments to investigate (Leon *et al*., 1998). There are two basic types of wind tunnel, the open circuit and the closed circuit or return flow tunnel. The open circuit tunnel may use a continuous supply of fresh air drawn from the atmosphere through an intake and contraction to the test section and then discharged back to the atmosphere through a diffuser (Bain *et al*., 1971). The main aim of this research was to investigate the influence of pad configuration on the evaporative cooling system effectiveness inside a wind tunnel. However, the specific objectives were as follows:

1. To investigate the effect of pad thickness and pad-face air velocity on the cooling effectiveness of the investigated system and
2. To experimentally estimate the cooling potential, saturation efficiency, the required airflow rate and static pressure drop for the evaporative cooling system.

Materials and Methods

To meet with the objectives of the present study, main evaporative cooling system using pad-fan wind tunnel was constructed and installed at Rice Mechanization Center, Meet Eldeeba village, Kafr Elsheikh governorate, Egypt during the summer

Fig. 1 A geometrical drawing of the wind tunnel

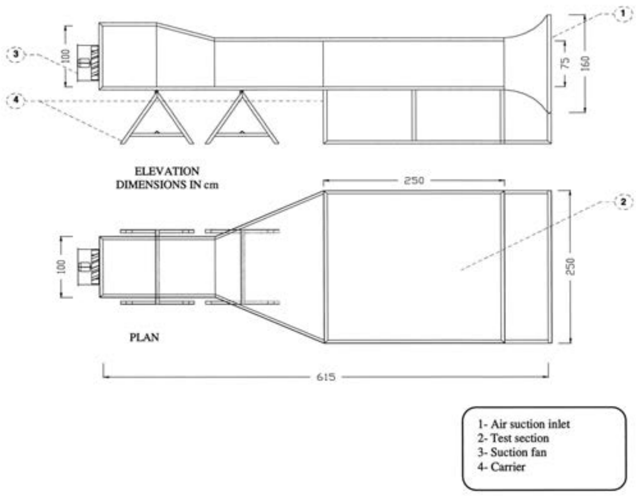
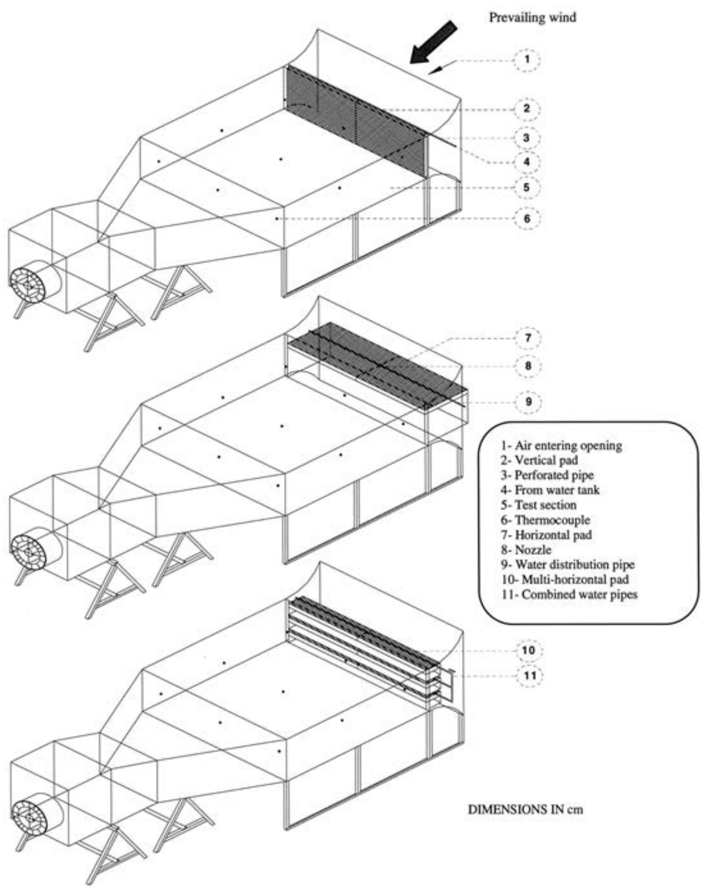


Fig. 2 A perspective drawing of the experimental test apparatus for evaporative cooling measurements



season of 2007.

Experimental Test Apparatus:

Wind Tunnel:

The wind tunnel was mainly developed to simulate pad-fan evaporative cooling systems and to provide direct measurements of system performance. It is a low speed open circuit type with a test section of 2.5 m long, 2.5 m wide and 0.75 m height. It was constructed of welded steel angles (50 × 50 mm) to form tunnel frame with overall length of 6.15 m. The constructed frame of the wind tunnel was covered with a 1mm thick iron sheet. A Plexiglas with 3 mm thick was used to cover the iron frame to form the ceiling and walls of the test section. An axial flow fan attached to the frame of the wind tunnel to provide air to wind tunnel. The rough structure of the wind tunnel is shown in **Fig. 1**. Construction details of the tunnel can be found in Basiouny (2005).

Pad Configuration:

Three different configurations of pad were employed in the present investigation. These were termed as vertical, horizontal and multi-horizontal. To accomplish the group of experiments, the three configurations of pad were alternately constructed with the wind tunnel at the opening of entering air (**Fig. 2**). The total area of the pad was of 1.8 m^2 (2.4 × 0.75 m) and it was identical for the three pad configurations under study. Meanwhile, for the multi-horizontal one, its total area was divided into three equal pads of 0.6 m^2 (2.4 × 0.25 m). The rice straw was utilized as a pad material for all investigated treatments. The density of pad material was kept constant at about 32 kg/m^3 in accordance with Hellickson and walker (1983) for all treatments. It was determined by knowing pad thickness and multiplying it by its total area that 32 kg rice straw required. Rice straw was uniformly distributed between two wires net, one of them was fixed at a steel angle and the other can be fixed through a number of bolts for the purpose of controlling the pad thicknesses. Water flow rate of pad was of about 0.259 m^3/h and it was kept constant at this value for all tests. It was selected in accordance with Wiersma and Benham (1974). The water supply system to the vertical pad consisted of perforated pipe which was positioned above the pad through its longitudinal axis. While relative to the horizontal and multi-horizontal pad configurations, supplying water was done by a number of nozzles fixed through the upper surface of the pad. The system of supplying water to the pad was constructed from water tank with a small pump. The water flow rate was controlled by a hand valve.

Investigated Variables:

The plan of the group of experiments was designed and carried out to acquire some indicators to determine the evaporative cooling process. These indicators were cooling potential, saturation efficiency, the required airflow rate and static pressure drop across the pad. The studied factors and their levels were set as follows:

1. Three different configurations of pad namely vertical, horizontal and multi-horizontal;
2. Four different pad thicknesses of 3, 7, 11 and 15 cm and
3. Three different pad-face air velocities of 0.75, 1.0 and 1.25 m/s.

The pad-fan evaporative cooling system was operated for each treatment from hour 9 to hour 18 during the summer period from 11/07/2007 to 15/08/2007.

Measurements and Instrumentation:

Air Temperature:

The air temperature was measured using J-type thermocouples and a digital thermometer (Model HH-26J-USA). The unit has a wide range of −80 to 760 ºC and it was used for recording air temperature outside and inside the wind tunnel. Nine thermocouples were employed to measure dry-bulb temperature inside the test section of wind tunnel. Two thermocouples were placed outside the wind tunnel for measuring the ambient dry and wet-bulb temperatures. The air relative humidity was determined from dry and wet-bulb temperatures using psychometric charts.

Air Velocity:

A Japanese hot-wire anemometer (Model 24-6111) was used to measure pad-face air velocity. The unit is a self-contained direct reading portable instrument, which is capable of measuring velocities from zero to 50 m/s with a precision of 0.1 m/s.

Static Pressure Drop Across the Pad:

It was measured using a Pitot-tube which was attached with the hot-wire anemomaster. The unit is capable of measuring pressure from zero to 500 mm that was expressed as a head of water with an accuracy of 0.1 mm.

Experimental Procedures:

Cooling Potential (Temperature Reduction):

The cooling potential can be expressed as temperature reduction. It was estimated using the following **Eqn.**:

$$\Delta T = T_{db} - T_c \quad (1)$$

Where;

ΔT: cooling potential (temperature reduction), ºC;

T_{db}: dry-bulb temperature of the ambient air, ºC and

T_c: dry-bulb temperature of the cooled air inside wind tunnel, ºC.

The average cooling potential was calculated for each experimental treatment.

Saturation Efficiency:

It is the ratio of change in saturation achieved to potential change in saturation or wet-bulb depression (Hellickson and walker, 1983). It was calculated using the following **Eqn.**:

Table 1 The measured data and calculated values of the average cooling potential and saturation efficiency at different pad thicknesses and pad-face air velocities for various configurations of pad

Pad thickness, cm	Pad-face air velocity, m/s	Vertical pad						Horizontal pad					
		T_{db}, ºC	SD of T_{db}, ºC	RH, %	T_c, ºC	ΔT, ºC	SE, %	Tdb, ºC	SD of T_{db}, ºC	RH, %	T_c, ºC	ΔT, ºC	SE, %
15	0.75	34.99	3.31	47.83	29.17	5.82	59.71	35.79	3.51	46.70	29.01	6.78	66.59
	1.00	34.97	3.24	48.39	27.80	7.16	76.76	34.35	3.35	47.60	27.32	7.58	79.80
	1.25	34.75	3.32	48.13	28.35	6.40	66.77	33.50	3.50	48.20	28.19	7.22	74.39
11	0.75	34.18	2.90	52.71	29.04	5.14	60.49	34.44	3.24	50.90	28.57	5.87	64.19
	1.00	34.35	2.67	52.35	28.64	5.71	68.45	34.76	3.47	49.70	27.71	7.06	78.36
	1.25	33.79	2.82	54.04	28.57	5.22	63.05	34.65	3.55	50.60	28.23	6.42	69.42
7	0.75	34.61	3.21	50.90	30.81	3.82	42.40	34.36	3.43	50.30	30.31	4.05	44.69
	1.00	34.47	3.39	49.67	29.54	5.42	59.08	34.71	3.15	49.70	28.82	5.88	65.46
	1.25	34.42	3.42	43.88	30.14	4.70	43.10	34.05	3.03	51.70	28.88	5.17	58.91
3	0.75	33.75	2.48	48.30	30.86	2.89	31.00	34.40	2.88	51.10	30.70	3.70	41.71
	1.00	33.64	2.82	46.30	28.93	4.71	48.93	34.16	3.33	52.40	28.64	5.52	65.97
	1.25	34.21	2.84	47.20	30.14	4.08	40.50	33.67	2.85	52.30	29.23	4.44	51.12

Pad thickness, cm	Pad-face air velocity, m/s	Multi-horizontal pad					
		T_{db}, ºC	SD of T_{db}, ºC	RH, %	T_c, ºC	ΔT, ºC	SE, %
15	0.75	34.18	3.37	50.00	27.03	7.15	78.85
	1.00	34.73	3.33	49.70	26.56	8.18	89.59
	1.25	34.58	3.66	49.80	27.09	7.48	81.43
11	0.75	35.53	3.46	46.20	28.54	6.99	67.97
	1.00	34.90	3.38	49.10	27.57	7.57	82.57
	1.25	34.60	2.90	48.90	27.67	6.99	74.71
7	0.75	32.88	2.36	54.10	28.60	4.28	52.97
	1.00	33.70	2.73	52.50	27.28	6.42	78.09
	1.25	33.47	1.92	51.60	27.77	5.70	67.86
3	0.75	34.22	3.41	49.90	30.21	4.01	44.29
	1.00	34.40	2.58	50.10	28.37	6.03	67.38
	1.25	33.30	2.65	53.40	28.40	4.90	58.50

$$SE = (T_{db} - T_c) / (T_{db} - T_{wb}) \times 100 \quad \text{...(2)}$$

Where;

SE: saturation efficiency, % and

T_{wb}: wet-bulb temperature of the ambient air, ºC.

