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VOL.IX,NO.1,WINTER 1978

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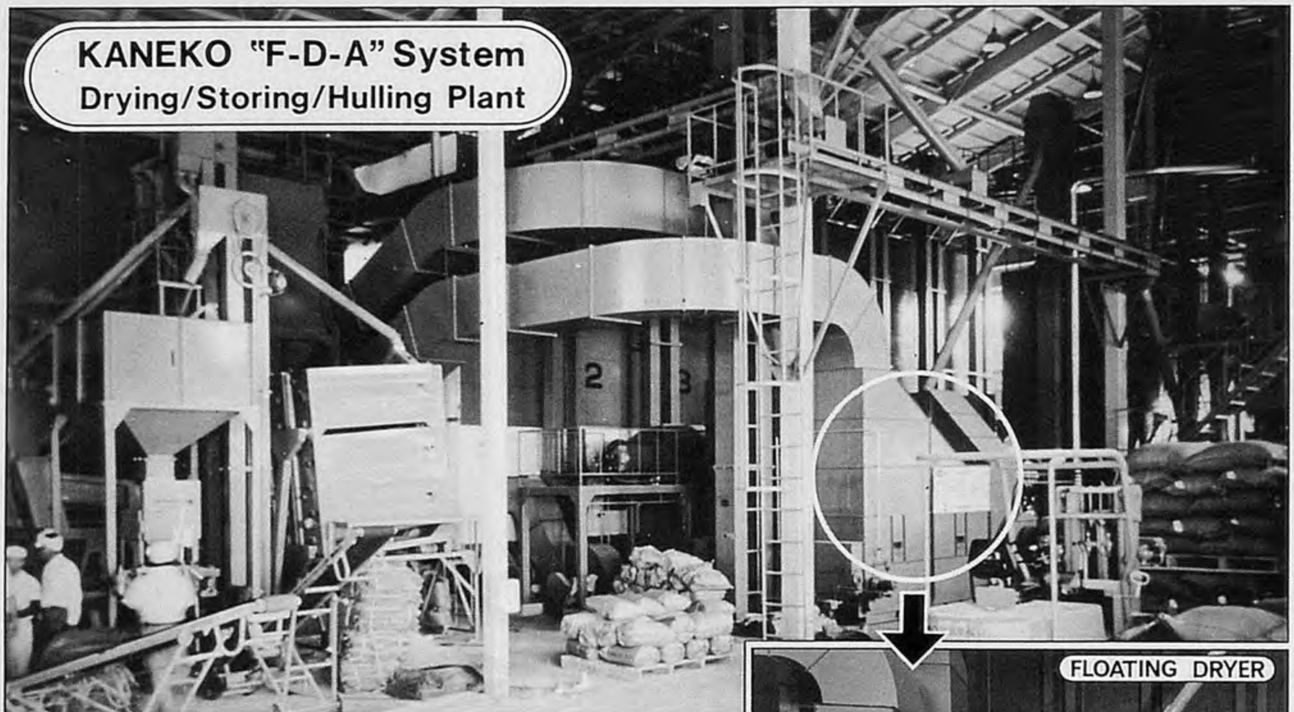

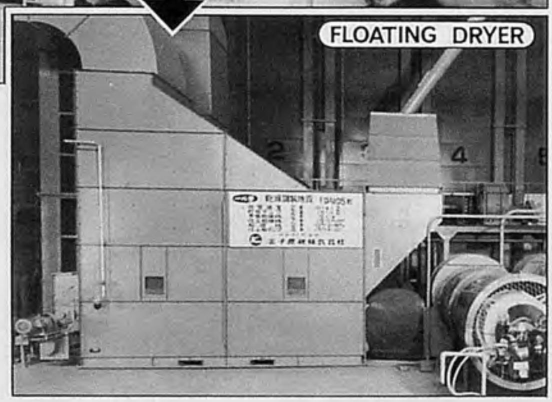

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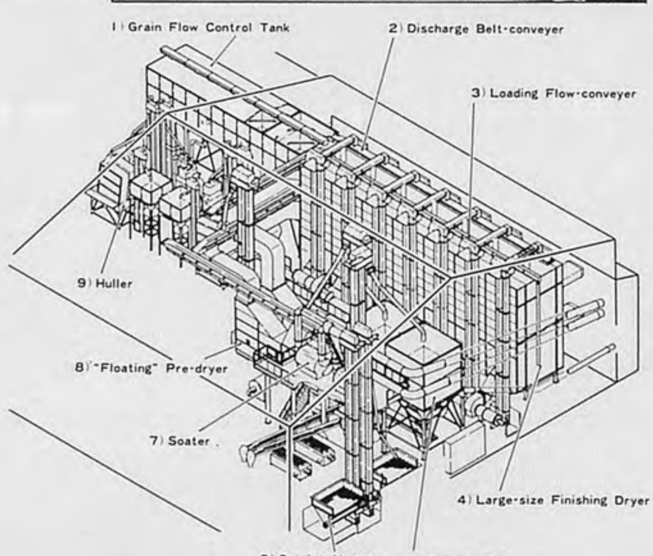

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This is the 18th issue from the first issue, Spring 1971.

Prefacc

A happy new year! Best wishes for this year with all our readers, also hoping heartily at beginning of new year that the agricultural mechanization in all developing countries will further more develop.

We started publishing AMA in Spring, 1971 entitled "Agricultural mechanization in Southeast Asia" and from No. 2 in the next year, we have published the issues changing the title to present "Agricultural Mechanization in Asia". From 1976 when the journal began to appear quarterly, it is three times years in this year. AMA has been supported every year by many useful contributions of the co-editors and earnest investigators in every country who are promoting agricultural mechanization in developing countries. The readers spreaded over the world and I hope to have more readers in this year than now.

The people have a problem of surplus food since last year in advanced countries, on the other hand, they are in trouble of being ill-fed in developing countries. We must make more efforts about storage and circulation of agricultural products. AMA is expected to be a true international communication journal to promote agricultural mechanization in developing countries, co-operating with all of readers hereafter, too.

Asking your kind assistance for the journal.

January 1978

Chief Editor

Yoshisuke Kishida

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AGRICULTURAL MECHANIZATION IN ASIA

Vol. IX, NO. 1 Winter, 1978

Solar Energy Utilization in a Greenhouse Solar Drying System

by
H. S. Chang
Associate Professor
Department of Agricultural Engineering
National Taiwan University
Taipei, Taiwan

The increasing scarcity and cost of many fuels has forced an awareness upon the agricultural and industrial community that energy is valuable resource which must be efficiently and conservatively used. Research efforts in alterative energy sources and more efficient energy processes are more important and of more concern today than in years past. Solar energy is a readily available, alterative clean energy source which can be used in the drying of farm crops.

However, the daily and seasonal energy variation, along with the collection and utilization equipment costs for solar energy have, in the past, slowed development of this alternative energy source. Today's energy situation provides a unique opportunity for the utilization of solar energy as a supplemental energy source for certain farm operations.

This paper describes a greenhouse solar drying system which is developed by Dr. B. K. Huang et al of North Carolina State University, U. S. A. (2, 5, 6, 7). The structure provides an efficient means of utilizing solar energy in crop drying and production.

The greenhouse solar drying system consists of a bulk drying module inside a specially designed greenhouse. It uses two basic approaches to the capture and storage of solar energy. First, as a bulk drying structure, it was designed to utilize physical equipment to collect store and use energy from the sun to dry farm product. Second, as a greenhouse in which the solar absorbers and some drying equipment are removed, solar energy is used for growing horticultural/floricultural plant or crop seedings.

Description of Solar Drying System

The greenhouse solar drying system relates to a farm structure that may be utilized as either a drying facility or as a plant growth facility. The system allows maximum utilization of available solar energy for fuel savings and plant production. The structure basically consists of : (1) a flat concrete slab and block wall foundation, (2) a transparent exterior with clear corrugated fiberglass, (3) frames to support agricultural product being dried or to support seedling growing and handling trays, (4) a heating unit (furnace) with temperature, humidity, and air

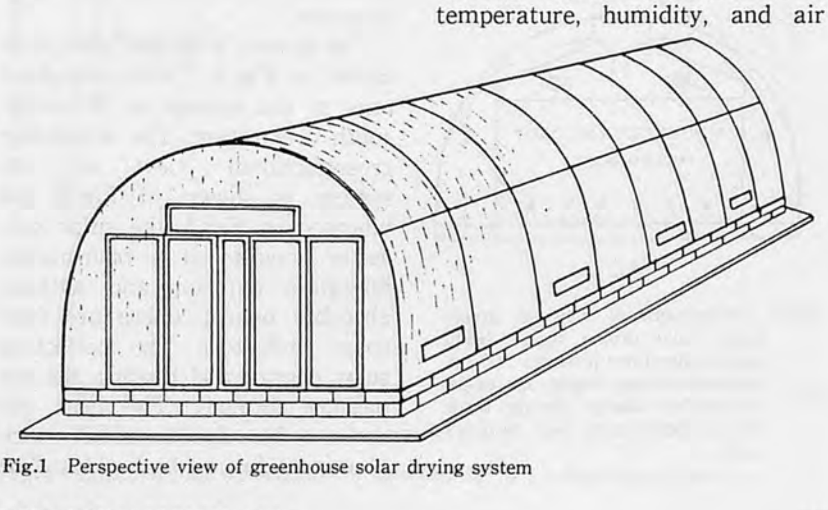


Fig.1 Perspective view of greenhouse solar drying system

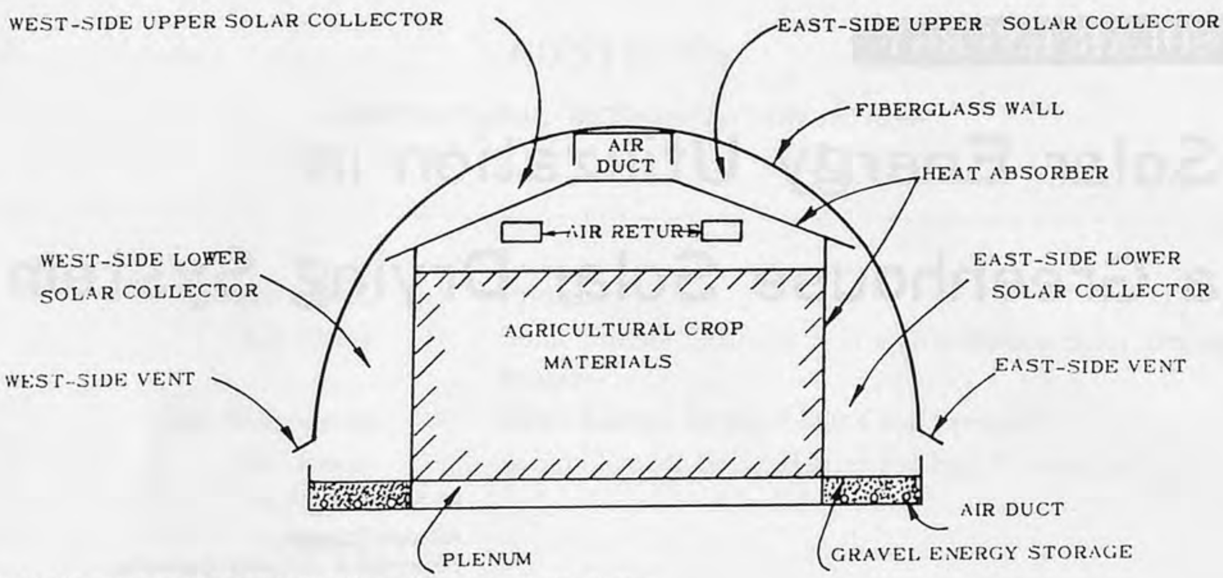


Fig.2 Schematic cross-sectional view of greenhouse solar drying system.

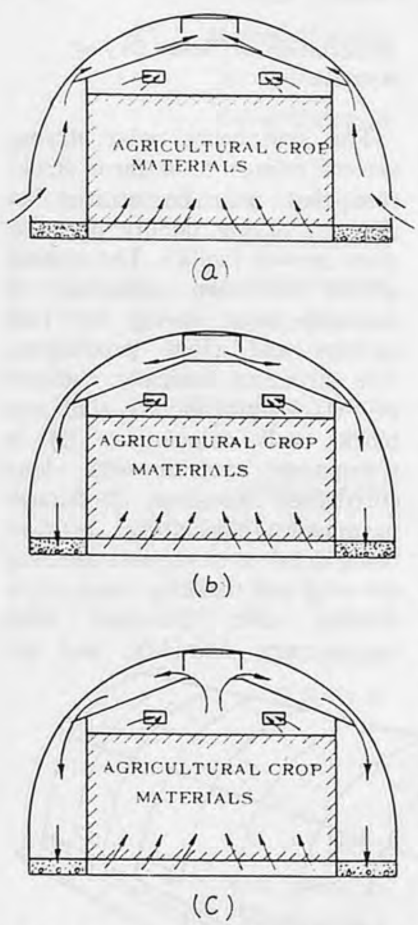


Fig.3 Coross-sectional view of greenhouse solar drying system being used to dry farm products : (a) Immediate daytime energy use mode, (b) Daytime energy storage mode and (c) Dehydration heat recovery mode.

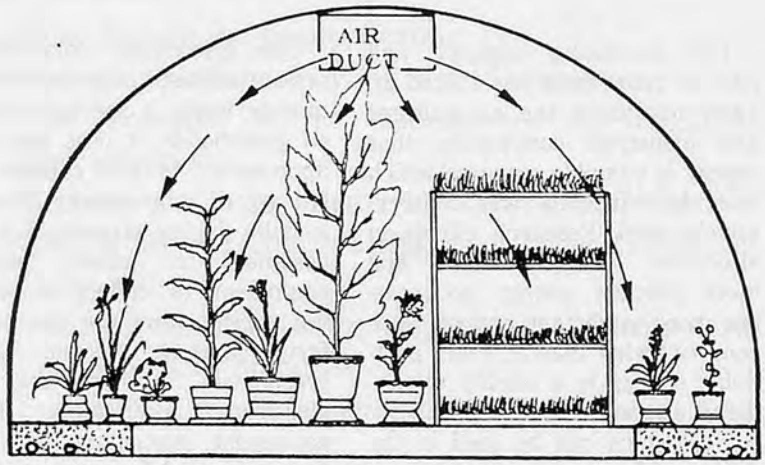


Fig.4 Cross-sectional view of greenhouse solar drying system being used as greenhouse for growing horticultural plant and crop seedlings.

flow controls, (5) air vents and ducts for air flow controls and (6) a gravel energy storage to store excess solar energy for the night-time use.

The system is of shell design as shown in Fig.1. The longitudinal axis of the system is of north-south orientation. The schematic cross-sectional view of the system is shown in Fig.2. As indicated in Fig.2, the solar collector consists of a transparent fiberglass exterior and a heat absorber board. There are four solar collectors for collecting solar energy and heating the air passing through. The heat absorber boards covered with aluminum foil on both sides. The outer side of the board is painted with black thermopaint for maximum solar radiation absorption efficiency. There are three distinct modes of operation-immediate energy use, energy storage and dehydration heat recovery. While the immediate energy use mode is applied, outside air enters the structure from the vents, and is preheated as the air passes over the heat absorbers, enters the top air duct leading to the furnace where additional heating is supplied as required, and is then to the lower plenums passing through the agricultural crop materials (Fig.3 (a)). While the energy storage mode is applied, the air that is preheated by the absorbers is forced through the gravel (Fig.3 (b)). While the dehydration heat recovery mode is used, the air flows out of the drying chamber and passes through the solar collectors. The cool surface of the fiberglass is used to condense out moisture before the air returns to the furnace so that the entire structure acts as a heat exchanger during this mode (Fig.3 (c)).

After the drying season the system is converted to a greenhouse configuration as shown in Fig.4 by removing the heat absorbers to allow the sunlight to penetrate through the transparent exterior and directly reach the plant. An automatic misting device or other effective watering system is provided for optimum moisture control for plant growth and also aids in the cooling of the greenhouse.