The average saturation efficiency for each treatment was calculated. Multiple linear regression equations were developed to predict the influence of pad thickness and pad-face air velocity on the saturation efficiency for various pad configurations.

The Required Airflow Rate:

An inverter was employed for controlling the airflow rate of the suction fan and hence changing pad-face air velocity. The wind tunnel-fan was calibrated for each treatment by measuring air velocity at the outlet of fan. This operation was accomplished by using a cylindrical pipe made of sheet-iron of 0.6 m diameter. This pipe was fixed at the outlet of fan to record air velocity of the exiting air. The quantity of airflow was determined by multiplying the average air velocity by the cross-section area of the pipe.

Static Pressure Drop:

Static pressure drop across the pad (inside wind tunnel), for different pad configurations was recorded for each pad thickness and pad-face air velocity. It was determined by using the following **Eqn.**:

$$P = \rho \times g \times h \quad \text{............................(3)}$$

Where;

P: static pressure drop across the pad, Pa;

ρ: density of water, 1000 kg/m^3;

g: acceleration of gravity, 9.81 m/s^2 and

h: head of water, m.

Single exponential regression equations were developed to describe the relationship between pad thickness and static pressure drop at different pad-face air velocities for each configuration of pad.

Results and Discussion

Ambient Weather Conditions:

Table 1 indicates the average values of the measured data for both outside (ambient) dry-bulb temperature and outside relative humidity. At the same time, the average values of both saturation efficiency and cooling potential were calculated and are also listed in **Table 1** for different pad thicknesses and pad-face air velocities for various pad configurations. The multi-horizontal pad configuration had the best influence in cooling during the whole operating period. This trend was observed for all treatments under study. Standard deviation was determined for the ambient dry-bulb temperature for all treatments and conditions. Its values ranged from 1.92 to 3.66 ºC. It can be noted that at pad thickness of 15 cm and pad-face air velocity of 1 m/s, the average temperature reduction was of 7.16, 7.58 and 8.18 ºC for vertical, horizontal and multi-horizontal pad configurations respectively. The increment percentage in cooling potential due to using the multi-horizontal pad was of 14.25 % in comparison with the vertical one. The lowest average cooled air temperature was found at pad thickness of 3 cm and pad-face air velocity of 0.75 m/s for the vertical pad configuration. The highest one was observed at pad thickness of 15 cm and pad-face air velocity of 1 m/s for the multi-horizontal pad configuration. The optimum condi-

Fig. 3 Variation of air temperature and relative humidity as affected by daytime at different configurations of pad when the pad thickness was 15 cm and pad-face air velocity was 1 m/s

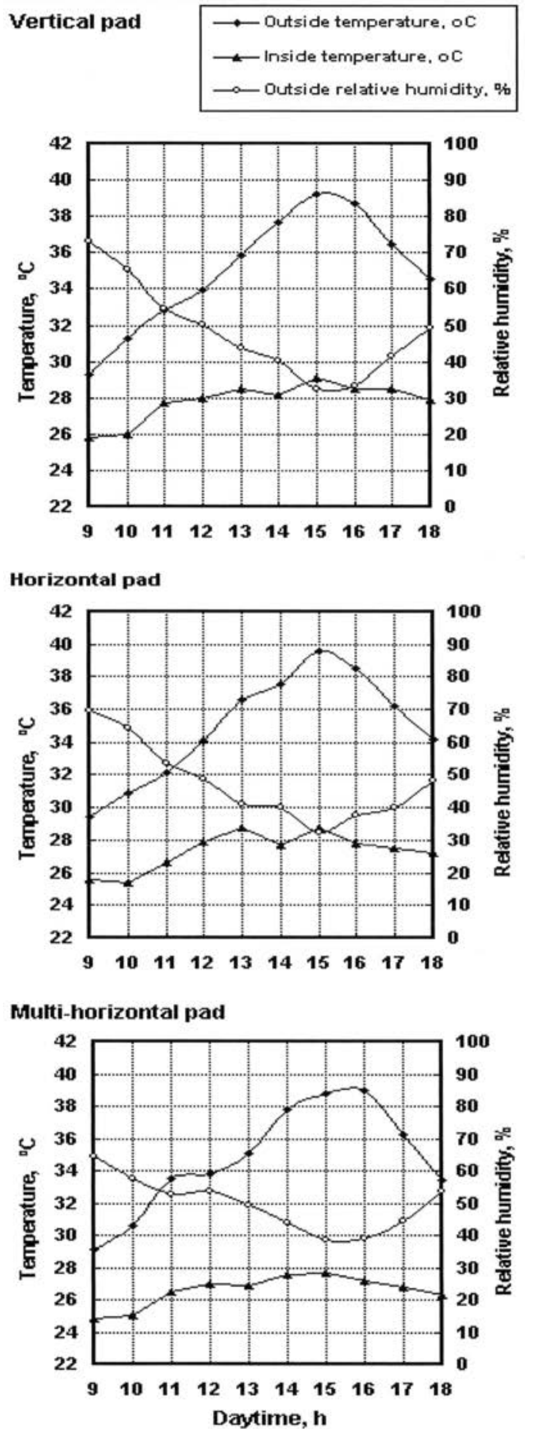
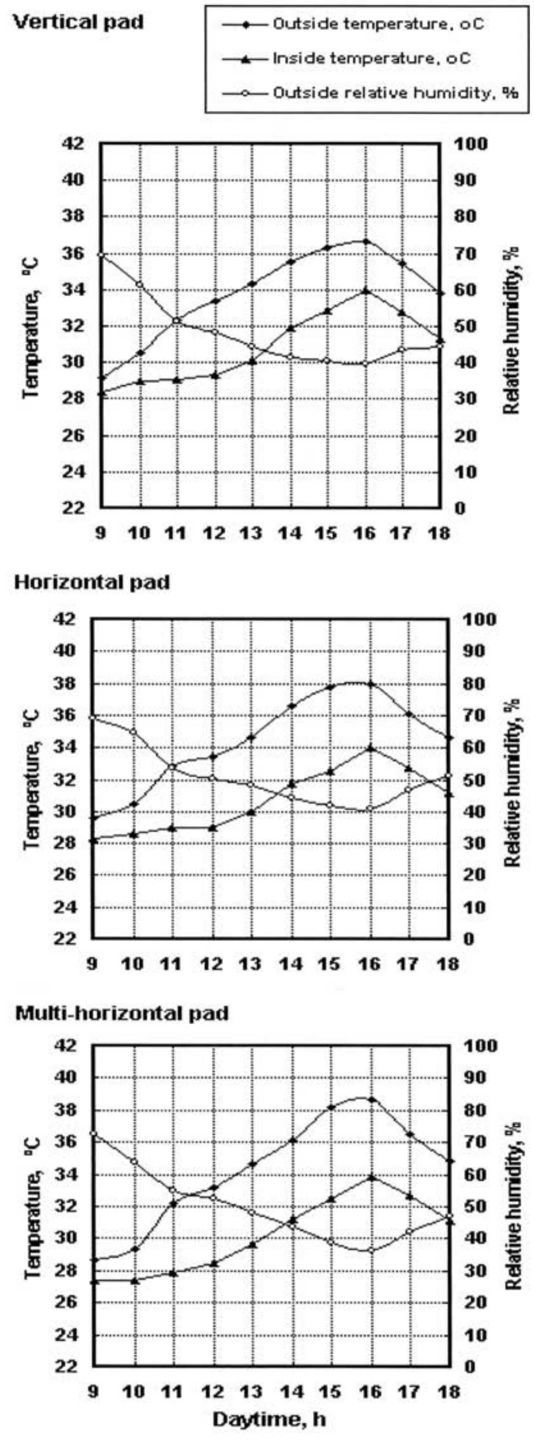


Fig. 4 Variation of air temperature and relative humidity as affected by daytime at different configurations of pad when the pad thickness was 3 cm and pad-face air velocity was 0.75 m/s



tions to increase the effectiveness of cooling process inside wind tunnel were found with the pad thickness of 15 cm and pad-face air velocity of 1 m/s. It was also noticed that the multi-horizontal pad configuration had the best cooling effectiveness for all investigated factors and conditions. **Fig. 3** shows the variation of air temperature and relative humidity during daytime at different configurations of pad when the pad thickness was 15 cm and pad-face air velocity was 1 m/s. As shown in **Fig. 3**, the maximum recorded ambient dry-bulb air temperatures were of 39.19, 39.57 and 38.95 ºC with a standard deviation of 0.31 ºC and the corresponding values of the outside relative humidity were of 32.6, 32.6 and 38.9 % for the vertical, horizontal and multi-horizontal pad configurations respectively. Meanwhile, the cooled air temperatures inside wind tunnel were of 29.07, 28.78 and 27.17 ºC for the vertical, horizontal and multi-horizontal pad configurations successively. It can be concluded that the multi-horizontal pad configuration achieved the best cooled air temperature inside wind tunnel with a reduction percentage of 6.54 and 5.59 % relative to the vertical and horizontal ones respectively. **Fig. 4** indicates the variation of air temperature and relative humidity during daytime at different configurations of pad at pad thickness of 3 cm and pad-face air velocity of 0.75 m/s. As illustrated in **Fig. 4**, the maximum recorded ambient dry-bulb air temperatures were of 36.62, 37.95 and 38.68 ºC with a standard deviation of 1.04 ºC and the corresponding values of the outside relative humidity were 39.5, 40.8 and 36.5 % for the vertical, horizontal and multi-horizontal pad configurations respectively. Meanwhile, the cooled air temperatures inside wind tunnel were of 34.01, 33.98 and 33.85 ºC for the vertical, horizontal and multi-horizontal pad configurations successively. As a conclusion, the vertical pad configuration has provided the worst cooled air temperature inside wind tunnel in relative to the other two.

Cooling Potential:

Temperature reduction was determined to describe the cooling potential of the investigated system. **Figs. 5** to **8** illustrate the variation of the average cooling potential as affected during daytime at different pad configurations and various pad-face air velocities for all pad thicknesses. **Figs. 5** to **8** also show that the multi-horizontal pad configuration achieved the highest values of temperature reduction when compared with the other two configurations of pad. The highest values were noticed around hour 16. By increasing pad thickness, the values of temperature reduction were also increased. For example, at hour 16 and pad-face air velocity of 1m/s for multi-horizontal pad configuration, its values were increased from 7.46 to 11.78 ºC (+57.91 %) by increasing the thickness of pad from 3 to 15 cm. Pad-face air velocity of 1 m/s achieved the highest values of temperature reduction compared with 0.75 and 1.25 m/s for all of pad configurations and its thicknesses. On the other hand, temperature reduction values were 10.23, 10.67 and 11.78 ºC for vertical, horizontal and multi-horizontal pad configurations respectively at hour 16 and pad thickness of 15 cm and pad-face air velocity of 1 m/s.