The greenhouse solar drying system was designed based on the following equations to estimate the solar energy absorbed by a heat absorber and stored by the gravel energy storage.

A. Solar energy absorbed by a heat absorber (Qs) can be approximated by (11) :

$Q_s = (q)$ (coeff. of transparency of the fiberglass wall) (absorptivity of the surface) (area of the surface) ...... (1)

$$q = \frac{\text{Cos}\,\theta}{\text{Sin}\,\beta}(H_t - H_d) + \frac{1}{2}(1 + \text{Cos}\,\phi)H_d + \frac{1}{2}(1 - \text{Cos}\,\phi)\rho H_t \cdots (2)$$

where

q = total radiation incident upon tilted surface per unit time per unit area (W/m^2)

Ht = total radiation incident upon a horizontal surface per unit time per unit area (W/m^2)

Hd = diffuse radiation incident upon a horizontal surface per unit time per unit area (W/m^2)

θ = incidence angle of solar energy upon the tilted surface

β = altitude angle of the sun

ϕ = tilt angle of the surface from the horizontal

ρ = ground surface reflectance

The incidence and altitude angles are determined from the following equations :

$$\text{Cos}\,\theta = \text{Cos}\,\beta\,\text{Cos}\,\psi\,\text{Sin}\,\phi + \text{Sin}\,\beta\,\text{Cos}\,\phi \cdots (3)$$

$$\text{Sin}\,\beta = \text{Cos L Cos H Cos D} + \text{Sin L Sin D} \cdots (4)$$

where

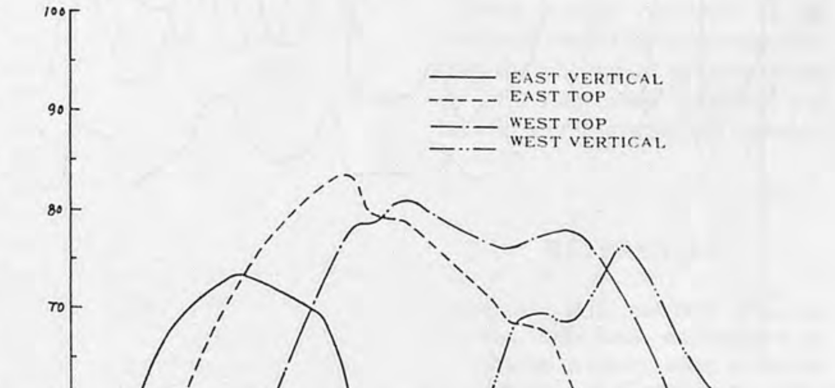
Ψ = wall solar azimuth angle and is the angle in a horizontal plane between the surface's azimuth and the sun's azimuth

L = latitude

H = hour angle

D = sun's declination

B. The gravel energy storage capacity is the sum of the individual heat storage components for the gravel, the concrete block walls and the concrete slab foundation. The storage capacity is defined as the energy stored in a system undergoing a temperature



Fgi.5 Typical surface temperatures of absorbers during a tobacco curing test.

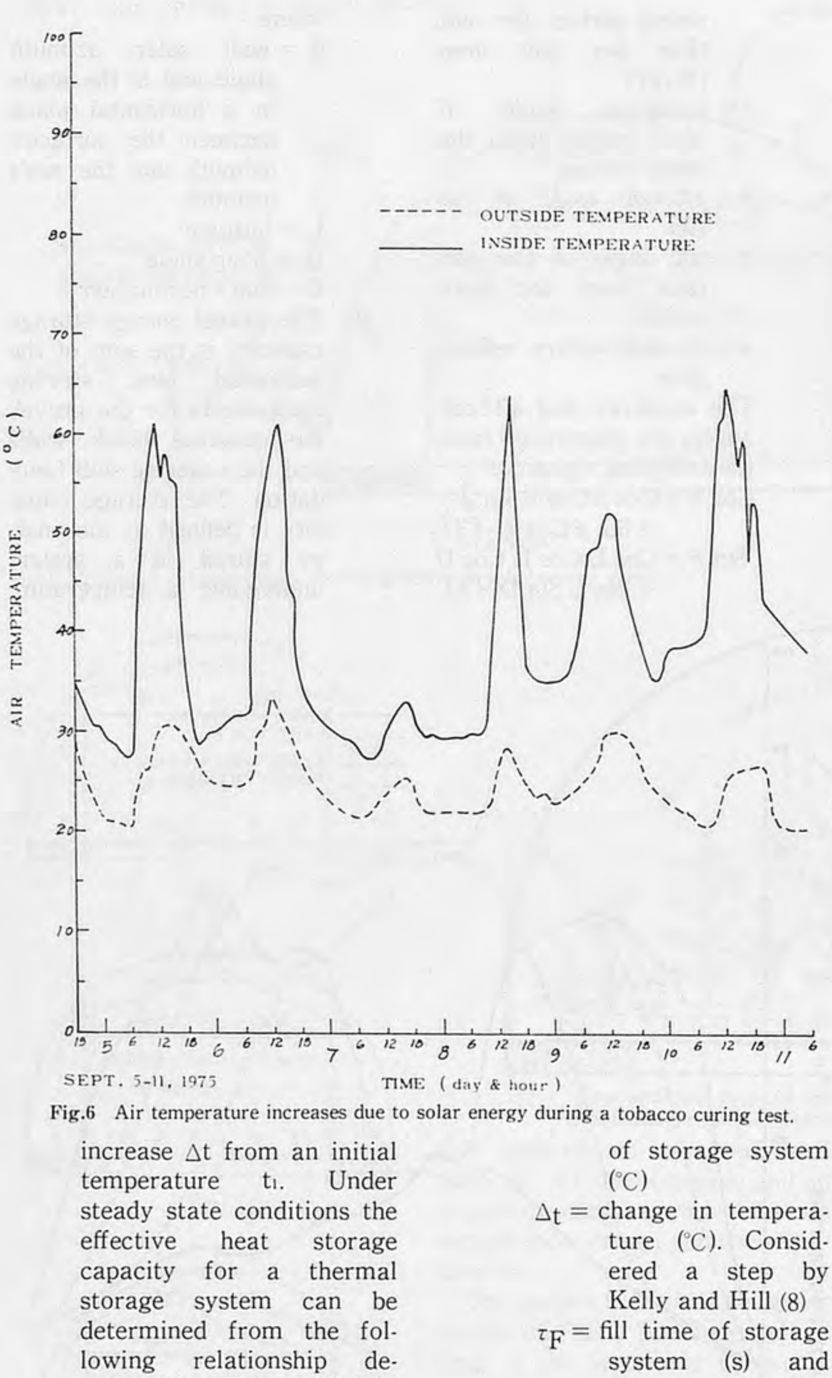


Fig.6 Air temperature increases due to solar energy during a tobacco curing test.

increase Δt from an initial temperature t_i. Under steady state conditions the effective heat storage capacity for a thermal storage system can be determined from the following relationship developed by Kelly and Hill (8) :

$$EC_{hs}(t_i, \Delta t, \tau_F) = \dot{m} c_{tf}(t_i) \int_{\tau_o}^{\tau_o + \tau_F} \delta t(\tau) d\tau - L \tau_F [t_i + \frac{\Delta t}{2} - t_a] \cdots (5)$$

where

EC_{hs} = effective heat storage capacity (J)

t_i = initial temperaute of storage system (°C)

Δt = change in temperature (°C). Considered a step by Kelly and Hill (8)

τ_F = fill time of storage system (s) and defined as time required to bring energy storage state of system at t_i to state at $t_i + \Delta t$ with constant flow rate $\dot{m}$

$\dot{m}$ = flow rate of transfer fluid (kg/s)

$c_{tf}(t_i)$ = specific heat of transfer fluid at t_i (J/kg °C)

τ = time

L = heat loss rate of storage system (W/°C)

t_a = average ambient air temperature (°C)

τ_o = initial time

$\delta t(\tau)$ = inlet temperature t_{in} (τ) minus outlet temperature t_{out} (τ) of transfer fluid (°C)

Performance of Solar Drying System

A greenhouse solar drying system was constructed in the Agricultural Experimental Station of North Carolina State University, U.S.A. Total eight tobacco curing and drying tests were conducted in the system during the summer of 1975 and 1976.

The maximum radiation levels during a typical curing day for direct plus diffuse radiation varies from 1.14 to 1.36 cal/cm^2 min. Typical surface temperatures of the heat absorbers during the day for almost no air movement are shown in Fig.5. Absorber temperatures were a maximum when the sun was perpendicular to the surfaces. A comparison between the outside air temperature and air temperature over the heat absorber for an entire cure is shown in Fig.6. The inside air temperature was taken 12.7 centimeters above the surface of the absorber and 30.5 centimeters from the edge of the top air duct. It is obvious that the heat absorber significantly increased the temperature of the air that passed on it and thus reduced the heating requirement of the furnace.

Gravel energy storage temperature is shown in Fig.7. As showned by the graph, the gravel energy storage system produced energy savings by decreasing night-time fuel consumption. The

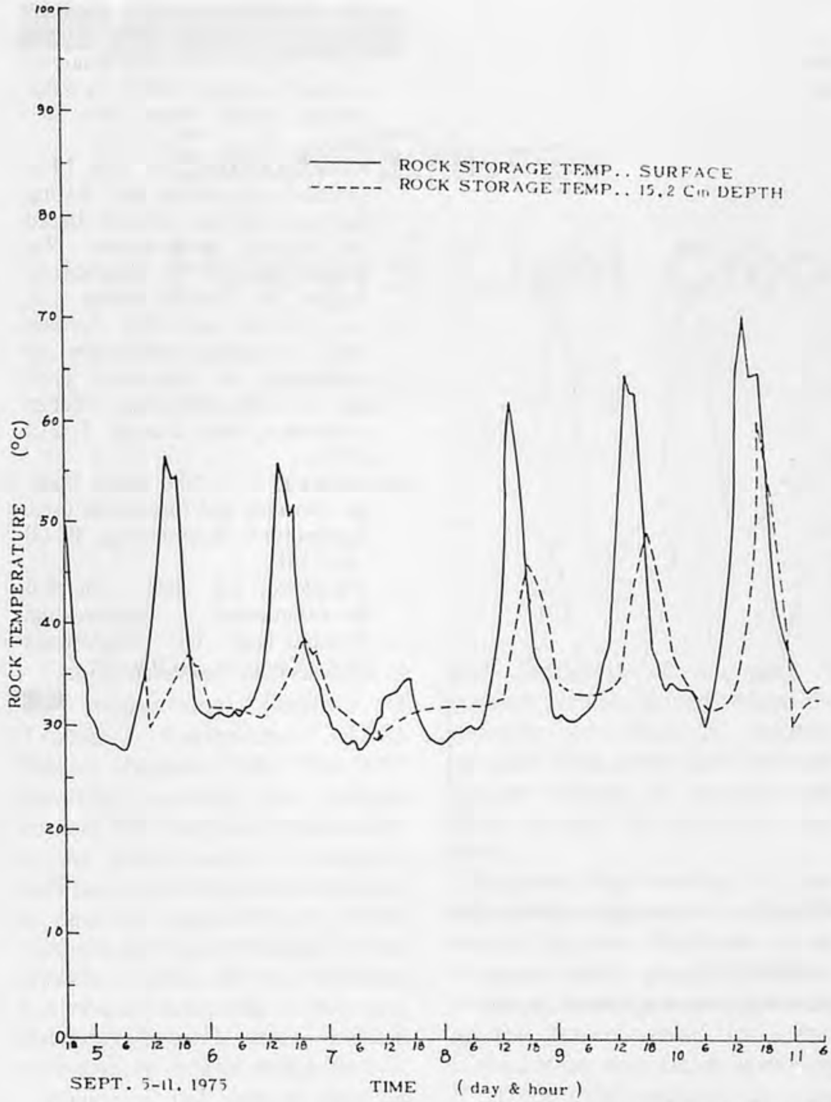


Fig.7 Gravel storage temperature changes due to solar energy during a tobacco curing test.

gravel energy storage consists of twenty tons of crushed granite ; 20 centimeter diameter, corrugated, perforated drainage pipes in the gravel, and a reversable 1-1/2 hp fan for air circulation.

According to Bowers et al (2), the overall fuel saving of the greenhouse solar drying system was 37% as compared to a conventional tobacco bulk curing barn.

Another one of the greenhouse solar drying system was constructed at Pingtung, Taiwan in November of 1976. The capacity of the system in Pingtung is 1/4 of the solar system built in North Carolina State University. Three tobacco cures were carried out after the solar system in Pingtung was completed. The outside air temperature and the air temperature inside the top air duct were recorded for an entire cure and is shown in Fig.8. Fig.8 indicates that the solar collector of the system increased the temperature of air passing through approximately 20°C. And the fuel consumption of the system was found to be 0.3kg of diesel oil/kg of dried tobacco leaves, while the locally made conventional tobacco bulk barn has 0.4-0.8kg of diesel oil/kg of dried tobacco leaves.

Conclusion

The greenhouse solar drying system, developed by Huang et al, was effectively used for curing and drying tobacco with solar energy utilization. The result of tests shows that the solar system achieved an overal fuel savings of 37% as compared to a conventional bulk curing barn. The solar system can be also converted to a greenhouse to grow horticultural plant and crop seedlings. However, further design optimization of the solar system such as modification of solar energy collection and storage equipment, is necessary for making it more efficient in performance and more economic in cost of use.

Solar energy research in agriculture should be encouraged so that the aboundant of solar energy will be better utilized and benefit our agricultural production.

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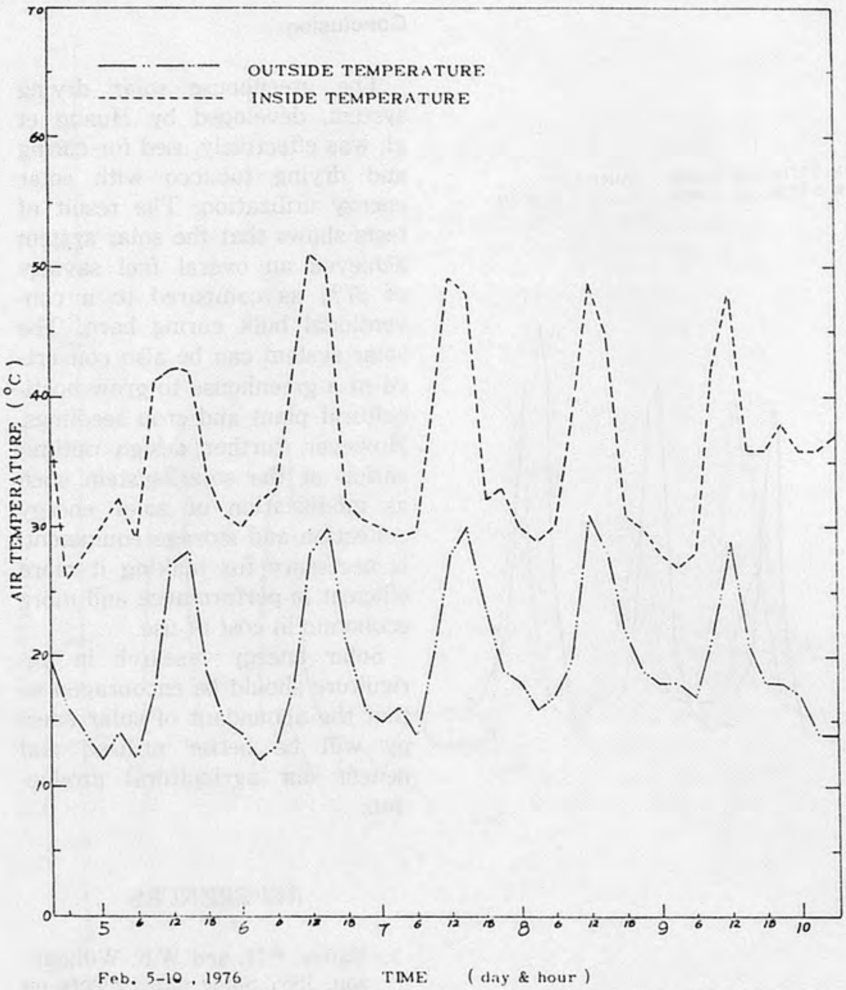

Fig.8 Air temperature increases due to solar energy during a tobacco curing test.

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Solar Energy Powers Light Crop Sprayer

by Ray Wijewardene
Agricultural Engineer
Farming Systems
International Institute of Tropical Agriculture
Oyo Road, P.M.B. 5320,
Ibadan, Nigeria

Complementing the research at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, into "No-Till" planting systems for erosion control and fertility conservation is the team work of scientists and engineers to present these in a package applicable by small farmers in the developing humid tropics. This is a package beamed at increasing farmer productivity several times without recourse to heavy machinery.

Basically, the system involves the use of minute quantities of herbicides, in the order of two to three kilograms per hectare of land farmed, to control weeds which must otherwise be laboriously cultivated out of competition with the crops being farmed. The problem however, is to apply this minute quantity of herbicide evenly over the farmed extent. A simple flashlight battery operated sprayer was evolved in Britain several years ago for spraying insecticide. This principle was then progressed to develop the somewhat larger droplets (300 microns in diameter) found more herbicide application and where the possibility of drift had to be avoided. Conversion to battery power not only saved the effort and drudgery of pumping a sprayer ; it also helped reduce the quantity of chemical solution sprayed from some 500 litres per hectare (about 50 gallons per acre) to only 15 litres per hectarel.

Because this enabled so considerable a reduction in applied energy, the idea developed to use a simple solar energy collector, about a foot square, to provide all the power needed for either herbicide or insecticide spraying. It is not often realized that the solar energy falling upon a square meter of sunlit surface is about 1000 watt (1kw). The collector is equipped with 38 wafer-thin silicon photo-voltaic cells which provide more than 5 watts of power in average sunlight, much more than is needed to operate the spinning disc of the sprayer. The surplus power then charges a battery of Ni-Cad cells in the handle of the sprayer to provide power even through patches of cloudy dull weather. At IITA, in continuous operation for eight hours a day, seven days a week the batteries were found to be as full of charge as on the first day.

Operators like the very light 'sunshade' over their heads ; - a panel which rests lightly on their shoulders and is almost unnoticeable during work. Admittedly, somewhat of a gimmick at its present stage of development, the small size of the solar generator however, emphasises the very low applied energy now involved in these new 'no-till' farming systems, - also the importance and feasibility of using alternative renewable fuels (sunlight) in place of diminishing fossil fuels for so vital an operation as food production.

P.S. An innovative operator at the IITA engineering workshop has hooked his transistor radio up to the solar generator and now has free music-while-you-farm.

Technical Note

The photo-voltaic generator comprises a panel, about 33 cm square, equipped with 38 semi-circular silicon cells, 7.5 cm in diameter, connected in series - to deliver about 6 watts at 12 to 14 volts. Cells are rated at a conservative 100 mW/cm^2 light intensity to deliver, each, 500 mA at 0.45 v. The panel is protected

Photo.1 'Micron Ulva' CDA Insecticide sprayer here powered from the sun through a panel of solar cells over the operator's head. Ni-Cad batteries in handles store the excess charge during sunny periods and stabilize the voltage to the motor spinning the spray disc.

Photo.2 'Micron-Herbi' Herbicide sprayer (CDA) now powered through the solar panel spraying post-emergent herbicide over rice. Panel acts as sun-shade.

with a blocking diode.

The 8 Ni-Cad cells in the handle of the sprayer are series connected and at full charge deliver 1.2 volts, each (total 9.6 volts) with a capacity of 4.0 Ah.

The sprayers are by 'MICRON' Sprayers Ltd., the insecticide sprayer ('ULVA') spinning at 7000 rpm absorbs 220 mA at 10 volts, i e. approx. 2.2 watts. The herbicide sprayer (HERBI) spinning at 1800 rpm (governed) absorbs 70 mA (i. e. 0.70 watts approx).

As expected, the speed of the 'ULVA' tends to vary with varying light intensities (e. g. when the sun goes behind a cloud) if operated direct from the solar panel. The inclusion of the Ni-Cad celles functions both as a voltage-stabilizer, - maintaining a constant 7000 rpm, - and also to store the considerably excess power generated by the panel during periods of medium to bright sunlight, (3 to 6 watts) over the requirements of the motors in the sprayers (0.8 to 2 watts).

The panel and shoulder-supports weigh only 1.2 kg. As soon as wiring from the panel is plugged into the sprayer, charging of the batteries commences when taken onto the field and continues throghout the day. The motor spinning the disc of the sprayer only operates when switched on for spraying. ■■

A Supplemental Solar Heater for Egg Production

by
M. L. Esmay, Professor; F.W. Hall, Reserach Associate; C. J. Flegal, Extension Specialist — Agricultural Engineering Department
C. C. Sheppard, Professor; H. C. Zindel, Professor — Poultry Science Department
Michigan State University, East Lansing, Michigan 48824, USA

Introduction

Two energy related problems persist in egg production enterprises in the northern states. One pertains to maintaining an optimum in-house temperature during cold weather for most efficient feed conversion, and two is the minimization of odors by dehydration of poultry excreta to a stable product having a 10 percent moisture content.

For most efficient feed conversion, the cold weather in-house environmental air temperature must be maintained at the 70°–75°F range rather than the more traditional 50° to 55°F. With well insulated houses in the northern states and controlled ventilation, a 55°F environmental temperature is possible without supplemetal heat. Supplemental heat is, however, generally required to maintain an acceptable environment at 75°F. Some poultrymen are now, due to higher feed prices, attempting to maintain the higher in-house environmental temperatures with better insulated houses, higher density of birds in the houses and by reducing ventilation airflow rates. The reduced airflow rates, however, tend to cause a critically high level of ammonia and humidity. Also, under these conditions of minimum ventilation air exchange the in-house drying of poultry excreta is undesirably low, thereby promoting uncontrolled anaerobic bacterial action with resulting unacceptable odors.

A 10 percent feed savings is potentially possible with the higher 75°F as compared to 55°F (1). Of the 300,000,000 laying hens in the U.S.A., about onehalf are in the northern states and the increased temperature would be effective during about one-half of the year. The savings of 15 gm or 0.033 lb. of feed/day/hen amounts to 4,930,000 lbs. or 2465 tons of feed/day, or an annual feed savings of 448,000 tons for the 150,000,000 hens in the northern states during six months of cold weather.

Objectives

Solar energy utilization for the supplemental heating of egg production housing in the northern states during the winter months is being investigated by the Agricultural Engineering and Poultry Science Departments of Michigan State University. The objectives of the project are to maintain 70° to 75°F house temperatures, increase feed efficiency, maximize in-house excreta drying and minimize undesirable odors.

Description of the Collector

A flat plate, single air pass collector, based on work done by Buelow and Boyd (2), was selected as the least cost and easiest to construct design. The completed installation at the poultry Research Center is shown in **Fig.1.** The 1200 square foot surface area is south facing and tilted at an angle 30° from the vertical for maximum winter solar energy absorption.

The absorber plate is square ridged, black painted aluminum roofing material with a single glazing of 18 tempered glass supported 3/4″ above the plate. The air duct behind the absorber plate is 2.25″ by 18″ wide. The

※ This paper was prepared for and presented at the 1977 Aunual Meeting of American Society of Agricultural Engineers.

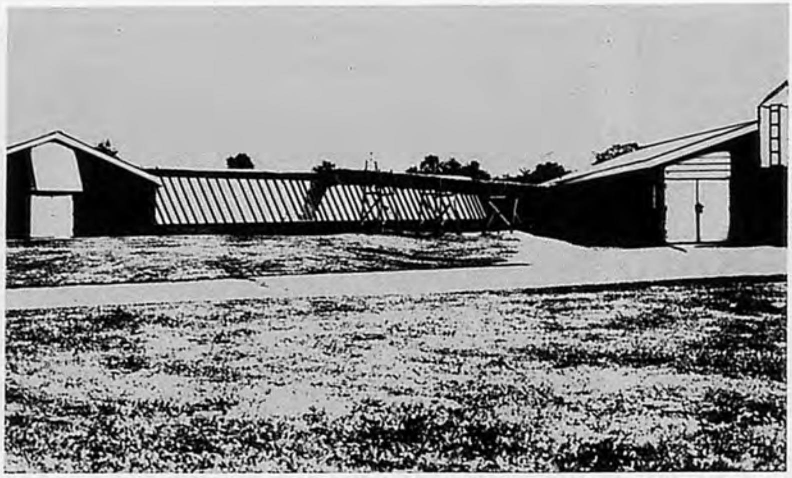

Fig.1 The heated air is drawn from the top of the collector to the building on the right.

whole structure is 10′ high and 120′ long. The details of the collector are shown in Fig.2 and 3.

Because of locational constraints, the collector was placed about 50 ft. from the north side of the poultry building to be heated. Therefore, a duct system had to be installed to deliver the heated air to the building. A 17 inch duct was placed along the top of the collector and a 24 inch duct runs from the center point of the collector to the house. Approximately seven inches of fiber glass blanket insulation, covered with black polyethelene, was used to insulate the duct. Total cost for the construction materials of the collector minus the duct work was $2.63 per square foot. Common farm construction materials were used throughout.

A 5000 cfm fan in the house draws air behind the absorber plate and through the duct. The fan then blows the heated air into a plastic distribution duct, suspended from the ceiling, along the ventilation air inlet side of the house. The distribution duct is 24 inches in diameter, 82 feet long and has two inch holes spaced six inches apart along the bottom.

The building itself houses 5000 laying hens in triple decked cages with a floor space of 2880 square feet, or an equivalent of 0.576 square feet per bird.

The collector was not operational until March of 1977.

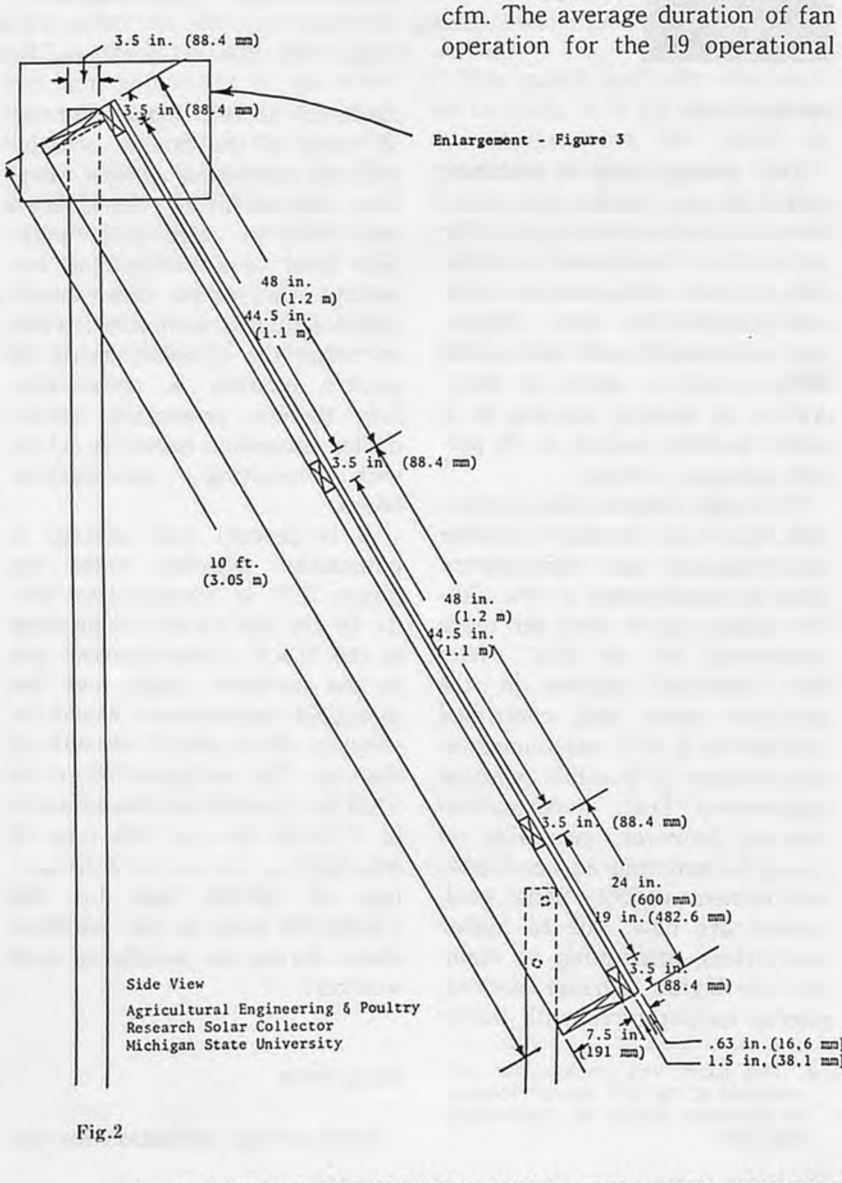

Fig.2

Operation and Data

A four week preliminary test run was conducted during the month of April, 1977, to determine the impact of available solar heating on the house environment. The house was managed as normal and the collector fan was manually operated during the weekdays whenever the collector air exceeded the outside ambient temperature. Heated air input during fan operation was approximately 2500 cfm. The average duration of fan operation for the 19 operational

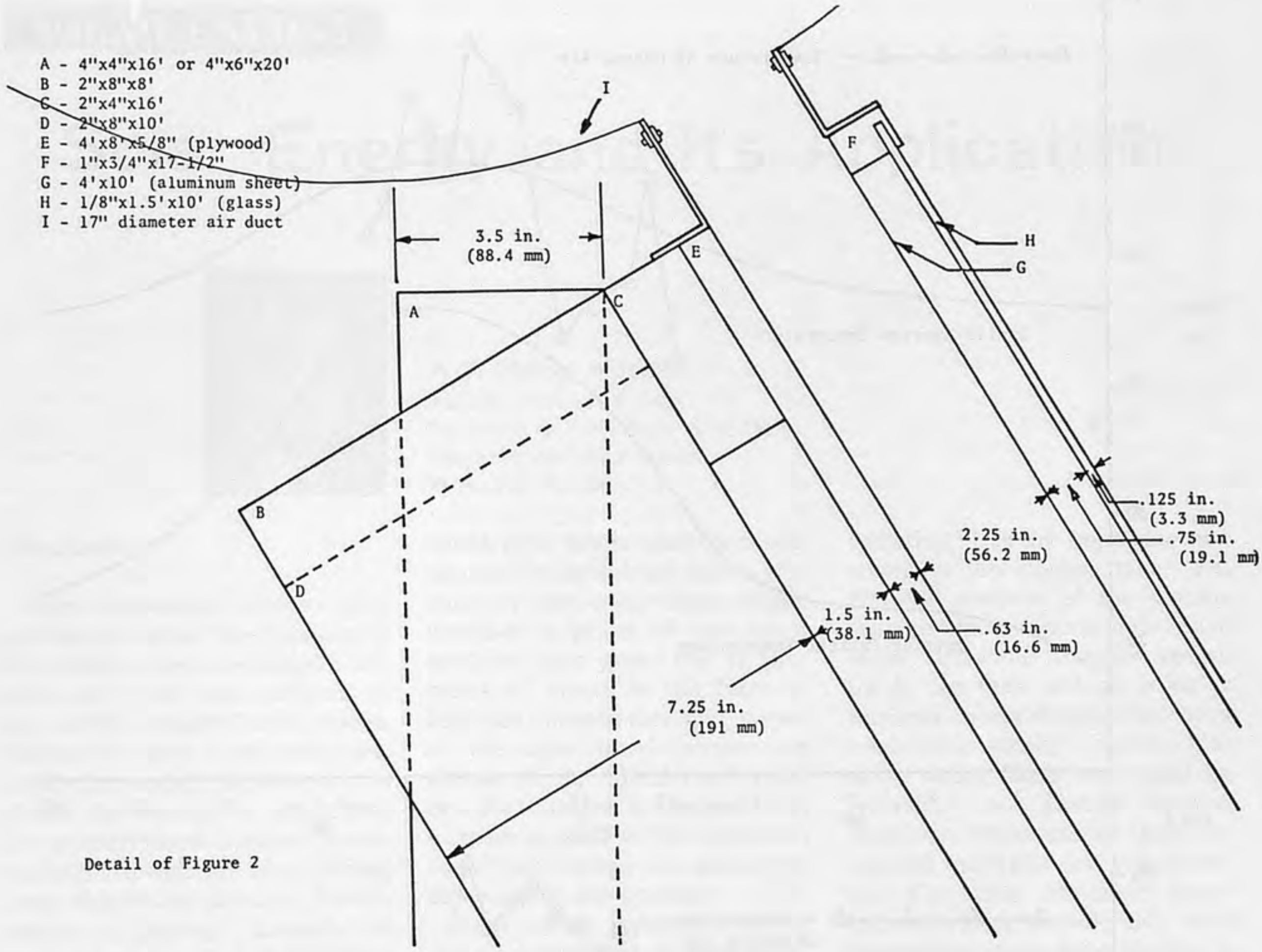

Fig.3

days was approximately seven hours. Due to a lack of recording channels, and other incomplete instrumentation, insufficient data were collected to assess collector efficiencies.