The increment in temperature reduction due to configuration of pad was 15.15 % for multi-horizontal in relative to the vertical one. This means that changing the configuration of pad plays an essential role for determining the effectiveness of the investigated system. Also, it can be noted that the values of temperature reduction were gradually increased from hour 9 up to hour 16, after that its values were dramatically decreased up to hour 18. Temperature reduction was highly influenced by the outside dry-bulb temperature. Its lowest values were found around hour 9 during the daytime for vertical pad configuration at pad thickness of 3 cm and pad-face air velocity of 1.25 m/s. Based on cooling potential, the multi-horizontal pad configuration in pad-fan evaporative cooling system was found satisfactory. Variation in the ambient weather conditions and airflow rate has resulted in difficulty of distinguishing the effectiveness between pad thickness and pad-face air velocity. **Fig. 9** illustrates the relationship between the mean cooling potential and pad thickness for different pad configurations and various pad-face air velocities. The mean values of temperature reduction were 7.16, 7.58 and 8.18 ºC for vertical, horizontal and multi-horizontal pad configurations respectively at pad thickness of 15 cm and pad-face air velocity of 1 m/s. As a conclusion, the highest mean values of cooling potential were found at pad thickness of 15 cm and pad-face air velocity of 1 m/s for multi-horizontal pad configuration. But its lowest mean values were obtained at pad thickness of 3 cm and pad-face air velocity of 0.75 m/s for vertical pad configuration.

Saturation Efficiency:

Fig. 10 shows the variation of the average saturation efficiency as a function of pad thickness for different pad configurations and various pad-face air velocities. In general, the multi-horizontal pad configuration resulted in the highest values of saturation efficiency in comparison with the other two pad configurations for all treatments. Also, saturation efficiency was increased by increasing pad thickness especially for multi-horizontal pad configuration. It can be observed from (**Fig. 10**) that there was a limitation in pad-face air velocity for each specific pad thickness, beyond which the saturation efficiency can be lowered. Saturation efficiency can be considered as a direct function for the time of air-water contact and pad-face air velocity. Hence, when pad-face air velocity was increased, the evaporation rate was also increased, but the time of air-water contact was decreased. The highest saturation efficiency was 89.59 % occurred at pad thickness of 15 cm and pad-face air velocity of 1 m/s for the multi-horizontal pad configuration. However, its lowest value was 31 % occurred at pad thickness of 3 cm and pad-face air velocity of 0.75 m/s for the vertical pad configuration. Values of saturation efficiency were 76.76, 79.80 and 89.59 % for vertical, horizontal and multi-horizontal pad respectively at

Fig. 5 Variation of cooling potential as affected by daytime at different configurations of pad and various pad-face air velocities when the pad thickness was 15 cm

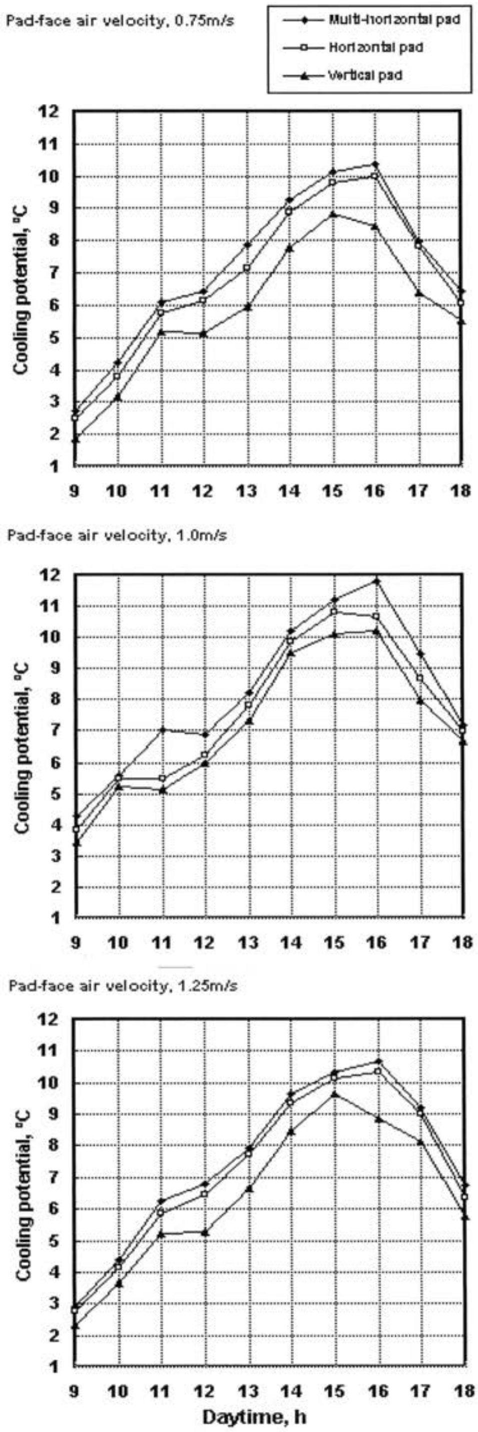
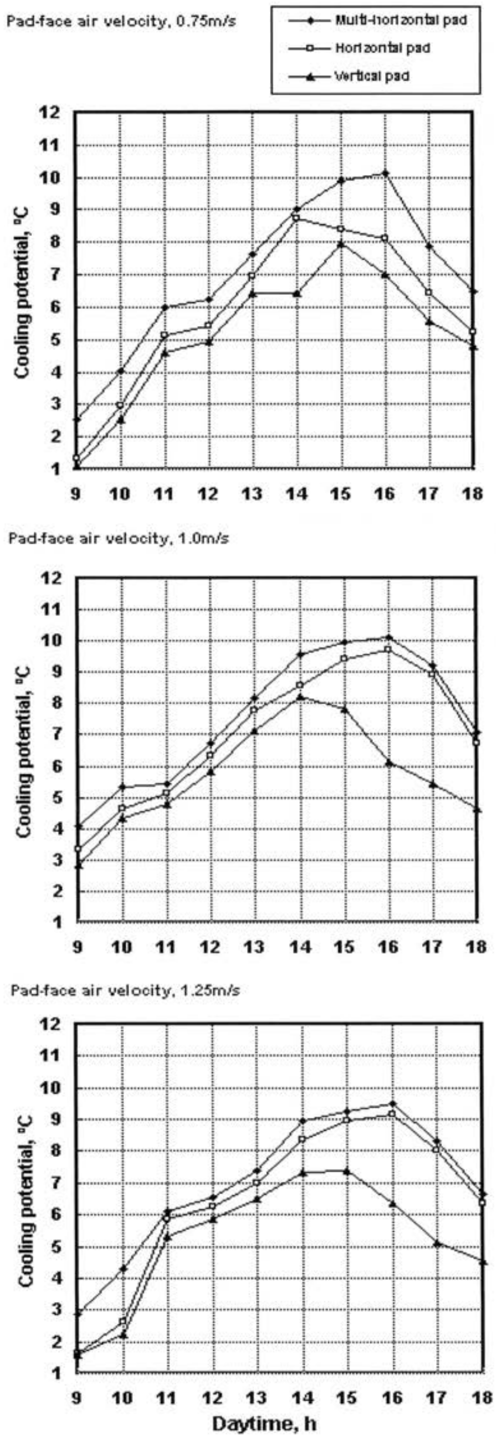


Fig. 6 Variation of cooling potential as affected by daytime at different configurations of pad and various pad-face air velocities when the pad thickness was 11 cm



pad thickness of 15 cm and pad-face air velocity of 1 m/s. The increase in saturation efficiency occurred due to employing the multi-horizontal pad configuration. This was found to be 16.71 % when compared with the vertical one. On the other hand, at constant pad-face air velocity of 1 m/s and for multi-horizontal pad, when the pad thickness was increased from 3 to 15 cm, saturation efficiency was increased from 67.38, to 89.59 % (+32.96 %). Meanwhile, it was increased from 78.85 to 89.59 % (+13.62 %) by increasing pad-face air velocity from 0.75 to 1 m/s at pad thickness of 15 cm for the multi-horizontal pad configuration.

Fig. 7 Variation of cooling potential as affected by daytime at different configurations of pad and various pad-face air velocities when the pad thickness was 7 cm

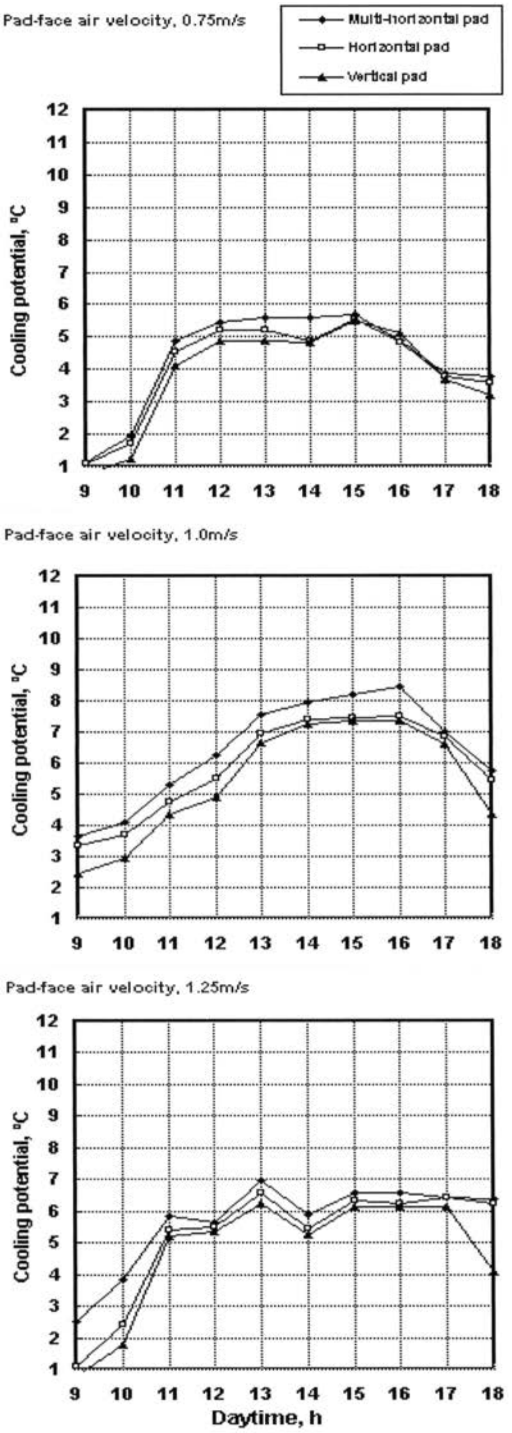
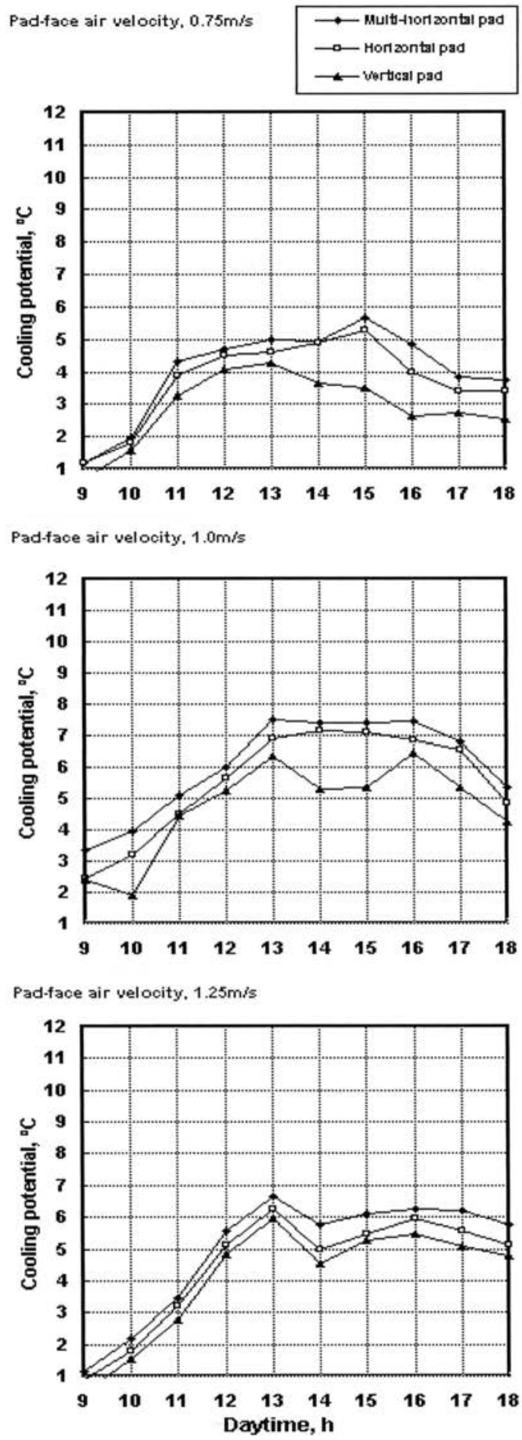