Examples of the type of data collected are shown in Fig.4 and 5. Six points in the cross-section of the poultry house were averaged to determine the inside temperature. The heated air temperature was recorded during the hours of fan operation.

Preliminary examination of these graphs show for a day with the outside temperature about 10°F cooler, the house temperature was held at the same level.

Future Work

Cold weather testing will be conducted on a more intensive basis during the next year to obtain a complete efficiency analysis of the collector and to determine the carryover effect of daytime solar heating on night-time housing environment. It is hoped this might establish the feasibility of solar heating without storage systems. Future work also includes plans for poultry manure drying during the summer months. This would give the collector more year round application and would increase its cost effectiveness. Simulation modeling of the collector and its impact are also being planned.

Summary

A low cost, flat plate, single air pass solar collector was constructed to provide supplemental heating for a 5000 bird poultry laying house in Michigan. This heat is to be used to maintain 70°F environmental temperature, increase feed efficiency of the laying hens, maximize in-house excreta drying and minimize undesirable odors.

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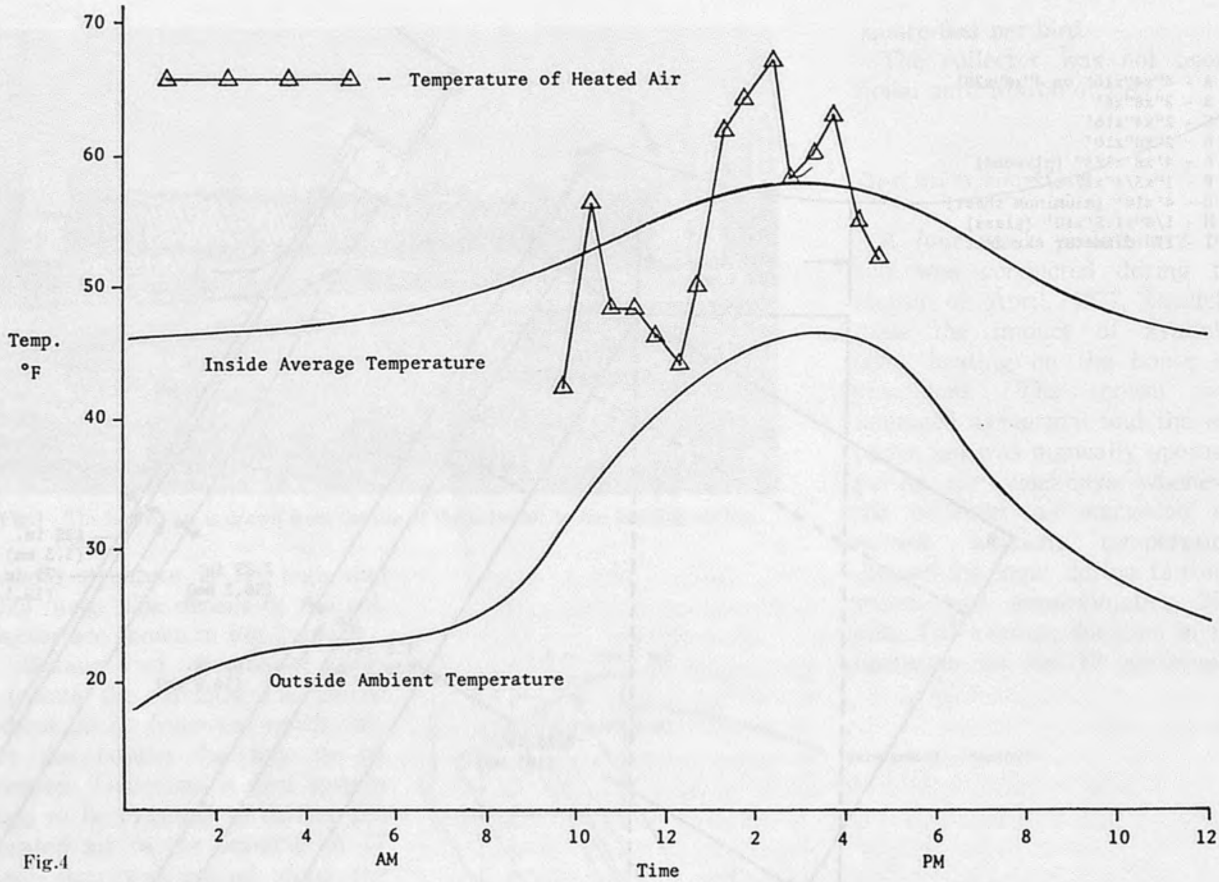
Temperature of Heated Air
Inside Average Temperature
Outside Ambient Temperature
Temp.
°F
70
60
50
40
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2
4
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2
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8
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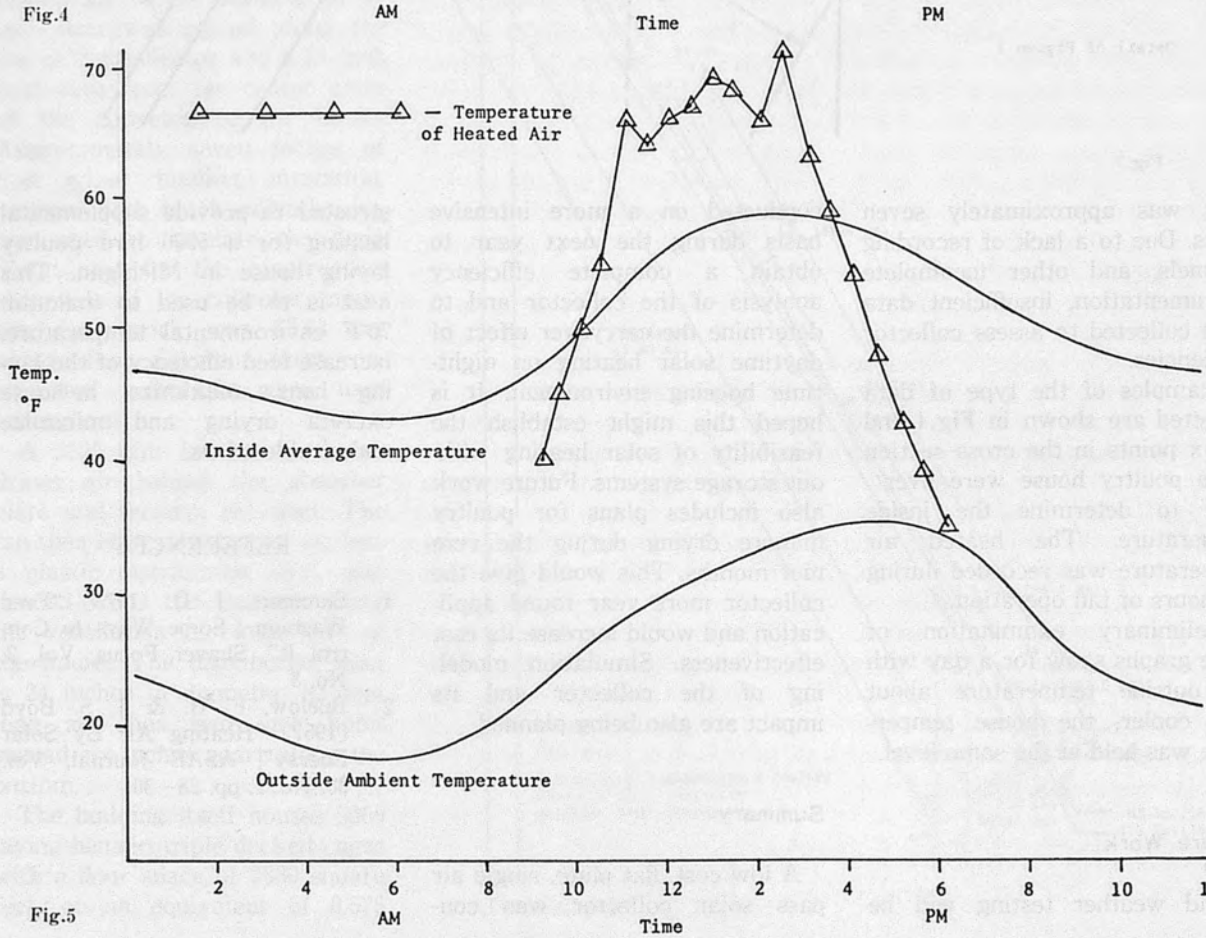
AM
Time
PM

Fig.4


Temperature
of Heated Air
Inside Average Temperature
Outside Ambient Temperature
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AM
Time
PM

Fig.5

SOLAR ENERGY

Solar Energy and Its Application

by
A. A Mainul Hossain
Associate Professor & Head,
Department of Farm Power & Machinery,
Bangladesh Agricultural University,
Mymensingh, Bangladesh

Introduction

The relationship between energy and economic development is as crucial in less developed countries as it was and continues to be in the industrialized nations. Moreover, many of the pesticides, herbicides and fertilizers on which the success of agriculture in industrialized nations traditionally depends are also derived from fossil fuel sources. Examination of energy demands of agriculture reveals a much higher degree of net energy usage and a closer correlation of energy application to productivity than had been anticipated. The phenomenal output of agriculture in the United States and other major food exporting countries can be traced in large part to the massive application of power and fertilizer to land. Because agricutural expansion in the less Developed countries is likely to take place in environments most unsuitable to agriculture e.g. tropical forests, poorly or inadequately watered lands or desert lands energy inputs to achieve the increase of food production required to satisfy the rural needs and an expanding rural population will be even more important then they were in the fertile lands. The inputs will continue to depend largely on petroleium and petroleum based products. The world as a whole must find substitutes for petroleum based products in very near future. Rapid Increase in prices of petroleum products have given rise to problems of inputs in the form of fertilizer, insecticides and power in the agricultural sectors. In almost all the LDCS food shortage and hunger is rampant and increase in price of the petroleum based fuel sources has given new dimension to the problem.

Solar energy represents a vast energy source that is most available in many areas where population density is often low and where conventional energy sources may be expensive.

Solar Water Heaters

Solar water heaters repressent a fairly recent development. Cold water in a container is exposed to the sun undergoes a rise in temperature. It consists of a flat plate collector and an insulated storage tank. The collector is commonly a blackned metal plate with attached metal tubing and is usually provided with a glass cover and layer of insulation beneath the plate. The collector tubing is connected by piping to a tank that stores hot water for use during non-sunny period. When mounted on a elevated place the collector absorbs solar radiation, thereby supplying hot water to the storage tank. The elevated position of the storage tank results in natural convection water circulates from the collector to the tank and no pump is required. Several countries have used solar water heaters for many years. They were used extensively in United States. However, their use in less developed countries are very limited. The cost of solar water heaters varies considerably with the quality of construction, but in general the price of a collector is about \$10-\$12 per ft^2 in the United States. Solar water heater is free of any moving part and require a minimum maintenance.

Heating and Cooling of Building —Solar space heating

The technology of solar space heating where water is the medium is essentially an extension of the technology employed in solar water heating, except the energy has to be recovered from the tank through a heat exchanger surface.

In addition to solar heating system standby convetional heating system are necessary for high degree of reliability. Systems using air as heat transfer medium between the collector and storage bin containing small rocks have been used successfully. Solar heat is stored as sensible heat in the rocks and recovered when needed, by passage of air over the rocks and then to the rooms. Solar air conditioning can be accomplished in the same manner by conversion of solar energy to the mechanical form needed to operate a compressor. The need for mechanical power and its relatively high cost from solar energy can be avoided by using absorption refrigeration cycle. Solar cooling has not been developed to the same extent as solar heating.

Solar Energy for Desalination

Solar energy for desalination and production of common salt from sea water is widely in use in many developing countries like Bangladesh, India and developed countries like United States, Greece, Australia and Soviet Union. In its simplest form it consists of a shallow pool of brine from which slow evaporation of water takes place. The pool is covered by sloping sheets of glass or plastic ; water condensing on the underside of the cooler glass covers run to troughs at the lower edges and to storage. For salt production from sea water small tracts of land by the side of the sea is flooded with sea water. The water is left exposed to the sun shine for few days till the concentration of the salt in water rises. Then the water is transferred to the next bed for further concentration. In this way the concentration of the salt in the sea water goes on increasing and ultimately yields common salt. This practice is used extensively in the costal belts of Coxes' Bazar in Bangladesh.

Solar Crop Drying

Of all the direct uses of solar energy, sun drying of crops is perhaps the most ancient and wide spread. The technique involves spreading the material to be dried in a thin layer on the ground to expose it to the sun and wind. Paddy, jute and many other crops are still dried in this manner in Bangladesh and many other parts of the world. In recent years the term solar drying also has come the process whereby agricultural materials are dried not by direct exposure to the sun and wind, rain, insects, vermin and birds but by means of solar heated air in more protected surroundings. A large portion of the worlds dry fruit and vegetables continue to be prepared by sun drying. The process is the cheapest and the simplest way to dry crops in region where sunshine is abundently available. To remain stable in storage, agricultural crops should be dried to a moisture content of 12–15 percent by weight. The relative humidity of the air which will be in equilibrium with crops of that moisture level varies from crop to crop and ranges from about 48–60 percent for fruits, grain and hay.

Power Generation

Solar energy for power generation, either in the form of electricity or mechanical work has been subject of extensive research in Soviet Union and United States, French, Italy and Israel. In addition to this photovoltic devices for electricity generation from solar energy is getting popular day by day. The operation of the solar cell is based on photovoltic effect. Charge carries are generated within a material by the absorption of energy from incident radiation. The materials which are used as solar cell are semiconductors whose properties lie in between those of conductors and insulators. Literally many materials, alone or in combination, possesses the semi-conductor properties required for high efficiency conversion of solar radiation to electricity. The most important of these materials are silicon, cadmium sulfide, and gallium arsenide. Since the invention of the silicon solar cell in 1955, there have been roughly a hundred different terrestrial applications of photovoltic solar energy conversion systems-photovoltic devices capable of generating a few watts to over a kilowatt peak power have been manufactured in different countries. These have provided power for lighthouse navigational and warning light radio ; microwave and television relay stations ; weather monitoring stations ; remote educational television sels ; etc. Photovoltic devices have no moving parts and is therefore highly reliable. Except occasional cleaning of the surfaces practically no other maintenance is necessary for photovoltic devices. However, at the present stage of development cost of energy production by photovoltic devices are excessive compared to other more conventional sources of energy production.