Fig. 8 Variation of cooling potential as affected by daytime at different configurations of pad and various pad-face air velocities when the pad thickness was 3 cm



Saturation efficiency was highly influenced by both of pad configuration and its thickness rather than the pad-face air velocity. From **Fig. 10**, it can be concluded that the highest saturation efficiency was found at pad-face air velocity of 1 m/s for the multi-horizontal pad configuration.

Three multiple linear regression equations were developed to describe the relationship between mean saturation efficiency as a dependent variable and both of pad thickness and pad-face air velocity as independent variables. The linear

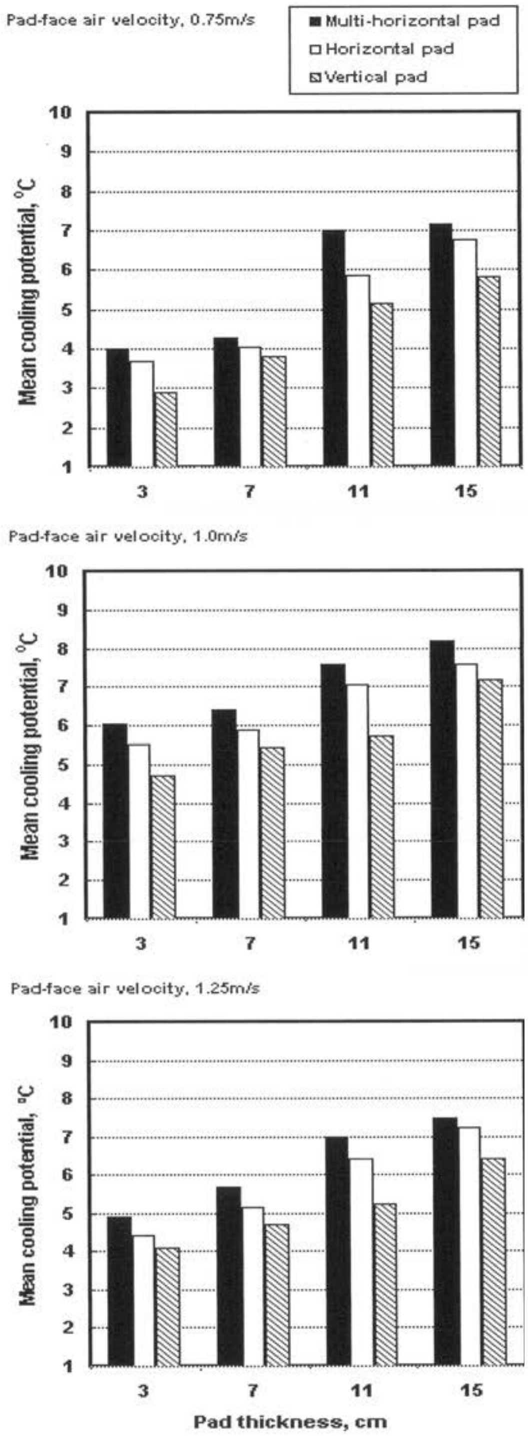


Fig. 9 Variation of mean cooling potential as affected by pad thickness for different pad configurations and pad-face air velocities

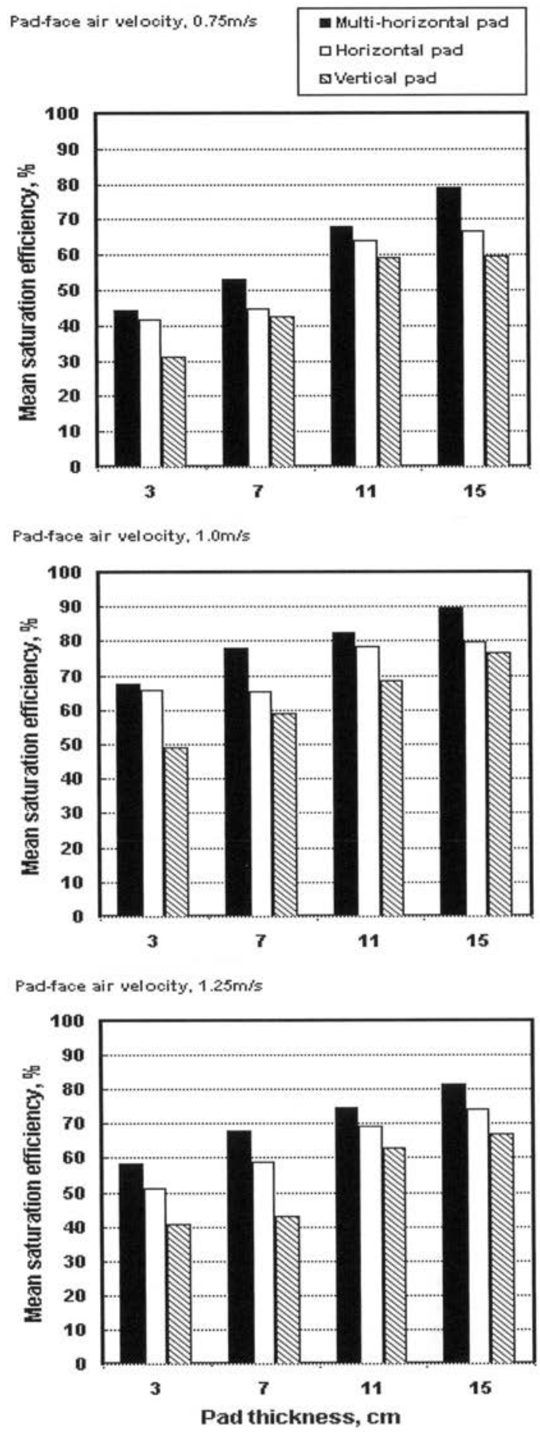


Fig. 10 Variation of mean saturation efficiency as affected by pad thickness for different pad configurations and pad-face air velocities

quadratic relationship was used as given in the following **Eqn.**:

$$SE = a_0 + b_1T + b_2V + b_3TV + b_4T^2 + b_5V^2 \qquad (4)$$

Where;

SE: mean saturation efficiency, %;
T: pad thickness, cm;
V: pad-face air velocity, m/s;
a_0: y-intercept and $b_{(1-5)}$ regression coefficients.

The values of predicted regression coefficients are listed in **Table 2** for three different configurations of pad. The relative effectiveness of each multiple relationship was mea-

Fig. 11 The required airflow rate as a function of pad thickness and pad-face air velocity for different pad configurations

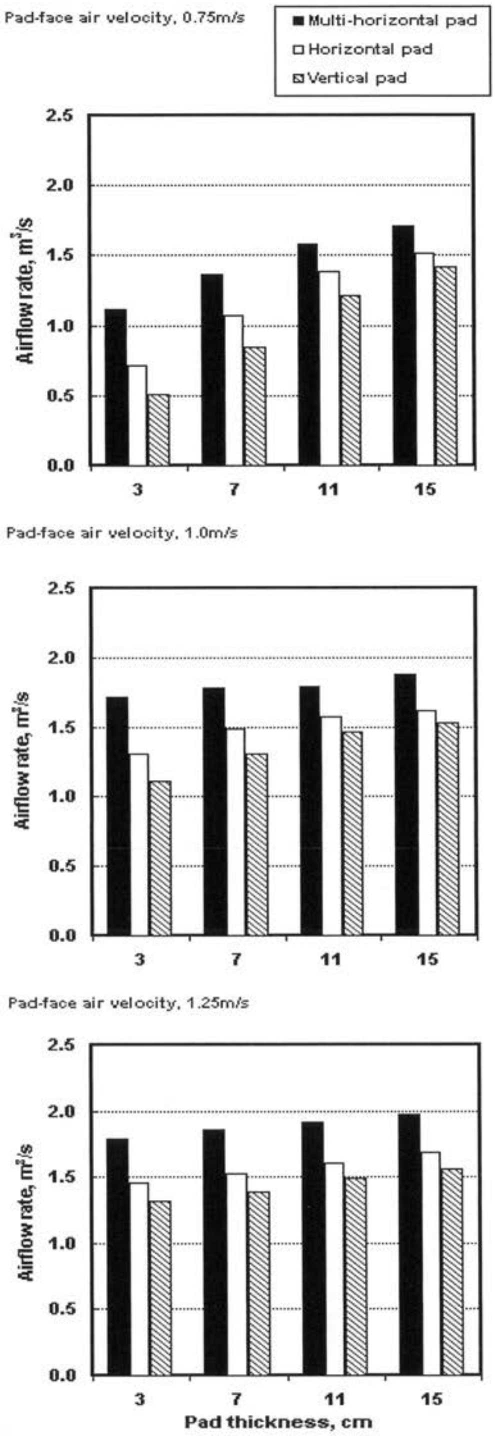


Fig. 12 Static pressure drop as a function of pad thickness and pad-face air velocity for different pad configurations

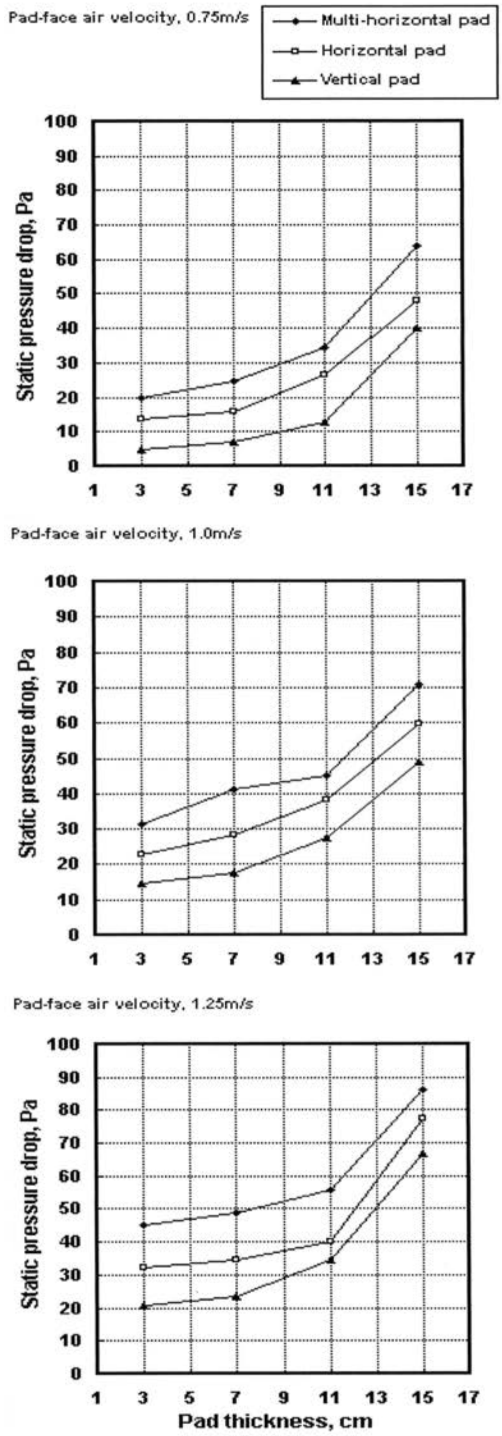


Table 2 The regression coefficients for predicting the mean saturation efficiency as affected by various configurations of pad

Pad configuration	Y-intercept (a_o)	Regression coefficients					Determination coefficient (R^2)
		b_1	b_2	b_3	b_4	b_5	
Vertical	−176.3761	+3.7470	+415.393	−0.2070	−0.0603	−201.480	0.9503
Horizontal	−186.0959	+2.7340	+457.189	−0.6910	−0.0076	−216.320	0.9220
Multi-horizontal	−197.7499	+4.7511	+473.298	−2.1520	−0.0215	−217.360	0.9808

Table 3 Static pressure drop as a function of pad thickness for each pad-face air velocity at different pad configurations

Pad configuration	Pad-face air velocity, m/s	Equation's constants		Determination coefficient (R^2)
		a	b	
Vertical	0.75	2.4102	0.1733	0.9347
	1.00	9.7707	0.1013	0.9533
	1.25	13.4930	0.0976	0.9153
Horizontal	0.75	8.7346	0.1070	0.9400
	1.00	16.8620	0.0806	0.9774
	1.25	23.0970	0.0694	0.7989
Multi-horizontal	0.75	13.4050	0.0968	0.9486
	1.00	25.5380	0.0631	0.9348
	1.25	35.8280	0.0519	0.8637

sured by the coefficient of determination (R^2).

Airflow Rate:

As the applied airflow rate was varied in each treatment, it was considered to provide a better criterion for comparison among the investigated factors. Also, the variation in airflow resistance due to the variation in pad configuration played an important role in this phenomenon. **Fig. 11** shows the relationship between the required airflow rate and pad thickness for each pad-face air velocity under different pad configurations. As shown in **Fig. 11**, the required airflow rate was increased by increasing both of pad thickness and pad-face air velocity for all configurations of pad. The multi-horizontal pad configuration achieved the highest values of the required airflow rate relative to the other two pad configurations at all pad thicknesses and pad-face air velocities. When pad thickness was constant at 15 cm and pad-face air velocity was of 1 m/s, the required airflow rate was of 1.53, 1.62 and 1.88 m^3/s for vertical, horizontal and multi-horizontal pad configurations respectively. The increment in the required airflow rate due to multi-horizontal pad configuration was of 22.88 % when compared with the vertical one. But when pad thickness was increased from 3 to 15 cm, for multi-horizontal pad and pad-face air velocity of 1 m/s, it was increased from 1.71 to 1.88 m^3/s (+9.94 %). On the other hand, when pad thickness was constant at 15cm and for multi-horizontal pad configuration, the required airflow rate was increased from 1.71 to 1.97 m^3/s (+15.2 %) by increasing pad-face air velocity from 0.75 to 1.25 m/s. Briefly, it can be stated that the highest required airflow rate was obtained at pad thickness of 15 cm and pad-face air velocity of 1.25 m/s under the condition of multi-horizontal pad configuration (**Fig. 11**). The only reason of the variation in the required airflow rate was due to the fluctuations occurred in airflow resistance.

Static Pressure Drop:

Airflow resistance is considered as an important parameter, which is directly related to static pressure drop and influencing the cooling performance of the system. As illustrated in **Fig. 12**, the static pressure drop increased as both of pad thickness and pad-face air velocity were increased for all pad configurations. Multi-horizontal pad configuration had the highest static pressure drop, while the vertical one had the lowest one for all pad thicknesses and pad-face air velocities. At pad thickness of 15 cm and pad-face air velocity of 1 m/s, static pressure drop ranged from 49.05 to 70.63 Pa (+44 %) for vertical and multi-horizontal pad respectively. On the other hand, for multi-horizontal pad configuration and pad-face air velocity of 1m/s, static pressure drop increased from 31.39 to 70.63 Pa (+125 %) by increasing pad thickness from 3 to 15 cm. While, at constant pad thickness of 15cm and for multi-horizontal pad configuration, static pressure drop increased from 63.77 to 86.33 Pa (+35.38) by increasing pad-face air velocity from 0.75 to 1.25 m/s. This means that the static pressure drop was highly influenced by changing both of pad thickness and its configuration. It was highly evident when using the multi-horizontal pad configuration. This finding can be attributed to that this configuration of pad had a higher airflow resistance relative to the other two pad configurations. **Table 3** indicates the best fitting coefficients which describe the relationship between static pressure drop as a dependent variable and pad thickness as an independent variable at each pad-face air velocity for all configurations of pad. The effect of pad thickness on the static pressure drop had the exponential equation as follows:

$y = ae^{bx}$......................................(5)

Where;

y: static pressure drop across the pad, Pa;

x: pad thickness, cm and

a, b: constants.

To study and design any evaporative cooling system, these exponential forms are important for simulation procedures. As listed in **Table 3**, the majority of exponential forms had a coefficient of determination (R^2) higher than 0.9153.

Conclusions

Based on the Results of the Present Study, The Following Specific Conclusions are Drawn:

1. The maximum difference between the ambient and cooled air temperatures inside wind tunnel (the highest temperature reduction) was found at 15 cm pad thickness and 1m/s pad-face air velocity for the multi-horizontal pad configuration. The lowest one was found at 3 cm pad thickness and 0.75 m/s pad-face air velocity for the vertical pad configuration.
2. For the multi-horizontal pad configuration and pad-face air velocity of 1 m/s, the highest average saturation efficiency was of 67.38, 78.09, 82.57 and 89.59 % at pad thicknesses of 3, 7, 11 and 15 cm respectively.
3. The highest required airflow rate was found at pad thickness of 15cm and 1.25 m/s pad-face air velocity when applying the multi-horizontal pad configuration. Its values were 1.71, 1.78, 1.79 and 1.88 m^3/s at pad thicknesses of 3, 7, 11 and 15 cm respectively for the multi-horizontal pad configuration and pad-face air velocity of 1 m/s.
4. The highest static pressure drop was noted at 15 cm pad thickness and 1.25 m/s pad-face air velocity when applying the pad configuration of multi-horizontal. These values were 31.39, 41.20, 45.13 and 70.63 Pa at pad thicknesses of 3, 7, 11 and 15 cm respectively for the multi-horizontal pad configuration and 1 m/s pad-face air velocity.

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Effects of Sowing Techniques and Seed Rates on Oilseed Rape Seedling Emergence, Crop Establishment and Grain Yield

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Abstract

Sowing techniques and type of seeding machines play an important role in seed placement and seedling emergence which ultimately affect crop growth and grain yield. The selection of suitable planting methods is dependant upon the time of planting rapeseeds, irrigation methods, amount of previous crop residue in the field and type of planting machines. A field experiment was conducted at Zanjan University research station. The main goals were to determine the effects of different seeding techniques and machines and also different rates of oilseed rape application on seedling emergence, plant establishment and final grain yield. A factorial experimental design in the form of randomized complete block was applied with four replications to measure the effects of the above factors. Two different pneumatic and common mechanical planters were used. Seeds were sown on flat and raised-bed with three levels of 5.5, 7 and 8.5 kg seeds per hectare. Results have shown that the planting machines had significant ($P \leq 0.05$) effect on seedling emergence. Mechanical planter had higher seedling emergence than pneumatic planter. Higher seedling emergence ($P \leq 0.05$) was shown where mechanical planter was used, 8.5 kg/ha seed compared to others. Uniformity on rows and proper seed depth of mechanical planter was significantly greater ($P \leq 0.01$) than pneumatic planter. Flat planting method showed more uniformity on rows ($P \leq 0.05$) than raised-bed methods. The pneumatic planter improved better post-winter plant establishment compared to mechanical planter ($P \leq 0.05$). Finally, grain harvested using pneumatic planter with flat planting method was greater when 8.5 kg/ha seed was applied at sowing in the experiment conditions. However, grain yield was not statistically different.

Introduction

Planting of rapeseed has been accepted for several centuries. This plant was discovered 1500 years b. c. (Azizy, *et al.*, 1999). Now, 22 million hectares of this crop are under cultivation in 53 countries around the world. China, Canada, Australia and India are the most important producers of rapeseed (Shahidi, *et al.*, 1999; Azizy, *et al.*, 1999). Common grain planters are used for planting rapeseeds, the cereal grain drills are especially recommended in Iran. Also planting methods and seed rates are different. So selection of planters and planting methods should be considered for proper seed placement, seedling emergence and higher grain yield (Asoodar, 2001; Gruber *et al.*, 2004; Asoodar, *et al.*, 2006).

While more than 80 % of the vegetable oil for human consumption in Iran is provided by importation and yearly high amounts of foreign exchange sources are being used for food importation, the importance effect of mechanized cropping rapeseed has appeared. Today, rapeseed is planted by pneumatic and mechanical planters in Iran. An evaluation of common rapeseed planters has revealed that mechanical grain drills could produce higher seedling emergence, emergence rate index, post-winter establishment, proper seed depth, uniformity on rows and grain yield compared to other planters (Yousefzadeh, 2004, Schneider *et al.*, 2006). Afzalinia

(1998) indicated that mechanical planters produce greater seedling emergence and uniformity on rows than pneumatic planters. However, Hammerschmid (1990) showed that pneumatic planters perform with higher uniformity on rows and lower seed damage than mechanical seeders. Yet the selection of suitable planting method is dependant upon the time of rapeseed planting, irrigation, amount of crop residue in the field and type of planting machines. Also, using furrowers affect crop root growth and weed control.