Conclusion

The form of nenrgy available from the solar radiation discussed so far are still more of scientific than commercial interest. The cost and complication of the devices are prohibitive compared to other conventional sources of energy now available. Harnessing of solar energy in different forms needs further investigation so as to reduce the operating and fixed costs of the devices compared to other conventional devices. However, in the immediate near future desalination of water and production of salt, and drying of agricultural products by using solar energy seem to have a promising future. ■■

Appropriate Technology for Rural Development

by
Amir U. Khan
Project Director
IRRI-PAK Agricultural Machinery Program
The International Rice Research Institute
P.O.Box 1237 Islamabad
Pakistan

Introduction

The twin problems of unemployment and low agricultural productivity are of serious concern to policy makers in the developing countries. There is no alternate to increasing productivity of small scale agriculture if significant progress is to be made in solving the problem of absolute poverty in rural areas. At the same time, the small farmer cannot prosper unless growth occurs in other sectors, both to provide the development resources they require and to create a demand for their additional product and services. Appropriate technologies offer considerable potential for serving these two sectors simultaneously in the developing economies. Efforts on introducing appropriate technologies must in essence focus on the industrialization of rural and semi-rural areas. Socio -economic benefits of greater employment, equitable income distribution, higher standards of living, utilization of local materials etc. Will accrue, if locally available resources are optimally used in the industrialization process.

※ Paper presented at the International Conference on Rural Development Technology : An Integrated Approach, June 21–24, 1977 Asian Institute of Technology, Bangkok, Thailand.

Successful Commercialization

Successful commercialization of appropriate technologies is an essential prerequisite for socio-economic benefits. Thus whatever objectives we have in introducing appropriate technologies, economic production of demand-oriented products and services assumes the most important significance. Appropriate technology priorities must therefore begin with an assessment of the demand for products and services in the rural and semi-rural areas of the developing societies and a subsequent selection and application of such technologies, both available and as yet to be developed, that could cater to these demands. Our overall emphasis in introducing appropriate technologies should be directed towards the establishment of small industries in the rural and semi-rural areas to serve the basic human needs of food, shelter, transportation, health and sanitation of the relatively poorer segment of the population.

Import Substitution

Many countries have placed considerable emphasis on developing import-substituting modern-sector industries in their urban areas. These industries duplicate the products as well as the production methods of the industrially advanced countries. Such efforts have failed to provide the required socio-economic benefits and have only served the needs of a small, relatively rich segment of the population. There is no doubt that we need to continue our efforts on import substitution, however, appropriate product design as we ll as production methods must be introduced to really spread the socio-economic benefits to a majority of the people in the developing countries.

Fabrication Versus Basic Material Industries

For a variety of reasons, manufacture of basic production materials does not offer as much employment potential as fabrication of products made from the basic materials. The basic production material industries are highly capital intensive and mostly suited for centralized operations. In selecting areas for appropriate technology focus, this factor needs careful consideration, especially since employment generation is one of our important objectives in the developing countries.

Many advocate the introduction of appropriate technology techniques in the manufacture of basic production materials such as steel, cement, textiles, glass, fertilizer and other chemicals, partly because of the success reported from China. China has been following the small plant strategy for the production of basic materials that are urgently needed for agriculture and rural development. This strategy has been advocated primarily to utilize smaller deposits of raw materials, to save transportation costs, and to achieve some degree of self-suffiency at the local level rather than to achieve major increases in employment.

The establishment of a highly decentralized network of fabrication industries at the Commune & Brigade levels in China, is much more relevant to our efforts of introducing appropriate technologies in the developing countries since it offers numerous possibilities for socio-economic benefits. The small scale processing of agricultural products, the fabrication of a variety of utility equipment and the manufacture of many consumer products offer a much greater potential for introducing appropriate technologies in the rural areas. This is not to say that scope does not exist for introducing appropriate technology techniques in capital intensive industries but to indicate that chances for desired socio-economic benefits from such industries is comparatively limited. Wherever possible, production of basic materials certainly should be encouraged through smaller plants however this sector need not be the focus of our appropriate technology efforts. As a broad rule of thumb, industries, that are highly sensitive to economies of scale, offer limited potential for application of appropriate technologies techniques.

Traditional Versus Modern Focus

There is a widespread belief among development scientists that simple improvements in products that are traditionally produced by rural craftsmen, can be a highly beneficial exercise for the developing countries. Consequently much effort has been expanded in designing and improving simple manual and animal drawn tools and equipment in a number of developing countries. Almost twenty five years of serious efforts to improve traditional agricultural implements in India and in many African countries have not produced any outstanding results. It is about time that we seriously look into the reasons for the apparant lack of farmer acceptance and commercial viability of such efforts.

On the basis of my personal experience of introducing appropriate farm mechanization technology in many developing countries, I firmly believe, that the cost-benefit ratios of marginally improved traditional technologies are not sufficiently attractive for successful commercialization. This has been the most important reason for a lack of success in such efforts. In order to introduce commerially viable appropriate technologies in the developing societies we will have to adopt stratagies that are capable of producing quantum rather than marginal technological improvements.

To do so I believe, the engineering community must concentrate on solving the bottlenecks that traditional craftsmen are not able to tackle on their own today. It is doubtful that with all the engineering know-how that we have at our command, we could make many significant improvements in traditional tools. Generally simple creative ideas, rather than modern engineering know-how are needed for improving traditional tools. Centuries of ingnuity have gone into improving the traditional tools and implements that are popular today in the developing countries. The qualified engineering community has no clear cut advantage over traditional craftsmen in creativity and as such it is doubtful that any major break through could be achieved by following the marginal improvement approach.

Market Demand

Demand for traditional-sector products in the developing countuies is not expected to substantially increase in the future and hence chances for rapid industrial growth in this sector are limited. Rural population in the deveilping countries are being rapidly exposed to modern-sector products, that are either imported from the industrialized countries or are being produced in their own metropolitan areas. People in the developing countries are aspiring to acquire modern-sector products such as cooking stoves, flashlights, gas lanerns, portable radios, sewing machines, electric fans, bicycles, scooters, motorcycles, power-tillers, small tractors, threshers, motorized carts, and a host of other similar utility products.

The low purchasing power of the people in the developing countries demand different product designs, specifications and quality standards than those acceptable to the industrialized societies. Utilitarian as well as manufacturing considerations also dictate introduction of different products and services in the developing countries. The craftsmen and small entrepreneurs in the rural and semi-rural area of the developing countries are unable to tap this large potential demand because of their inability to develop appropriate marketable products which could be manufactured with the available production technology.

For most developing countries, maximum potential for introducing appropriate technologies lies in serving the demand for modern sector products and services in domestic markets. Production of the traditional sector products may be necessary in some countries for export, however this sector offers a limited potential for rural industrialization. The ultimate objective of our appropriate technology efforts, therefore, must be on the development of small business enterprises in the rural and semi-rural areas to produce low-cost, demand oriented, modern-sector products and services for the domestic markets. To achieve this objective, major engineering efforts will be needed in the development of appropriate products designs and their production techniques suitable for conditions in the developing countries.

Product and Production Elements

There are two elements of technology, the product and the production process which play a significant part in the Industrialization process. The design of a product is closely related to its production processes and conversely, the available manufacturing processes can significantly dicatate the design of a product. Manipulation of these two elements of technology can be an effective tool for the introduction of appropriate technologies in the developing countries.

Since it is often rndesirable to introduce capital intensive manufacture, it is necessary to develop products that could be produced with labor-intensive production methods. Simultaneous efforts are also needed to develop low cost labor intensive production equipment and techniques for more economic production of modern sector products in the developing countries. There are many interesting examples in South and South-East Asia which indicating that low volume production of modern sector products is economically feasible if product designs and production methods are appropriately tailored. Recent production of Power-tiller and Threshers in Thailand and in the Philippines are excellent examples. Similarly production of jeepneys in the Philippines, machine tools in India and Pakistan are good examples which support this thesis.

Marketable Product and Service

A wide range of day to day utility products are required today to serve the basic human needs of the rural population in the developing countries. The design and development of such products and their small scale decentralized production is a challenge that must be met to improve the socio-economic plight of the rural masses. Some of these utility products are :

(1) **Food.** Various types of equipment for the small scall production processing and preparation of food. These include power-tillers, small tractors, harvesters, threshers, irrigation equipment, village and farm level crop and food processing equipment, milk and dairy products processing equipment, bakery, chapati making and other home and communal food preparation equipment etc.

(2) **Shelter.** Simple equipment and products for home and buildings construction such as concrete mixers, blocks and brick making machines, woodworking tools and equipment These could also include low-cost home appliances such as cooking stoves ; water heaters, (wood, sawdust, rice hull, solar, electric etc) laundry equipment household waterpums and distribution systems etc.

(3) **Transportation.** Low cost equipment for rural transport such as animal-drawn carts, cycle and auto rickshaws, motor scooters, motorcycles, theree and four-wheel motorized farm carts etc. It could also include simiple equipment for road and canal construction etc. for the rural areas.

(4) **Health and sanitation.** Equipment for providing basic health, sewage, cleaning, fire fighting and other municipal services in rural areas and small town, Equipment for rural dispensaries and hospitals etc.

(5) **Rural Industrialization.** Simple tools and equipment for use in rural and handicrafts industries, for commercial processing of food and fiber and for consumer goods manufacturing.

Summary and Conclusion

One could draw some general conclusions from the above discussions on appropriate technologies.

First : Successful commercialization of appropriate technologies in a prerequisite for socio-economic benefits.

Second : Selection of appropriate technologies should be based on the potential demand for products and services that technologies will generats Consideration of labor intensity, income distribution, local material utilization etc. are all important however these are dependent factors and must be treated accordingly.

Third : Products and Services originating from the application of appropriate technologies should meet the basic human necessities of food, shelter, transportation-health and sanitation of the relatively poorer segment of the developing countries population.

Fourth : Appropriate technologies should offer new products and services which are not presently met from local sources in the rural areas. Major attention should be directed towards the establishment of import-substituting modern-sector inductries for the production of appropriate products through capital saving production methods.

Fifth : Demand for traditional-sector products will not increase substantially, hence, this sector should receive limited attention.

Sixth : Major appropriate technology inputs should be focused in establishing industries which fabricate utility products in the rural areas rather than the manufacture of basic production materials.

Seventh : Technological innovations in product designs and production methods will accelerate indicenous manufacture of modern-sector products and can help to generate substantial employment, for both skilled and unskilled workers, in the rural and semi-rural areas.

Presently there seems to be an excellent understanding of the broader issues of appropriate technologies, however, the subject is not as well understood in its elements. Consequently appropriate technology development efforts have been spotty and rncoordinated. Organizations concerned with introduction of appropriate technologies need to focus their attention to solving specific bottlenecks for rural industrialization rather than spreading their limited resources too thinly in all directions. ■■

New Concepts in the Optimization of Irrigation Mechanization

by
Zahid Mahmud
Project Engineer
Rainbow Manufacturing Company
P.O.Box 70, Fitzgerald,
Georgia 31750, U.S.A.

Technology in irrigation, like in other fields, is changing very rapidly. Demands are being made of the irrigation industry by farmers for automated, labor saving devices and systems that will perform well at a reasonable cost. The new equipments that are constantly being introduced in the irrigation market are evidence that this challenge is being met. Four irrigation systems are emerging to take the lead in the irrigation field for cash crop production : Automated gated pipe, traveling gun sprinklers, center pivot, and drip irrigation. In this paper, gated pipe, center pivot, and drip irrigation have been discussed first but briefly, and traveling gun sprinklers have been discussed later, at greater detail.

Automated gate are in primarilly advanced furrow irrigation systems. They have the advantages of low labor costs and requirements, high irrigation, higher uniform coefficient, and lower energy requirements. Its limitation : generally cannot be used efficiently where slope is less than 0.2 percent or greater than 1.5 percent. Slopes of 0.3–0.5 percent are recommended for fine sandy loam soils. Flatter slopes cause difficulties in advancing the stream through furrow, and steaper slopes cause excessive erosion. Furrow size depends upon the type of soil which controls the time the water should reach the end of the furrow. **Table 1** represents the suggested furrow lengths and the time of advancements for various types of soils.

Table 1. Various Furrow Lengths and Time of Advancement for Various Types of Soils.

Soil Type	Maximum Furrow Length (ft.)	Maximum Time of Advancement (hr.)
Sandy Soil	···	···
Sandy Loam	750	3.75
Fine Sandy Loam	950	4.75
Silt Loam	1125	6.25
Silty Clay Loam	1350	7.50

The data for sandy soil has not been reported, as the automated gate pipe systems are suitable only where the basic intake rate of the soil is 0.5 inches per hour or less. Soils with higher intake will require sprinkler irrigation. During irrigation, the intake rate is high in the beginning, as the surface may be cracked or crumbly, and it decreases after the initial wetting. Applying water at a rate faster than the intake rate of the soil may cause soil compaction, puddling erosion and runoff. This reduces the intake rate of the soil for the next irrigation. The gated pipe should be large enough to deliver 50 gallons of water per minute each, with 1/3 PSI pressure on each gate.

For well design, automated gated pipe systems with adequate storage in the reuse pit, the first set width would be such that inflow to the system from a well or a canal would be equal to the maximum nonerosive stream size times the number of furrows. The tailwater pump would turn on at about the time of the beginning of the second set, and the second and all subsequent sets would be wide enough so that the system inflow plus tailwater pump discharge would equal the maximum nonerosive stream size times the number of furrows per set, (Maximum nonerosive stream size, GPM= 10 /percent slope.) A handy conversion to remember is that 450 gallons per minute equals 1 acre inch per hour.

The center pivot system is the most labor saving device known in the irrigation system, with less than an hour required per application on 100 acres. It offers the ability to apply water lightly and frequently. The light and frequently distributed application of water from a center pivot sprinkler system replenishes the moisture in the root zone sufficiently to allow intensive cropping on coarse textured soils with limited water holding capacities. It can also be used for applying fertili-

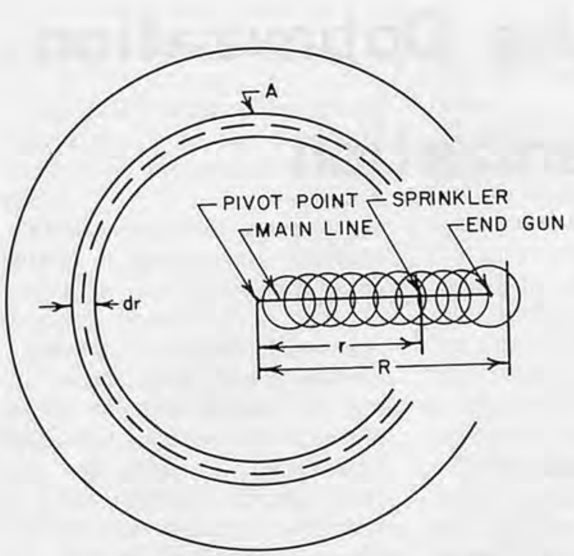

Fig.1 Schematic diagram of a center pivot system

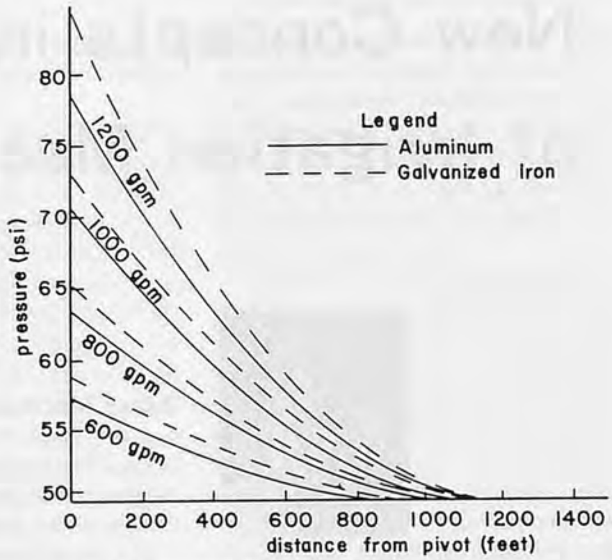

Fig.2 Pressure distribution in 6-in. pipe

zer and herbicides.