However, at seeding time, using row crop planters as raised-bed planting would be more preferable than flat land planting. Ozpinar (2004) reported that cotton raised-bed planting had higher seedling emergence and grain yield compared to flat land planting. Also Oswald, *et al.* (2002) indicated that corn brought more grain yield when it was sown on raised bed in comparison with flat-planting. Narang *et al.* (1994) reported wheat yielded under flat-planting was about 4-5 tons per hectare in India, while, Aguino (1998) indicated that 6 tons per hectare of wheat was harvested from raised-bed planting in the north of Mexico.

Therefore, in recent years it has become more necessary to improve sowing techniques through preferred seedbed preparation and early crop growth (Eskandari, 1999; Asoodar *et al*., 2000 and Asoodar and Barzegar, 2006; Gruber and Claupein, 2006). Current regular planting systems put the seeds in soils without controlling the seed depth variation which results in reduced seedling emergence (Tessier *et al*., 1991; Riethmuller, 1995; Rainbow *et al*., 1992; 1994; Eshraghi *et al*., 2007). Also using the correct type of furrow openers give better crop emergence and establishment which is due to improve depth control and seed-to-soil contact (Asoodar, *et al*., 2006; Asoodar and Desbiolles, 2004; Buttar *et al*., 2006). Most of agricultural lands in Iran are under cultivation, whichis not economical to extend or develop new cultivated lands to increase crop yield (Seyedan, 2002; Behrens *et al*., 2006). So, the efforts of agricultural scientists are on the effects of different seed varieties, better ways of using technology and new methods of crop cultivation. The use of innovated farm machinery is one of the important applications for increasing crop production (Asoodar, 2001). Day (1967) and Hossain (2005) indicated that flat and raised-bed planting methods of wheat were not shown significantly effective on grain yield, but the amount of yield was higher under raised-bed planting. Increasing the sowing rapeseed from 3 kg/ha to 7 kg/ha, decreased duration of seedling emergence and number of spikes in rapeseed planting (Rahnama, 2002). Yazdandoust *et al.* (2002) and Jasinska *et al*. (1989) reported maximum grain yield for rapeseed by using 6 kg/ha of oilseed rape at planting. Anderson and Bengtson (1992) obtained maximum rapeseed grain yield where 10 kg/ha of seed was sown using row distance of 12 cm in Sweden. Also Popa *et al.* (1989) suggested seeding rate of 10 kg/ha according to their studies. Sadegipor *et al*. (1998) indicated that 17, 25 or 50 plants per square meter had no significant effect on grain yield of spring rapeseed. But the use of fertilizer would increase crop yield (Sieling and Kage. 2006; Rathke and Diepenbrock, 2006).

Materials and Methods

Location and Soil

The field experiment was conducted at the University of Zanjan research station (latitude 48º24′ N, longitude 36º40′ E), 5 km east of Zanjan city, at an average altitude of 1610 m. Soil used for the experiment was a sandy loam soil. The climate was characterized as a cold area and the mean annual rainfall was 265.8 mm.

Experimental Design

A factorial experiment in the form of randomized complete block design was applied with four replications. Experimental plots were 2.5 × 20 and 3 × 20 for mechanical and pneumatic planter, respectively.

Planter treatments were:

1. Machine Barzegar planter (locally-made for planting wheat) equipped with shoe openers and fluted rollers seed-metering devices (a_1, mechanical planter).

Rau pneumatic combination seeder, without furrow opener and with pressurized air and fluted seed-metering system (a_2, pneumatic planter).

Planting methods treatments were:

1. flat planting (b_1)
2. raised-bed planting (b_2)

Seed rates treatments were 5.5 (c_1), 7 (c_2) and 8.5 (c_3) kgs of seeds per hectare.

Planting Machines Preparation

Okapi variety of rapeseed, a common seed for most planting areas was used for the experiment. For flat planting, openers of mechanical planter separated and spaced among openers about 30 cm. For preparation of pneumatic combination seeder, rollers behind the seeder were separated and spaced by 30 cm. For raised-bed planting, furrowers were used with the similar mechanical seeder. The planting depth was about 2.5 cm in all treatments. To control weed seeds before planting, 2 liters per hectare of Treflan herbicide was applied. 2.5 liters per hectare of Galant herbicide was used for weed control after plant emergence.

Measurements

Seed depth uniformity was measured after final seedling emergence by using **Eqn. 1** (Senapati, 1989):

$$Se = (1 - Y/D) \times 100 \quad (1)$$

Where:

Se = proper seed depth coefficient (%)

D = mean of measured seed depth

Y= differential of mean

Also, emergence rate index was calculated by using **Eqn. 2** (Afzalinia, 1998).

$$ERI = \sum_{i=f}^{L} \frac{[\% di - \%(di-1)]}{D} \quad .(2)$$

Where:

d = seedling emergence percent at D day

(d − 1) = seedling emergence percent at (d − 1) day

D = number of post-plant days

F= number of post-plant days at emergence of primary plant

L = number of post-plant days when emergence has completed

Seedling emergence percentage was calculated by **Eqn. 3** (Hemmat, 1996):

m = [ppsm / {(spsm) × P × G}] × 100..(3)

Where

Ppsm = number of plants emerged per square meter

Spsm = number of seeds sown per square meter

P = seed purity percentage

G = Germination percentage

Crop yield including straw and grain, was measured at maturity. The data was analyzed using SAS statistical package for analysis of variance. Means were compared by using the least significant difference analysis (LSD).

Results and Discussion

Seedling Emergence and Rate Index

Interaction between type of planters and rate of seeding were shown to be significant ($P \leq 0.05$) where seedling emergence was compared. Mechanical planter (a_1) had higher seedling emergence than pneumatic planter (a_2). Poor seed depth control with pneumatic raised-bed planting might be one of the reasons for reduced number of seedling emergence. Mechanical planter with 8.5 kg/ha sowing seeds was shown better seedling emergence ($P \leq 0.05$) than others (**Fig. 1**). Also, Yousefzadeh (2004) and Afzalinia (1998) reported the same results that the pneumatic planter produced lower number of seedlings than the mechanical planter.

The effects of planter types, planting methods and seeding rates were not significant on emergence rate index, but it was higher for the mechanical planter compared to the pneumatic. This might be as a result of proper seed depth control and uniformity on rows for mechanical planter that put the seeds in 2-3 cm depth. Likewise, Yousefzadeh (2004) reported similar results, that mechanical planter produced higher emergence rate index than the pneumatic planter.

Uniformity on Rows

Type of planters showed significant effect on uniformity on rows ($P \leq 0.01$). The mechanical planter had higher uniformity than the pneumatic planter (**Fig. 2**). Seeds were scattered by pressurized air in the flowing soil. Using pneumatic planter could be a reason of lower uniformity on rows. These results were similar to Yousefzadeh (2004) and Afzalinia (1998) findings. Also, the effect of planting method was significant ($P \leq 0.05$) on uniformity on rows where flat-planting was greater than raised-bed planting (**Fig. 2**).

Proper Seed Depth Control

Type of planter had significant effect on seed placement ($P \leq 0.01$). Proper seed depth of mechanical planter was higher than pneumatic planter (**Fig. 3**). The pneumatic planter was not equipped with furrow openers and also the reduced efficiency of seed depth control could be the reason of lower effect of seed depth.

Pre and Post-Winter Plant Establishment

All treatments had no significant effect on pre-winter plant establishment, but the pneumatic planter

Fig. 1 Effect of planter types and interaction among planters and rate of seed on seedling emergence percentage

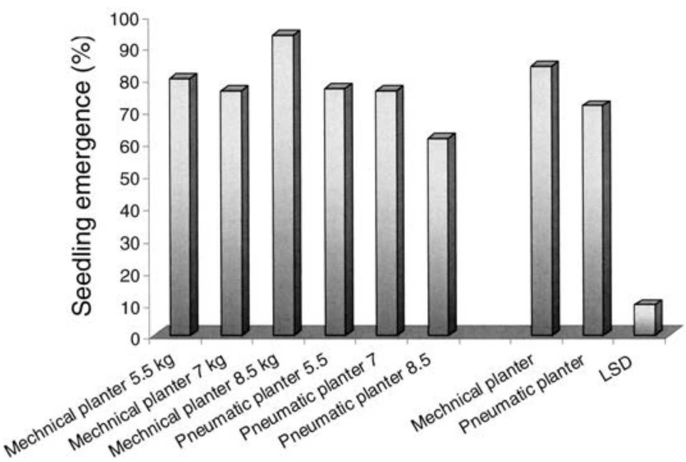
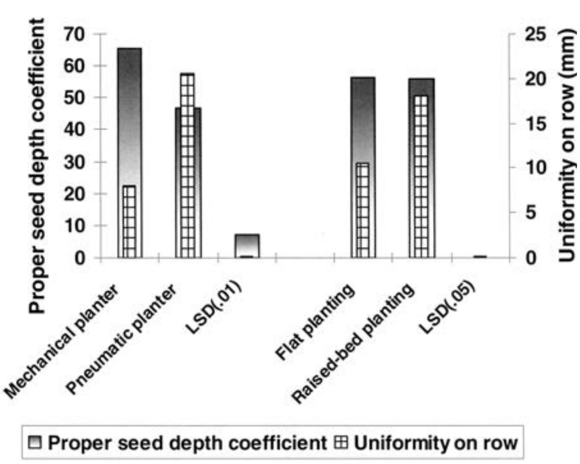


Fig. 2 Effect of planter types and planting methods on seed depth and uniformity on rows



showed higher pre-winter plant establishment than the mechanical planter (**Fig. 3**). Type of planter had significant effect on post-winter plant establishment ($P \leq 0.05$). The pneumatic planter had greater post-winter plant establishment than the mechanical planter (**Fig. 3**). Suitable preparation seed bed by rotivator attached in front of pneumatic planter caused high post-winter plant establishment. Interaction among planter types and planting methods showed significant effect on post-winter establishment ($P \leq 0.01$) and the pneumatic planter using flat-planting method was produced more post-winter plant establishment than others (**Fig. 3**). Post-winter plant establishment of mechanical planter decreased about 4 percent compared to pre-winter plant establishment, but post-winter plant establishment of pneumatic planter increased 3 percent compared to pre-winter plant establishment.

Fig. 3 Effect of planter type and interaction among planter and planting method on pre- and post- winter establishment

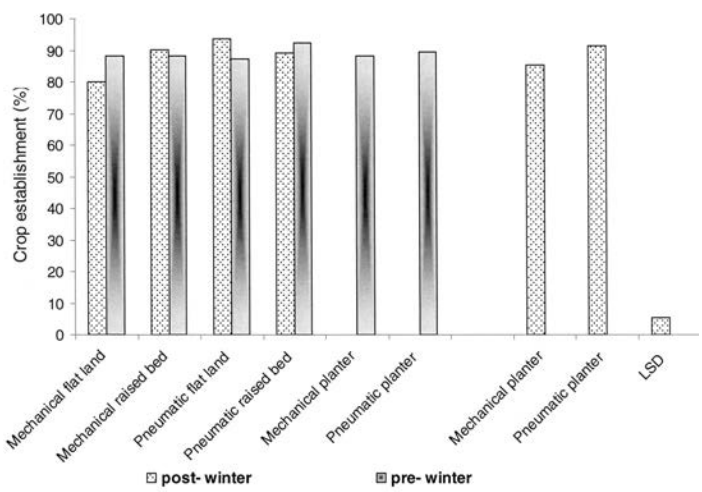
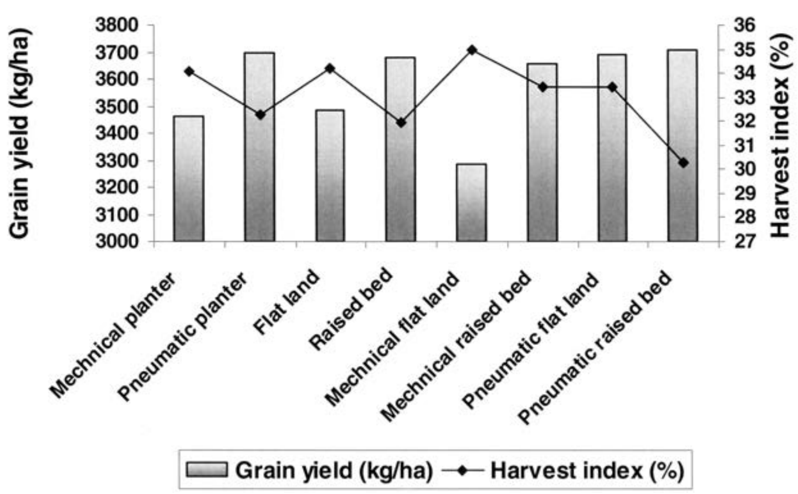


Fig. 4 Effect of planter types and planting methods on grain yield and harvest index



Grain Yield

All treatments showed to have no-significant effects on crop grain yield. These findings were similar to Day (1967) and Hossain *et al.* (2005) who reported that raised-bed and flat planting method were not significantly effective on resulted grain yield. Yield of raised-bed planting method (3679 kg/ha) was higher (**Fig. 4**) than flat planting (3489 kg/ha). Likewise for crops like cotton (Ozpinar, 2004), corn (Oswald *et al.*, 2002) and wheat (Hossain *et al.*, 2005) raised-bed planting showed a significantly higher yield compared to flat planting. Also Aubertot *et al.* (2004) and Adamsen and Coffelt (2005) reported that seeding time and seeding methods influence grain yield. However, in spite of higher seedling emergence percentage for mechanical planter the post-winter plant establishment and grain thousand weight which came out of pneumatic planter were greater than mechanical planter. It might be a strong reason to produce higher grain yield where the pneumatic planter is used. In these 12 experimental treatments, combination of pneumatic planter and flat-planting method using 8.5 kg seed-per-hectare had greatest amount of grain yield, but did not become significant compared to other treatments.

Harvest Index and Grain-Thousand-Weight

Harvest index was the same for all treatments. But, for mechanical planter it was greater than pneumatic planter and for flat-planting method it was higher than raised-bed planting.

Interaction among planter types and planting methods had significant effect on grain-thousand-weight ($P \leq 0.05$). The pneumatic planter using flat-planting method had greater grain-thousand-weight (3.56 g) than others.

Conclusions

Mechanical planter equipped with furrow opener was a suitable planter for providing greater rapeseed seedling emergence. Pneumatic combination seeder with tilling soil by a rotivator attached on the front could prepare smoother seed beds which resulted greater post-winter plant establishment and grain yield.

Rate of sowing seed had no significant effect on grain yield which indicates oilseed rape has high flexibility relative to rate of sowing seed and able to compensate lower rate with produced side foliage and increased grain yield of plant unit. On the whole combination of using pneumatic planter with flat-planting method applying 8.5 kg seed per hectare produced the highest grain yield.

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Development of Tea Carding Machine for Chinese Green Tea

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Abstract

The tea carding machine was designed, developed and its performance was evaluated. The major parts of the tea carding machine were main frame, electromotor, transmission framework, electric heater. The transmission was crank slider mechanism. The orthogonal experiment of 7 factors 3 levels was adapted to optimum structural Parameters. The result showed: crank length was 59 mm, crank speed was 130 m, connecting rod length was 442 mm , eccentricity was 57 mm, the height and depth of the U-shaped unit was 110 mm and 80 mm respectively, the total power of far infrared metal heating tubes was 11 kW, the stripping tea rate was 89.5 %.

Introduction

Green tea is tea made solely with the leaves of Camellia sinensis that have undergone minimal oxidation during processing. Green tea originates from China and has become associated with many cultures in Asia from Japan and South Korea to the Middle East. Recently, it has become more widespread in the west, where black tea is traditionally consumed. Chinese tea output was 588 thousand metric tonnes in 1994, which was 1258 thousand metric tonnes in 2008, increased 114 %. Chinese tea export was 179.6 thousand metric tonnes in 1994, which was 297 thousand metric tonnes in 2008, increased 65 %, and the domestic demand was expanded at the same time (Tan Junfeng, 2007). The process of Chinese green tea production included fixation, rolling, carding, and baking. The carding is the process to make the green tea to the particular shape after rolling. traditional carding process is by hand. It takes a long time to do this process and hence labor charges

Fig. 1 prototype tea carding machine

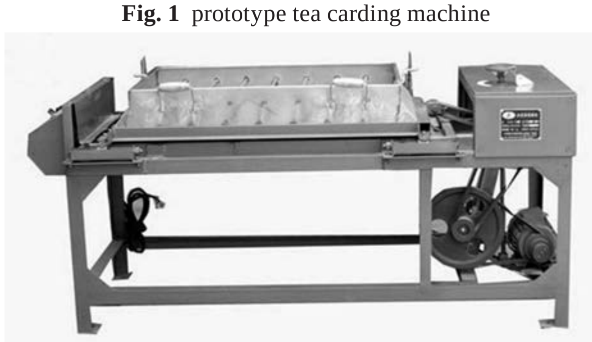
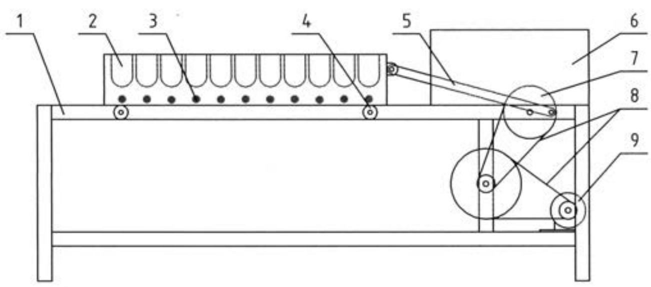


Fig. 2 schematic view of tea carding machine



1. main frame, 2. crank, 3. infrared metal heating tube, 4. roller, 5. connecting rod, 6. control box, 7. v-belt pulley, 8. v-belt, 9. motor

Table 1 factors and levels of the orthogonal design

A	B	C	D	E	F	G
Crank length, mm	Crank speed, rpm	Connec-ting rod length, mm	Eccentri-city, mm	Depth of the U-shaped, mm	Width of the U-shaped, mm	Heating tubes power, kW
49	90	342	40	95	80	9
59	110	400	57	105	90	11
69	130	442	64	110	100	13

Table 2 The orthogonal experimental date of tea carding machine

Experiment number	A	B	C	D	E	F	G	stripping tea rate %
1	1	1	1	1	1	1	1	75.3
2	1	2	2	2	2	2	2	76.1
3	1	3	3	3	3	3	3	77.2
4	2	1	1	2	2	3	3	77.1
5	2	2	2	3	3	1	1	76.5
6	2	3	3	1	1	2	2	78.4
7	3	1	2	1	3	2	3	77.8
8	3	2	3	2	1	3	1	79.0
9	3	3	1	3	2	1	2	83.1
10	1	1	3	3	2	2	1	74.2
11	1	2	1	1	3	3	2	76.3
12	1	3	2	2	1	1	3	78.4
13	2	1	2	3	1	3	2	81.2
14	2	2	3	1	2	1	3	79.4
15	2	3	1	2	3	2	1	78.7
16	3	1	3	2	3	1	2	84.5
17	3	2	1	3	1	2	3	75.4
18	3	3	2	1	2	3	1	79.6
K1	76.250	78.350	77.650	77.800	77.950	79.533	77.217	
k2	78.550	77.117	78.267	78.967	78.250	76.767	79.933	
K3	79.900	79.233	78.783	77.933	78.500	78.400	77.500	
R	3.650	2.116	1.133	1.167	0.550	2.766	2.716	

Order: A > F > G > B > D > C > E, Optimum combination: A3B3C3D2E3F1G2

will be more. Moreover, there are chance of creating fannings. The manual carding is labor, tine consuming, not standardized. The rolled leaves would be twisted shape by it. Chinese tea was by means of the mode continuous and cleaning production, and the tea carding machine was the key equipment of the tea automatic production line (Xiao Hongru, 2007). To raise tea production, A U-shaped Multi-hollowware tea carding machine was designed, developed and its performance was evaluated to provide economical and efficient carding machine suitable for modernized tea processing factory.

Machine Development

The crankshaft, in conjunction with the connecting rod, converts the rotary motion of the piston to the reciprocating motion needed to drive the U-shaped hollowware. The tea in the hollowware was heated and was rubbed, squeezed, rolled, crashed, should be twisted to Chinese green tea's unique shape.

The developed tea carding machine is photographed in **Fig. 1** and illustrated schematically in **Fig. 2**. It consisted of following main parts.

Main Frame

The main frame of the tea carding machine was made of 40 × 40 × 5 mm M.S. angle. The main frame was supported by four 700 mm high columns, the overall size of the frame was 1200 × 690 × 800 mm First drive was two-stage belt mechanism, the driving and driven pulley diameter of the first-stage belt mechanism were 50 mm and 200 mm, respectively, which of the second-stage belt mechanism were 40 mm and 160 mm, respectively. The whole system was driven by a 1500 rpm, 0.55 kW motor. Second drive was slider-crank mechanism, which was designed to convert rotary motion to reciprocating straight-line motion, and the slider was U-shaped Multi-hollowware.

U-Shaped Hollowware

U-shaped hollowware was composed of 11 stainless sheet steel U-shaped units. There was a far infrared metal heating tube of power 1Kw under each U-shaped hollow wares. The rolled leaves would be shaped easily by the application of the heat and force, the depth and width of the U-shaped units was the key Parameters of the hollowware. Quality of tea was influenced by the Parameters shape of U-shaped hollowware and the Crank slider mechanism of the machine (Zhao Huayong, 2009).

Crank Slider Mechanism

U-shaped Multi-hollowware was derived by crank slider mechanism.. It was equivalent to the slider, and it could reciprocate on it's slide. The main parameters of the crank slider mechanism were crank length, crank speed, connecting rod length and eccentricity, which would influence the quality of the tea.

Materials and Methods

The orthogonal experiment of 7 factors 3 levels was adapted to optimum structural Parameters. The stripping tea rate was the evaluating indicator of the tea carding machine. Factors influencing the stripping tea rate were crank length, crank speed, connecting rod length, eccentricity, depth and width of the U-shaped unite, heating tubes power. The 3 levels of 7 the independent variables are given in **Table 1**. The stripping tea rate was calculated as follows.

stripping tea rate= (MS/M) × 100 %

where,

MS = mass of the tea shaped, g

M = mass of the sample taken, g

Results and Discussion

The orthogonal experimental date of tea carding machine are shown in **Table 2**. The seven factors of the machine influencing the stripping tea rate were studied. The result showed that The order of the seven factors was crank length > width of the U-shaped > heating tubes power > crank speed > Eccentricity > connecting rod length > depth of the U-shaped. The most effective combination for the stripping tea rate was under the following conditions: crank length was 59 mm, crank speed was 110 rpm, connecting rod length was 342 mm , eccentricity was 57 mm, the height and depth of the U-shaped unit was 95 mm and 80 mm respectively, the total power of far infrared metal heating tubes was 11 kW the experiment showed the stripping tea rate was 89.5 % under this condition.