Center pivot systems are the most mechanized systems in the mechanical move group. It covers a circular area, however, it is adaptable to square blocks from 40 to 350 acres in size with about 86 percent of the area receiving irrigation. Newer models have an automatic on-off end gun that irrigates the four corners or almost all the acreage. The smallest system considered practical and economical is the 160 acres system. In smaller sizes the cost per acre is considered economically prohibitive. Average initial total costs for a 160 acre unit are about \$35,000 or about \$218. per acre. Labor costs are also very low.

The distribution of water in the center pivot is a complex phenomenon. Consider sprinkler at distance r from pivot point, it irrigates area A, Fig.1.

$$A=2\pi rdr$$

The sprinkler discharge, q, for area A will be :

$$q=2\pi rdr(t/T)$$

Where :

t= depth of water application per revolution of the system.

T= time required for one revolution of the system.

Integrating the above equation, give the discharge in the mainline, Q, at any point r :

$$Q=\pi R^2(t/T)\ (1-r^2/R^2)$$

The pressure in the mainline pipe wlthin 500 ft. of the pivot point generally are higher than the recommended for the sprinkler heads used, therefore, these sprinkler must be equipped with pressure regulators. Fig.2 represents pressure distribution curves for 6 inch pipe for 600-1200 GPM discharge. Correct operating pressure is important for optimum performance. Pressures exceeding 80 PSI at the pivot point have lowered application rates and resultant puddling and runoff.

Drip irrigation is the slow application of water to soil through mechanical devices or holes called emitters located along the supply line. Drip irrigation has the advantages of efficient use of water, better crop response, ideal root environment, decreasing pests and diseaes, weeds free field and flexability of using saline water. It has the drawbacks of frequent clogging, salinity build up and poor soil moisture distribution.

Drip irrigation is particularly attractive for situations where water is costly, water has high salt concentrations, hilly terrain makes surface systems impractical, scaracity of farm labor, coarse textured soils and high winds. It is not always realistic to directly compare drip irrigation with other systems of irrigation because each type has its own peculiar set of characteristics which are suitable for different conditions. The rapid growth of drip-manufacture confirm its valadity under circmstances.

It is estimated that 200,000 acres were drip irrigated around the world in 1974. The emitters are basically of either of the three types : (1) Small orifice of 0.01-0.02 inch diameter ; (2) large orifice 0.02-0.04 inch and (3) larger orifice of more than 0.04 inch diameter. The function of the emitter is to slowly dischage water to the soil at a low pressure without soil dispacement. The projected acreage by the end of 1978 under drip irrigation is going to be about 500,000 acres in the world. The current cost of complete drip irrigation varies between \$150/acre to \$1000/acre depending upon filteration requirement, degree of artomation, pressure regulation needed, spacing of plant and chemical application equipment.

The traveling gun sprinkler systems are simply large self-propelled guns, pulled across the field by a cable winch, and can

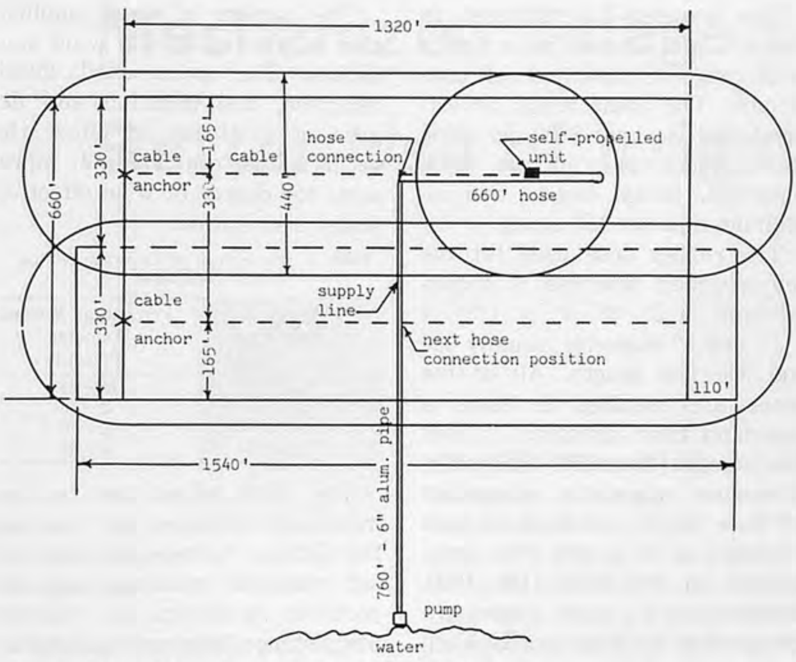

Fig.3 System layout for a traveling gun sprinkler system

irrigate square, rectangular or any shape of the field. The traveler is a giant sprinkler, 150–1000 GPM gun, mounted on a 4-wheel transport and powered by either an internal combustion engine, hydraulic turbine or water piston.

It can irrigate 24 acres (9.6 hectares) a day with one inch of water. One complete cycle for 12 acres require one man and a tractor for less than an hour. Most of the machines have the flexability to apply 1/2 to 3 inches of water. It can irrigate any type of crop, equally suitable for vegetables and orchards.

Fig.3 represents a typical layout of the self-propelled sprinkler system.

The self-propelled unit with a rubber hose 660 feet long will irrigate a strip up to 1540 feet

Photo.1 Traveling gun sprinkler made by Good Year

long and 330 feet wide. This is approximately 12 acres irrigated in less than 10 hours. An aluminum supply line feeds across the center of the 1540 feet block. The hose is connected to the center supply line and the other end to the self-propelled unit. The unit is taken 660 feet to the end of the strip, the steel cable is then reeled out to the far end of the strip and anchored. The self-propelled machine moves smoothly along the strip by automatically reeling up the cable. The speed can be varied easily to apply the amount of water per acre desired. The aluminum supply line can then be extended or shortened to the center of the next strip. This move completed and started on the next run can be accomplished in one hour or less. **Table 2.** represents the speed required for desired irrigation application.

Table 2. Optimum Machine Speed for Different Irrigation Applications with 550 GPM Gun.

Irrigation Application (inch)	Machine Speed (inch/min.)	Time for 1320 feet Run (Hr.)
0.50	64	4.10
0.75	43	6.10
1.00	32	8.25
1.50	21	12.50
2.00	16	16.50
2.50	12	22.00
3.00	10	26.40

The travelers are adapted to odd-size and shaped fields and a wide range of plant and soil conditions. The total initial investment cost is about $200 per acre, this includes traveler, gun, hose, hose-reel, pump, engine and aluminum pipe for 150 acres.

The rubber hose used for the self-propelled machine is manufactured in 2″, 3″, 4″, 4 1/8″, 4 1/2″, and 5″ diameter, usually 660 and 990 feet length. All of the hoses are required to have a minimum burst pressure of 2000 Kilopascals (Kpa) (290 PSI). The maximum allowable elongation for hose should not be more than 3 percent of its length when pressurized to 700 KPa (100 PSI). Unsatisfactory hoses represent the problem of kinkling. Kinkling is the vertical transverse folding from the normal round configuration of a pressurized hose. For properly designed hose, the minimum internal pressures at which kinkling should not occur for various sizes is shown in **Table 3.**

Table 3. Non-Kinkling Minimum Pressures for Various Rubber Hoses

Nominal Hose Diameter (inch)	Minimum Internal Pressure KPa-PSI
2 $\frac{1}{2}$	350−50
3 & 3 $\frac{1}{2}$	400−58
4 & 4 $\frac{1}{2}$	500−72
5	550−80

The pattern of water application is effected by the wind conditions. The mean wind speed, direction, and duration and degree of gustiness all effect the sprinkler pattern. **Table 4.** represents the degree of wind effect on water distribution.

Table 4. Percentage of Coverage During Windy Conditions

Speed of the Wind (miles/hour)	Percentage Wetted Diameter (Percent)
Calm	80−85
2−5	72−78
6−10	62−70
over 10	55−60

The wind effect can be tremendously reduced by varying the distance between the runs for self-propelled machines and for portable sprinklers by varying the distance between the laterals and sprinkler positions.

The adoption of any of these four mentioned systems, does not guarantee the successful crop or increase in production. It is the proper use of these systems coupled with correct selection of the seed, fertilizer, herbicide and insecticide that brings successful crop. The selection of any of these systems depends upon the availability of labor, land configuration and value of the crop. ■■

Mechanized Tillage — Better Use of Irrigation Water

by
Bherulal T.Devrajani
Sind Agriculture University
Tandojam, Pakistan

Introduction

All over the world, particularly in arid and semi-arid zones, every country is trying to attain maximum benefits from its water resources by improving irrigation methods. Judicious water application, to irrigate crops at higher efficiency, could save water without affecting unit production. Pakistan being an agricultural country, does not have adequate natural moisture for successful crop production and needs enhanced irrigation facilities. Of the Pakistan's gross area of about 199 million acres, more than 66 percent receives an average rainfall of less than 10 inches. River Indus forms the major source of irrigation water.

The proper use of irrigation water is of the utmost importance for achieving maximum production. But a little attention has been paid to this aspect. It is quite possible to achieve higher yields with less of the irrigation water than presently being applied. More land could be brought under plow if economic use of water is taken. Higher efficiency of the application of irrigation water could be attained through technological skill and soil management practices by machine use, proper land forming, seed bed preparation. interculturing, and other agronomical practices help reduce water losses. Research in the field of irrigation methodology, soil-plant-water relationship, on-farm irrigation application, drainage system design and other water conserving techniques need comprehension.

The irrigation system in Pakistan is large with vast potential, but old cultivation methods and defective water management practices cause considerable water losses in conveyance and on field application. The length of water courses in the field is abnormally long and over irrigation is preferred though water is scarce and a limiting factor in agriculture. Nothing has been carried out relative to improving the irrigation farming practices, infact, are still traditional which must be considered an important part of the irrigation system.

Generally, the level basin system of irrigation is practiced in Pakistan. It is adopted only because it fits the economic means and confinements. The majority of farmers attempt to form land on a dead level basis with traditional implements drawn by bullocks. The amount of water to be applied during an irrigation depends on the soil reservoir and crop grown. But practically the criteria to apply water are to cover fields to an adequate depth over any existing highest spots (oppressions). Farmers do not have sufficent information relative to time of irrigation and quantity of water to be applied.

Usually, the farmers adopt crop-fallow rotation in the land use system and cropping pattern which on one hand does not conserve moisture and on other hand lessen soil fertility. Better tillage practices on the principle of optimum tillage with machines designed for maximum moisture conservation and soil protection, can increase production. The soil moisture content is of major importance. The soil at the root zone of plants forms a moisture reservoir that is indispensable to agriculture. The water that infiltrates can be stored for longer periods with relatively little loss. The amount of water stored in the soil can be increased for successful crop production. The purpose of a tillage practice is to improve the soil condition for plant growth, soil aeration, soil saturation, soil turning, seed bed preparation, root development, and to maintain soil and surface of the soil in such a condition that resists soil erosion but assists in penetration and retention of water. To attain these objectives, proper selection of implements, methods of cultivation and

Table 1. Physico-chemical Analysis of Soil of the Experimental Area.

Depth	Water holding capacity	CaCo 3 %	Mechanical composition of the soil				T.S.S. %	pH	O.M. %	N %	P ppm.	K ppm.
			Clay %	Silt %	Sand %	Texture.						
0–6"	36.233	9.833	20.500	39.880	39.580	Loam	0.0791	7.8	0.6865	0.0597	16.100	251
6–12"	36.550	9.000	18.740	44.540	34.213	Loam	0.0849	7.7	0.5133	0.0448	13.400	215
1–2'	32.750	9.333	14.907	52.273	32.820	Silt loam	0.0754	7.8	0.3570	0.0387	9.800	150
Average	34.930	9.388	18.049	45.564	35.537	Loam	0.0798	7.77	0.5189	0.0477	13.100	205
0–6"	36.517	9.917	21.993	42.540	35.460	Loam	0.0760	7.8	0.5992	0.0532	10.267	290
6–12"	36.050	9.250	16.333	45.963	38.703	Loam	0.0585	7.7	0.3542	0.0392	7.333	228
1–2'	32.650	9.250	14.690	53.693	31.583	Silt loam	0.0586	7.7	0.3087	0.0364	5.467	178
Average	35.072	9.472	17.672	47.065	35.249	Loam	0.0644	7.7	0.4207	0.0429	7.689	232

timeliness of operation are important.

There is a need to evaluate the suitability of tillage machines as compared to traditional implements in terms of economic use of irrigation water. The objective of this article is to review and appraise the role of agricultural machinery in better use of irrigation water.

Abstract

An experiment, to evaluate the role of agricultural machinery in better use of irrigation water, was conducted on a privately owned farm situated in Hyderabad district in Sind Province of Pakistan, on cotton crop. The study was mainly confined to the time for applying irrigation, number of irrigations for the maturity of crop, acre inches of water applied for each irrigation and interval of irrigation. The role of tillage machines was examined by making comparisons with the use of traditional implements drawn by bullocks.

Methods

The experiment was conducted on 8 acres of land. The selected piece of land was of loam type. The soil samples were taken at three depths ; 0-6 inches, 6-12 inches and 12-24 inches for physico-chemical analysis (table 1). The experiment was laid out in a randomized block design with 8 replication and 2 treatments ; Bullock Farming and Mechanized Farming, 16 field plots were prepared with 104x208 square feet (1/2 acre) each. The standart of tillage was maintained as :

Bullock Farming

4 dry plowings with mould board plow followed by plankings.

Mechanized Farming

One dry plowing with disc plow and one harrowing with tandem disc harrow. Levelling with tractor blade, once before irrigation and once after irrigation by recording cuts and fills by staking at 100 feet squares before levelling (Fig. 1) and at 50 feet squares after setting treatments (Fig. 2), on the entire experimental area.

In $treatment_1$, fields were given two soaking doses of water for final seed bed preparation and seed germination, 4 inches and 3 inches, and two wet plowings were given with local plow and planked. The cotton seed at the rate of 10 seers per acre was sown on 25th of April with pora, a bomboo tube with funnel, attached to local plow drawn by bullocks maintaining row to row space of about 2½ feet. Whereas, in $treatment_2$, a soaking dose of 4 inches of water was applied and

4.85	4.95	4.30	4.75
5.20	5.05	4.90	5.00
5.15	5.00	4.80	4.90
4.95	4.90	5.00	4.85
4.70	4.20	4.30	4.50
4.05	3.90	3.95	4.35
4.90	4.55	4.60	4.40
4.50	4.35	4.75	4.20

Fig.1 Rod readings before field operations

4.00	4.05	4.05	4.15	4.10	4.05	4.05	4.15
4.00	3.95	4.00	3.96	4.10	4.05	4.10	4.00
4.05	3.95	3.95	4.15	4.05	4.10	4.00	3.95
4.05	4.05	4.10	4.15	4.05	4.05	4.10	4.05
4.15	4.18	4.00	4.05	4.10	3.90	4.10	4.05
4.05	4.06	3.95	3.95	3.95	3.95	4.00	4.10
4.00	4.10	4.00	3.95	3.90	4.05	4.10	4.05
4.15	4.10	3.96	4.00	4.10	4.05	4.00	4.05
4.00	4.00	4.05	3.95	3.95	4.00	3.95	3.95
4.05	3.95	3.95	3.95	4.00	4.05	3.85	3.90
3.95	3.90	3.90	3.85	3.90	3.95	4.00	3.90
3.90	4.00	3.85	3.90	3.95	4.00	3.85	3.95
3.95	4.10	4.05	4.10	4.10	3.95	4.00	3.95
3.90	4.00	4.10	4.05	4.05	4.10	3.90	4.00
3.95	3.95	4.10	4.10	4.05	4.10	3.95	4.00
4.05	4.00	4.16	4.15	3.95	4.10	3.95	3.95

Scale 1/2" = 100'

Fig.2 Rod readings after levelling

Photo.1 Tillage with tandem harrow & bullock cultivation

Photo.2 Soil opening with cultivator after applying soaking dose of water

the soil was opened with tandem disc harrow and levelled with tractor blade.

In both treatments, the inter-culturing operations were carried out twice with local plow and cultivator in $treatment_1$, and $treatmemt_2$ respectively after first and second irrigation. Equal amount of fertilizer was applied in both treatments at the same stages of plant growth. The average amount of water applied for each irrigation was measured for each treatment (Table 2). The frequency of irrigation was not kept uniform and water was applied as and when necessary. The soil moisture was recorded immediately before each irrigation and analysed (Table 3) to ascertain soil type. Three cotton pickings were taken on September 12–14, September 28–30, and October 14–15 respectively to examine uniformity of crop maturation.

Table 2. Date-wise Application of Irrigation Water in Acre Inches in Mechanized v/s Bullock Farming.

Date	Mechanized farming Amount of water in acre inches.	Date	Bullock farming Amount of water in acre inches.
		April-16	4.0
April-20	4.0	April-20	3.0
May-28	3.0	May-26	4.0
June-16	3.0	June-10	3.7
June-29	3.0	June-23	3.6
July-20	3.0	July-22	3.4
August-8	3.0	August-3	3.3
September-16	3.0	September-13	3.3
October-2	3.0	October-1	3.3
Total water applied.	25 acre inches		31.6 acre inches

Table 3. Data-wise Average Moisture Content Before Irrigation in Different Depths.

Date	Mechanized farming.			Date.	Bullock farming.		
	0-6"	6-12"	12-18"		0-6"	6-12"	12-18"
May-28	11.30	12.78	12.87	May-26	11.38	13.84	13.98
				June-10	10.20	11.96	12.93
June-16	10.64	12.38	13.54	June-23	9.83	10.96	11.85
June-29	8.64	11.14	12.40	July-10	9.78	13.64	14.66
July-20	9.69	15.16	18.15	July-22	10.00	11.99	13.83
August-8	9.25	10.96	11.28	August-3	9.66	10.49	13.49
September-16	9.95	11.28	15.59	September-13	10.11	10.49	12.91
October-2	10.54	11.38	13.61	October-1	10.89	11.58	12.61
Average of season	10.00	12.08	14.59		10.23	11.87	13.28

Results

To improve On-farm irrigation efficiency and to reduce water losses, improvement of water application by improved methods of land levelling is necessary. Land levelling not only saves water but also incrceases crop yield and assists in the transition of cultivation system from traditional farming to mechanized agriculture. Land forming is highly desireable in pakistan where furrow and flood irrigation methods are practiced. The study of the effectcts of land levelling on the irrigation and absorption of water by the soil showed that on levelled plots the water distribution was uniform and less amount of water was required to cover the fields to a desired depth.

Deep plowing to an agreeable depth has a positive effect on moisture conservation and crop yield. Comparatively, deep plowing tith tracter drawn disc plow and better crumbling through tandem disc harrow increased cotton yield and saved water considerably. Both, amount of water required to irrigate an acre was less in mechanized farming, due to comparatively better levelling, and interval of irrigation was increased due to more water retention offected by deeper plowing producting pulverized soil thereby reducing number of irrigations to produce cotton crop. It was also observed that cotton

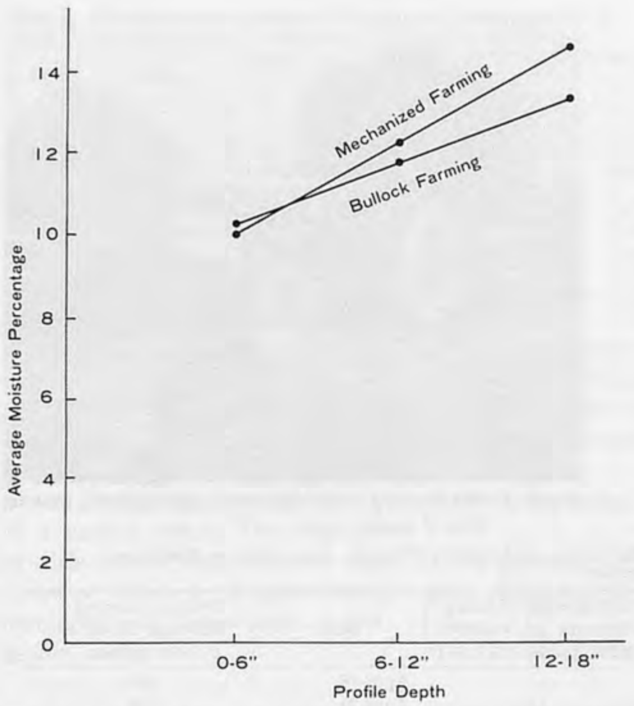

Fig.3 Moisture percent in each profile before irrigation

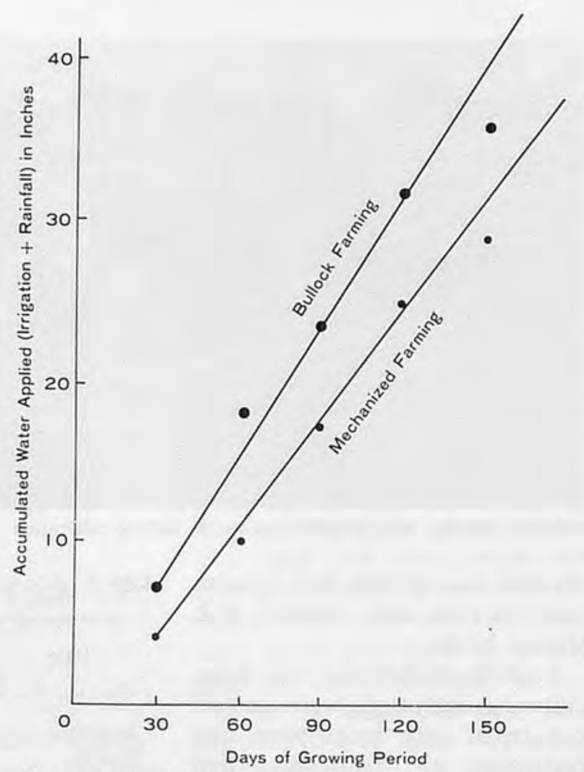

Fig.4 Accumulated water use

crop flourished well on plots where plowing under $treatment_2$ was given. The average depth of plow on bullock operated plots was 5 inches, whereas, tractor operated area had plow depth of about 10 inches. Also fields plowed with disc plow controlled weeds to some what more extent as compared to traditional plow drawn by bullocks.

Average moisture content before application of various irrigations recorded for the depth of 0–6 inches, 6–12 inches and 12–18 inches for both mechanized as well as bullock treatments (**Table** 3) appeared that the soil moisture samples taken at these depths on various dates had more or less same moisture content at a particular depth. The statistical snalysis of variance showed that there was no moisture difference between machinery and bullock operated plots at all the like profiles, but there was significant difference among the three depths. The upper 6 inches were the driest and these differences contributed towards signifificant machinery and bullock operated profile depth interactions as indicated in **Table** 4. and **Fig**.3.

Table 4. Analysis of Variance of Moisture Content in Three Profile Depths in Mechanized v/s Bullock Farming.

Source	DF	SS	MS	F
Total SS	44	161.0909	–	–
M/B-SS	1	0.5981	0.5981	L 1
Profile SS	2	89.8045	44.9023	73.67 **
P X M/B SS	2	46.9211	23.4605	38.49 **
Errer SS	39	23.7672	0.6095	

(**) Significant at 1% level of prebability.

From the average moisture percetage of the full profile of 0–18 inches, in the mechanized v/s bullock tillage, before every irrigation, it appeared that total watr applied to mechanically cultivated area was less than bullock operated area being 32.8 acre inches and 40 acre inches respectively (**Table** 5.). The results also show that there was

Table 5. Date-wise Irrigation/Rainfall Water Rates and Average Moisture Content in 18-inches Profile in Mechanized v/s Bullock Farming.

Date.	Mechanized farming		Date.	Bullock farming	
	Water applied in acre inches.	Moisture percent in 0-18 inches profile.		Water applied in acre inches.	Moisture percent in 0-18 inches profile.
			April-16	4.0	6.0
April-20	4.0	6.0	April-20	3.0	20.0
May-28	3.00	12.32	May-26	4.0	13.66
			June-10	3.7	11.69
June-16	3.0	12.19	June-23	3.6	10.88
June-29	3.0	10.73			
* July-3, 4	1.3	14.33	* July-3, 4	1.3	12.69
			* July-10	0.6	
July-20	3.0	10.49	July-22	3.4	11.94
			August-3	3.3	11.21
* August-5	0.3		* August-5	0.3	
August-8	3.0	10.49			
* August-15-23	4.3		* August-15-23	4.3	
* September-3, 8	1.0		* September-3, 8	1.0	
September-16	3.0	12.27	September-13	3.3	11.17
* September-26	0.9		* September-26	0.9	
October-2	3.0	11.84	October-1	3.3	11.69
Total	32.8	acre inches		40.0	acre inches

(*) Rain fall.

Table 6. Analysis of Variance of First Picking (Yield) of Cotton in Mechanized v/s Bullock Farming.

Source	DF	SS	MS	F
Total	15	23.6090	–	
Replication	7	12.2443	–	
Treatment	1	9.1884	9.1884	29.5542**
Errer	7	2.1763	0.3109	–
Coefficient of variation 7.64 %				

(**) Significant at 1% level of probability.

Table 7. Analysis of Variance of Second Picking (Yield) of Cotton in Mechanized v/s Bullock Farming.

Source	DF	SS	MS	F
Total	15	4.1449	–	
Replication	7	2.4527	–	
Treatment	1	0.4812	0.4812	3.00N.S.
Errer	7	1.1211	0.1602	
Coefficient of variation 8.54 %				

(N.S.) Non-significant.

Table 8. Analysis of Variance of Third Picking (Yield) of Cotton in Mechanized v/s Bullock Farming.

Source	DF	SS	MS	F
Total	15	0.7615	–	–
Replication	7	0.0793	–	–
Treatment	1	0.4987	0.4987	19.0344**
Errer	7	0.1835	0.0262	–
Coefficient of variation 44.98 %				

(**) Significant at 1% level of probability.

Table 9. Analysis of Variance of Total Yield of Cotton in Mechanized v/s Bullock Farming.

Source	DF	SS	MS	F
Total	15	21.7474	–	
Replication	7	8.1286	–	
Treatment	1	9.0752	9.0752	13.98**
Errer	7	4.5436	0.6491	
Coefficient of variation 6.54 %				

(**) Significant at 1% level of probabiljty.

Table 10. Statistical Analysis of Average Cotton Yields in Various Pickings in Mechanized v/s Bullock Farming.

Time of Picking	Mechanized farming	Bullock farming.	Over all means
First Picking	16.10 a*	13.08 b	14.59
Second Picking	9.72 a	9.02 a	9.38
Third Picking	0.36 b	1.06 a	0.72
Total Yield	26.18 a	23.16 b	24.67

(*) The figures followed by same letters in a-row-are not significant from each other.

considerably more moisture in mechanized plots than bullock farmed plots though mechanized plots were sparingly irrigated. The accumulated water applied to cotton crop in both treatments on every stage of plant growth, mechanized plots needed less water at more intervals than bullock operated plots. Thus, the accumulated water use including rainfall in both treatments had linear trend with the stage of growth (Fig. 4). The seasonal rainfall supplementing irrigation was about 7 inches.

The farmer is interested in unit production or per acre yield of a crop. But it is very low in this part of the world due mainly to inadquate technical know-how of farmers about modern methods of farming. The agricultural engineers and specialists have to make best use of the available soil and water in order to maximize agricultural production. Soil condition providing root environment produced by the machine affects the plant growth and yield. To save water at the risk of unit production is not adviseable. Above all these factors, on should consider increased crop yield without which the objective of saving water does not benefit the former. To evaluate the feasibility of these factors, the average yield of both treatments was recorded. One of the objectives of mechanical cultivation uniform maturity of a crop. For this purpose the yibld for all the three pickings was recorded separately, From the results it appeared that the first picking was highly significant (Table 6),
second picking was non-significant (table 7.), whereas, third picking was again highly significant (table 8.) but with the highest coefficient of variation (44.98%) which may be un-reliable. The result of the analysis of variance for the total yield was highly significant (table 9.). The mean of both the treatments for all pickings and total yield was compared (table 10.). The yield obtained from mechanized fields was higher (26.14 mds/acre) than bullock farming plots (23.18 mds/acre). The first picking of seed cotton yield was the highest in mechanized farming than in bullock farming, the second picking produced almost equal in both the treatments, but the third picking yielded more in bullock operated plots.

Conclusion

It was found that the deeper plowing with disc plow enhanced the retention and conservation of moisture and increased cotton yield as compared to bullock drawn plow. The pulverization effects and levelling of land encouraged uniform growth of plants and application of irrigation water. Mechanized tillage saved about 7 acre inches of water and increased yield by about 3 maunds per acre with more interval of irrigation and less amount of water at various doses. Thus, it was concluded that mechanized farming not only saved water, but also increased cotton yield appreciably.

Suggestions

Agricultural mechanization is a recent discipline in Parkistan. The climate and solis are highly suitable for agriculture, but precipitation is inadequate and untimely. Without supplemental water crop production is quite insufficient and difficult. No attempt has ever been made to determine water requirements or to design a system to meet crop needs efficiently through intensive scientific studies. Tillage practices including water management and on-farm irrigation application need to be modernized in order to reduce water losses.

The type and size of implement and method of operation have a remarked influence on the quality of tillage. The tillage operations have beneficial effects in respect of improvement of soil structure and conservation of soil and water and thus to crop production if properly standardized. Optimized tillage techniques need to be followed because when the soil surface is hard and dry, the loss of water is more as the water slowly moves through pore-spaces, evaporation is more. The tillage quality should encourage infiltration, but not percolation beyond root zone and should resist crust formation. The traditional methods of tillage commonly adopted in Pakistan have adverse effects. Little attention has been given to land grading which suggests smoothening the surface of the field to eliminate water pondage. Precision land levelling is the solution of this problem which could only be accomplished efficiently by adopting engineering principles. These factors suggest a production potential many times more than presently achieved. These patterns are more or less similar over very wide agricultural belts inspits of the great variations due to various combinations of topography, soil type, and climate. But such system cannot be fully adopted atonce because of technical and socio-economic problems. Thus, I don't suggest complete mechanization of all these aspects at the start but a gradual and reasonable change in our methods.

If such studies are disseminated, the farmers will get more assistance in making decisions regarding tillage practics for a particular crop, amount of water to be applied each time at a proper interval and the amount of land they should irrigate in a particular crop season.

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Testing MF-400 Combine Harvest under Conditions of the Sudan

by
I. A. Mohammed
Chief Engineer
May Working People Corporation
Khartoum, D.R. of Sudan

A.H. Abdoun
Deputy Director
Department of Agric. Engineering,
Ministry of Agriculture, Food & N.R.,
Khartoum, D.R. of Sudan

1. THRESHING OF SORGHUMS

Introduction

Sorghrm as one of the important crops in the country is set to be mechanically harvested in most areas of the mechanized crop production. Combineable varieties, however, exist in these areas, but they normally do not appeal edible for the natives. The Popular varieties are actually not consistantly combineable, because they are not even in height. In such cases stationary thresher become the rule for harvesting sorghums.

In general, harsesting as a whole does not create great problems, except that the machine the best coperating conditions for a MF-400 combine, in order to minimize seed losses and seed damage. It is more or less contemplated to attain basic information to predict combine behaviour wieneke (1964) and Finkbeiner (1966), but this should be applied under the Sudan conditions.