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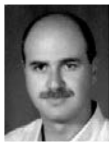
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g. art: supported by authentic sources, reference or bibliography.
h. written on CD-R.

Rejected/Accepted Articles

a. As a rule, articles that are not chosen for AMA publication are not returned unless the writer(s) asks for their return and are covered with adequate postage stamps. At the earliest time possible, the writer(s) is advised whether the article is rejected or accepted.
b. When an article is accepted but requires revision/modification, the details will be indicated in the return reply from the AMA Chief Editor in which case such revision/modification must be completed and returned to AMA within three months from the date of receipt from the Editorial Staff.
c. The AMA does not pay for articles published.
d. Complimentary copies: Following the publishing, three successive issue are sent to the author(s).

Procedure

a. Articles for publication (original and one-copy) must be sent to AMA through the Co-operating Editor in the country where the article originates. (Please refer to the names and addresses of Co-operating Editors in any issue of the AMA). However, in the absence of any Co-operating Editor, the article needs to be sent to Co-operating Editor in the writer's neighboring country.
b. Contributors of articles for the AMA for the first time are required to attach a passport size ID photograph (black and white print preferred) to the article. The same applies to those who have contributed articles three years earlier. In either case, ID photographs taken within the last 6 months are preferred.
c. The article must bear the writer(s) name, title/designation, office/organization, nationality and complete mailing address.

Format/Style Guidance

a. Article must be sent on CD-R with MS DOS format (e.g. Word Perfect, Word for DOS, Word for Windows... **Absolutely necessary TEXT FORMAT**) along with two printed copy (A4).
b. The data for graphs and photographs must be saved into piecemeal dates and enclosed with the article.
c. Whether the article is a technical or popular contribution, lecture, research result, thesis or special report, the format must contain the following features:
   (i) brief and appropriate title;
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   (iii) an abstract following ii) above;
   (iv) body proper (text/discussion);
   (v) conclusion/recommendation; and a
   (vi) bibliography
d. The printed copy must be numbered (Arabic numeral) successively at the top center whereas the disc copy pages should not be number. Tables, graphs and diagrams must likewise be numbered. Table numbers must precede table titles, e.g., "Table 1. Rate of Seeding per Hectare". Such table number and title must be typed at the top center of the table. On the other hand, graphs, diagrams, maps and photographs are considered figures in which case the captions must be indicated below the figure and preceded by number, e.g., "Figure 1. View of the Farm Buildings".
e. **The data for the graph must also be included. (e.g. EXCEL for Windows)**
f. Tables and figures must be preceded by texts or discussions. Inclusion of such tables and figures not otherwise referred to in the text/discussion must be avoided.
g. Tables must be typed clearly without vertical lines or partitions. Horizontal lines must be drawn only to contain the sub-title heads of columns and at the bottom of the table.
h. Express measurements in the metric system and crop yields in metric tons per hectare (t/ha) and smaller units in kilogram or gram (kg/plot or g/row).
i. Indicate by footnotes or legends any abbreviations or symbols used in tables or figures.
j. Convert national currencies in US dollars and use the later consistently.
k. Round off numbers, if possible, to one or two decimal units, e.g., 45.5 kg/ha instead of 45.4762 kg/ha.
l. When numbers must start a sentence, such numbers must be written in words, e.g., Forty-five workers..., or Five tractors..."instead of 45 workers..., or, 5 tractors.

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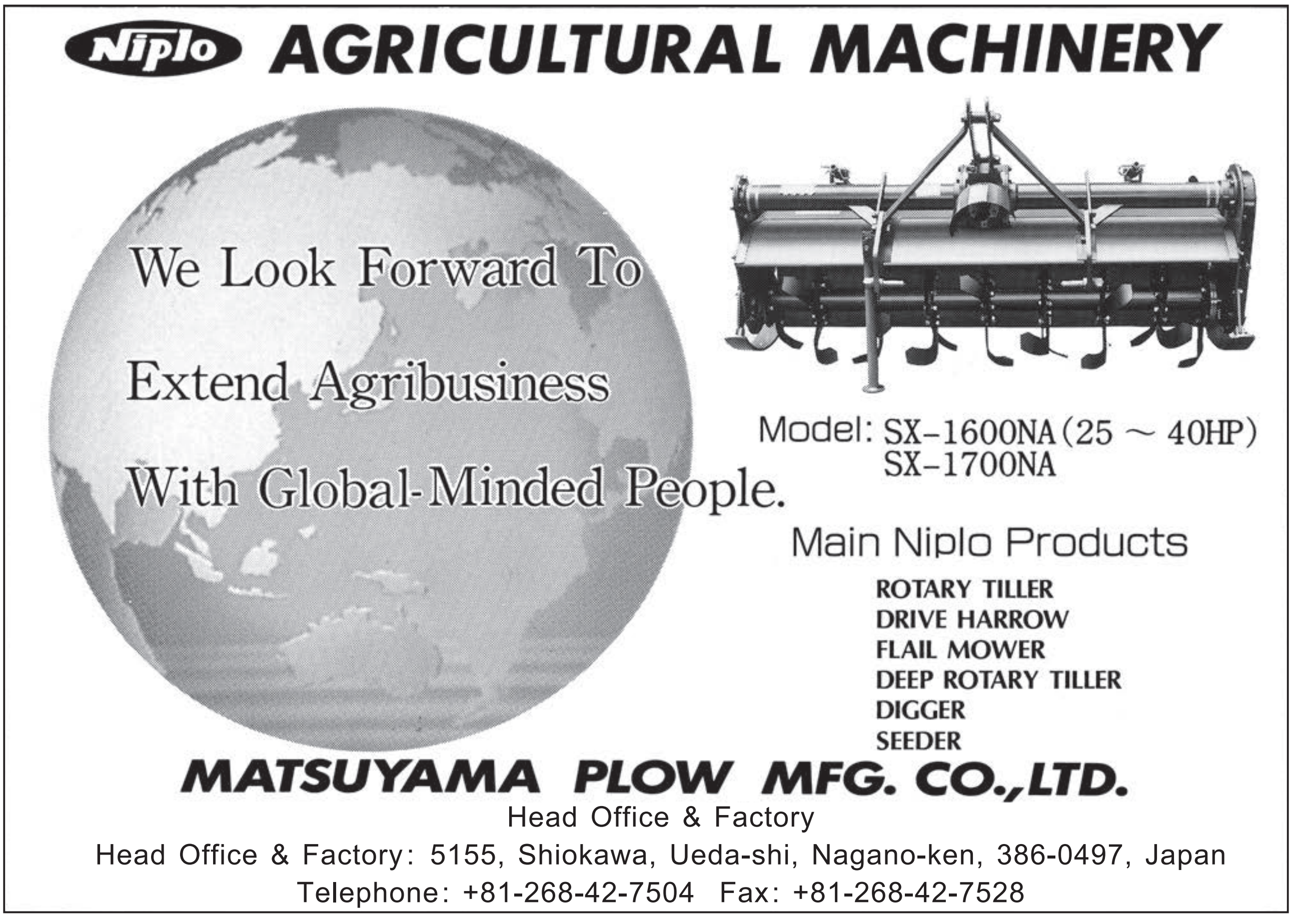

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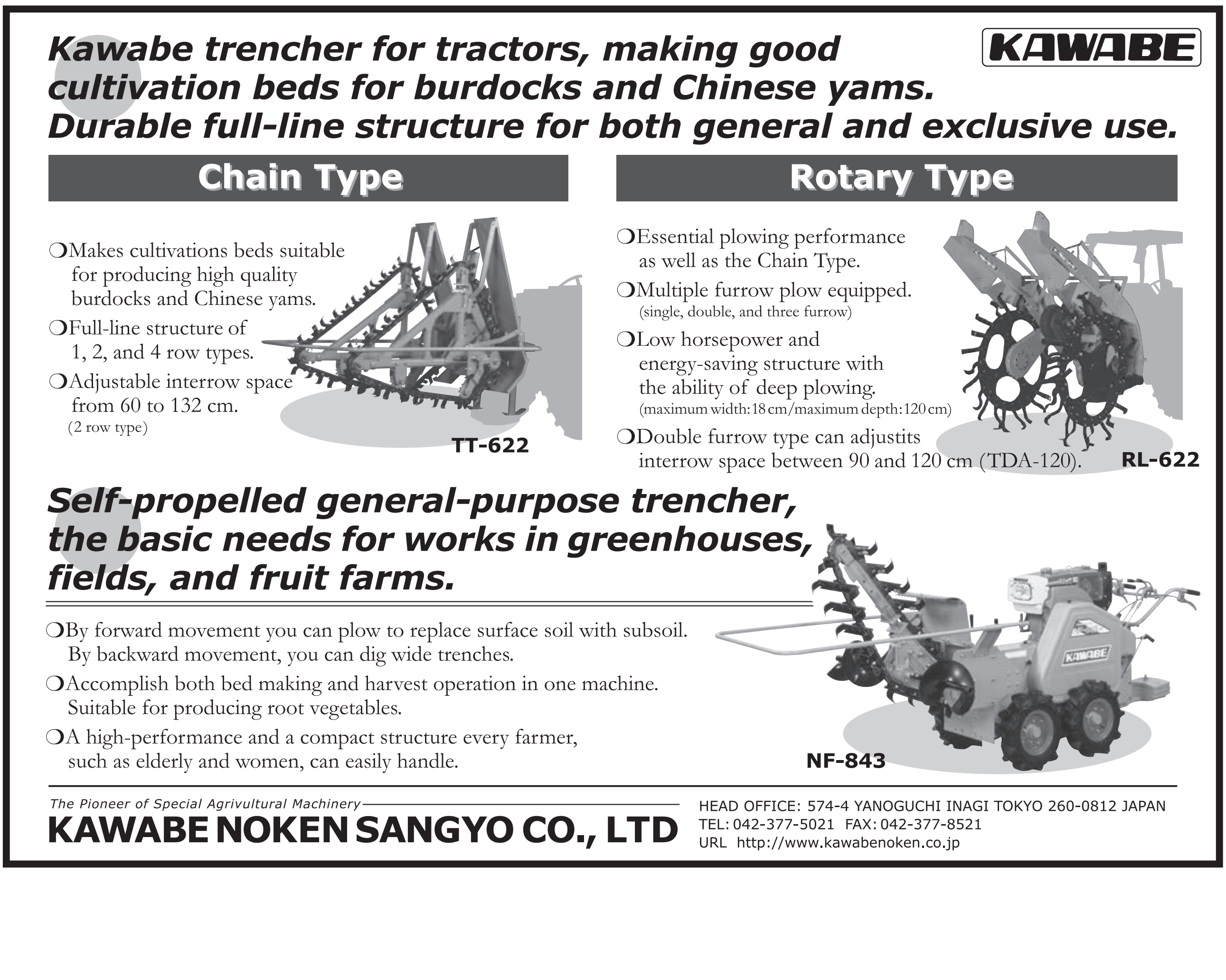

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