Method and Equipment

A MF-400 combine havester was used as a stationary thresher for the purpose. The combine has a header with a width of 12 feet and a rasp cylinder of a length of 37 inches and 22 inches in diameter. The separating unit was composed of an open bottom type of walkers (4 walkers), having a length 9c 114 inchs and toal area of 4218 inches sq. The cleaning shoe is consisting of reciprocating adjustable sieves giving a total of about 3085 inches sq. The machine

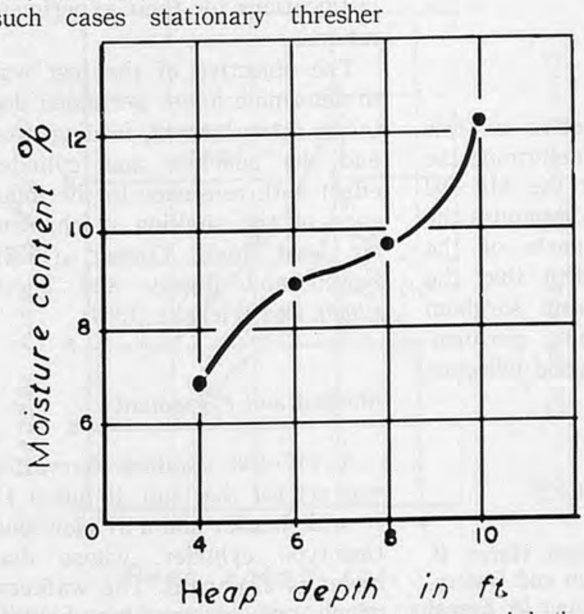

Fig.1 Relationship between moisture content and depth of heap.

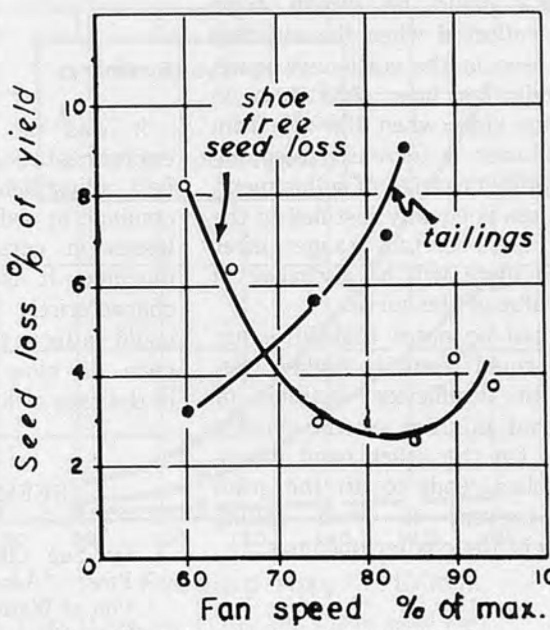

Fig.2 Effect of fan speed on shoe performance.

was equipped with four sets of finger beaters acting as rethreshers, and searated concave with blanking plate.

The heads of an early maturity variety of sorghums were cut off in early November, when there was some humidty in the atmosphere due to late rains (moisture contents of grain was about 12-14%). The heads were dumped on the ground in small heaps scattered all over the field. Then they were piled into larger heaps having roughly a diameter of 12 feet.

Threshing was started by feeding the material from the heaps into the machine a sort of continuous flow.

Results

The state of grain the field was invevtigated. Results were plotted in Fig.1. It was clearly observed that the grain in the bottom of the heaps keeps slightly higher moisture content than that at the surface. It accordihgly reveals that the rate of evaporation due to wind and heat was greater at the surface and that the grain at the centre was least affected, do Sup Chung (1967).

Fig.2 could be drawn from data collected when the machine was used in the stationary state. It indicates how seed loss in tailings rises when the air from the blower is increased stepping its optimum range of adjustment. The loss is equally justified in the shoe to a certain range, after which there will be a change in the value of the curve.

It can be noted that little air blow could result in higher loss, due to insufficient shaking of material mixture on the chaffer sieve. On the other hand excessive blast tends to lift the grain and prevent it from falling throught the chaffer openings.

Discussion

It has been already confirmed that the rate of seed loss in the combine could be determined by the effect of certain factors, Wieneke (1966). In sorghums it could be clearly seen from Fig.2 that on measuring timed different weights at settings of the fan speed, the free seed in the tailings would represent 50-60% of the total weights at minimum fan opening and about 80-90% by full setting.

The unthreshed seeds represent the about 1-2% of the total. The cause for this might be that the increase in the amount of free seed in tailings took because the higher air velocities interfered with the passage of seed through the sieve openings.

Shortage of labour at harvesting time in particular could let the heaps of seed stay longer in the field. From Fig.1 the moisture content is different in the various parts of the heap. So the risk of fungus attack might reveal itself on grains at the centre of the heaps if harvested at a moisture content over 15%. Larger heaps in these conditions could not be useful and so they are not recommended.

Summary

It was the objective of this expreimentation to determine the best adjustment for the MF-400 combine in order to minimise the losses in certain parts of the machine. It is evident that the characteristic of grain sorghum could affect threshing performance. Air blow has good influence in the rate of loss.

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2. USING WHEAT

Introduction

A remarkable increase in wheat production in the Sudan is detected annually. Generally, all areas concerned with the production of wheat practise almost full mechanization. This includes harvesting, which is carried out by combine harvesters that are present in varying numbers in the country. To correctly achieve the accurate performance of the machine, certain adjustments should be fulfilled ; Lanz (1964), and Schilling (1968) could have justifications for their experimentations.

The objective of the test was to determine losses pertained due to the action of reel, feeding rate, and the concave and cylinder effect with reference to the influence of the shaking mechanism on seed loss, Cooper (1972), Frisen and Bigsby and Zoerb (1966), and Wieneks (1964).

Method and Equipment

A MF-400 combine harvester was set for the trial. It has a 12 ft. wide header and a 37 inch long rasp-type cylinder, whose diameter is 22 inches. The walkers, which are of an open bottom type, are 114 inches long, and having a total area of 4218 inches sq. Adjustable reciprocating sieves are fixed in the combine. They enclose a total area of 3085 inches sq.

A number of wheat fields had been selected to run in the trial of combining. In these fields average heights of the plants were ranging from 30-36 inches. The weather at time of harvest was rather warm. On the other hand the straw moisture content was varying from 6-9%.

To determine the header losses canvas-like containers were used to collect the required material. By this method it is expected that the removal of the material to one side along an area of 40 ft. long on the forward line of travel could be easily conducted. The seeds and the shattered heads could be gathered from a number of randomised small plots, each is of an area of 1 X 2 ft. This area had been outlined by wooden frames within the overall travel areas.

For further trial purposes, fixed bat and pick-up reels were used. Their speeds had a fixed relation to the forward speed of the machine. They are not affected unless the sprockets are changed.

In order to obtain accurate measurements of the feeding rate, two canvases were used to collect separately and simultaneously the material discharged from the walkers and shoes. The material on the top canvas consisted of straw and threshed seeds (walker loss) and some of the unthreshed seeds as well (cylinder loss). The lower canvas contained collected chaff and free seed from the shoe as well as unthreshed seeds. These arrangements gave very reliable data.

Results

The fixed bat reel was adjusted at a distance of about 12 inches forward, which was actually metered from the top of the knife sections in a line directly set below the reel axis. The height was kept at 4 inches. This was measured from the lowest position of the bat or tine with reference to the cutting plane. Fig.3 displays the effect of speed ratio of the types of reels in relation to the header losses.

To check up losses on the rear of the combine, samples were collected from the top canvas and each collection was weighed separately. Threshed seeds were carefully winnrowed and weighed. On the other hand chaff and thresched seeds were together removed from the lower canvas. The threshed seeds were weighed too. The results were transformed into percentage and plotted in Fig.4 Keeping the cylinder speed and the concave clearance constant, will indicate that there is somewhat an effect of feeding on the percentage loss in the different parts of the machine.

It is worth mentioning that a constant feeding rate into the machine could hardly be maintained for a particular speed, due to variations in crop stand in the field. Therefore more runs were taken into consideration in order to statistically justify the results.

Discussion

It can be concluded from Fig.3 that a high reel speed ratio could in general cause excessive see loss. In case of pick-up reel a speed ratio of 1.25 gave the best results, whereas the results by the fixed bat reel were satisfactory at a speed ratio of 1.5. Increasing this ratio to shoot up to 2.5 resulted in aimost double head

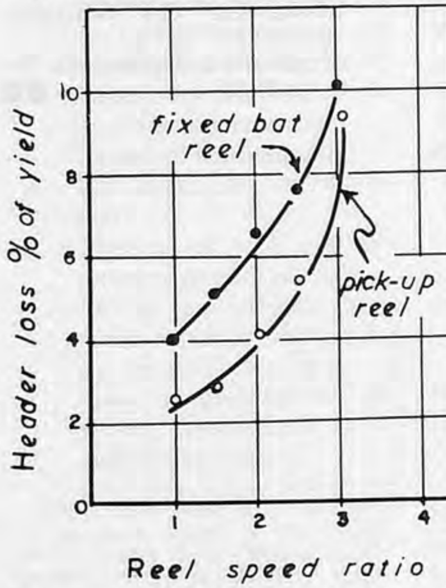

Fig.3 Header loss relationship to the reel speed ratio (R. S. R.) R. S. R. = $\frac{\text{reel periph. speed}}{\text{forward speed}}$

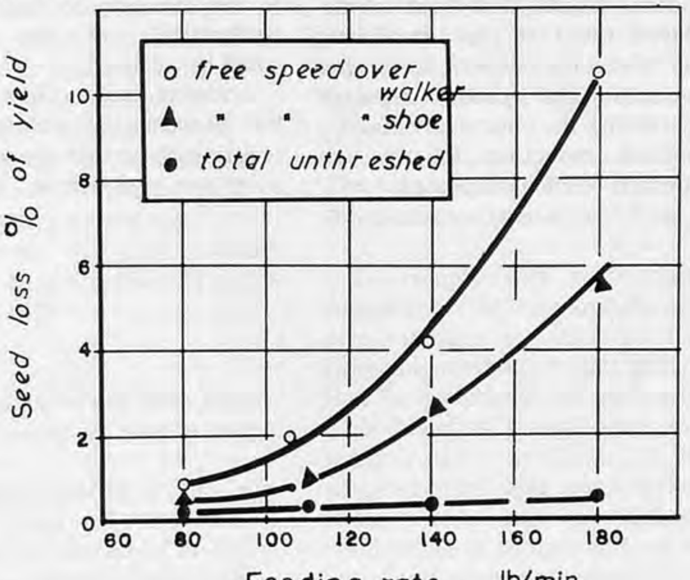

Fig.4 Effect of feed rate on seed loss. Cylider speed was 800 r. p. m. Concave clearance was 1/2 inch.

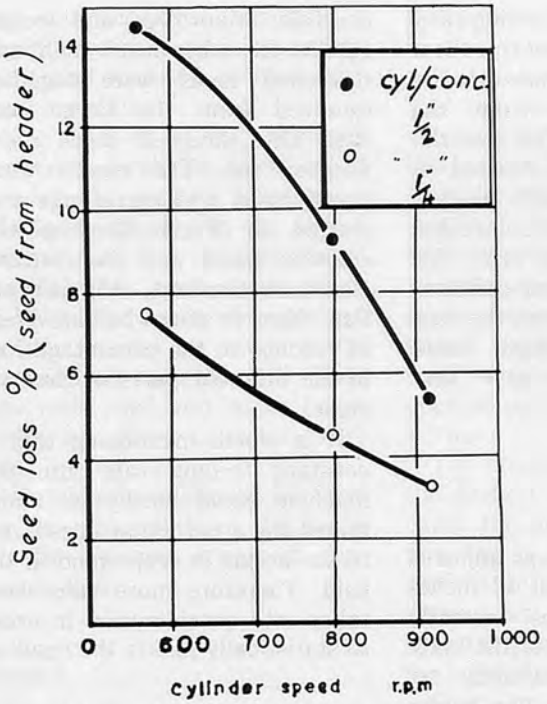

Fig.5 Effect of cylinder adjustment on the seed loss.
Feed rate was 125-145 lb/min.

losses.

Fig.4 indicates clearly that the feeding rate had a marked effect on losses. This might explain why a machine gets choked. The results complied in general in spirit with the works of Frisen (1966) and Wieneke (1964).

A combination of cylinder-concave clearance and speed were chosen, Fig.5. The results displayed the fact that measuring the threshing effect, by either increasing the cylinder speed or decreasing the clearance caused a marked reduction in the unthreshed seeds as expected.

Summary

In recent years attention has been ernstly paid to explore defects or points of weakness of the existing machines and try to handle these factors, which affect the yields considerably experimentaly in order to eliminate or otherwise reduce their influence to the mininum so that a better performance of the machine could be attained.

Evidence could likewise draw the attention the present characteristics of certain crops such as sorghums and wheat, which require appropriate adjustments if machines are to be used.

This paper is dealing with some factors affecting the performance of a type of combine harvester used in the wheat fields in the Sudan. The results could be considered as of a high calibre, which could help greatly in the right adjustment of the machine to the local conditions in complyance of the results elsewehere.

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Some of the Engineering Aspects of A Simple Low Cost Rice Bran Stabilizer

by
P. S. Barton
Industrial Extension Engineer
The International Rice Research Institute
G.P.O. Box 2453, Bangkok, Thailand

Foreward

Within its work programme for 1976, UNIDO initiated a global programme of research and development geared to the design and manufacture of a prototype, low cost rice bran stabilizer suitable for manufacture and use in developing countries where rice forms a main factor of food consumption and agroproduction output. The stabilizing equipment is to be characterized by the following basic criteria :

1. Suitable as an attachment to existing small and medium capacity rice mills ;
2. An effective stabilization process is to be carried out by technically simple and unsophisticated equipment suitable for manufacture in developing countries ;
3. No steam consumption ;
4. No electricity consuump-tion ;
5. The use of rice mill by-products (husks) as fuel ;
6. As far as possible automatic function not requiring (expert) attendance ;
7. Easy maintenance-not involving mechanical parts-and limited repairs.

This paper is based on one presented by the same author to the UNIDO Ad-hoc Expert Group Meeting on the Research and Development of a Small-Scale, Low Cost Rice Bran Stabilizing Unit at Vienna, Austria December 6—10—1976.

Introduction

The development of rice bran stabilization equipment involves at least two technologies :

—Food technology to determine that the process developed effectively stabilizes the bran without destroying the nutriment contents the oil, vitamins etc.

—Engineering to design and develop machinery to efficiently and economically achieve the required stabilization.

This paper will not consider the Food technology aspects but concentrate on the Engineering aspects. There are a namber of processes which can be used to stabilize rice bran including :

(A) Dry Heat Treatment
(B) Moist Heat Treatment
(C) Chemical Treatment
(D) Inert Atmosphere
(E) Gamma Irradiation

This paper will only consider solutions to the problem by processes (A) & (B).

Brief Description of Rice Bran & the Process of Stabilization

Rice bran, with a protein content of about 10—15% and a vegetable oil content of 18—20%, is an important raw material for the extraction of rice bran edible oil for human consumption as well as for the production of rice bran meal, a valuable component of protein animal feed.

Some 8 mill, tons of this rice bran remain unused in the rural areas of developing countries because of rapid deterioration during storage and transportation caused by a biological encymatic process, splitting the oil contained in the bran into free-fatty acids and glycerin, thereby not only destroying the neutral oil but quickly turning the bran into a valueless waste product. In order to maintain its value as a raw material for the production of edible oil and protein feed meal and to make optimum use of it, the rice bran needs to be stabilized by a special heat treatment combined with a certain dehydration effect.

The Use of Rice Mill By-products (Husks) as a Fuel

To comply with the UNIDO suggestion that rice mill by-products (husks) are used as fuel. Only this method of heat generation is considered in the paper. This fuel has the advantage of being readily available at the required place, and is not a finite energy source also provided the combustion is complete, does not create excessive atmospheric pollution when burning.

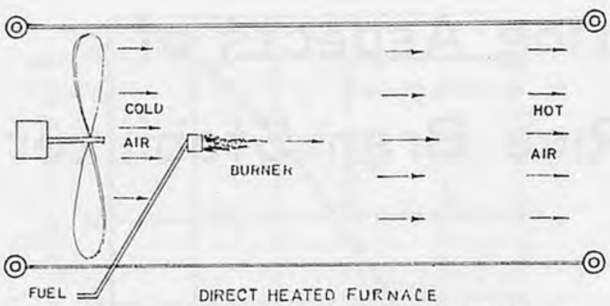

Fig.1 Schematic drawing of a direct fired heater (Note : Liquid fuel shown)

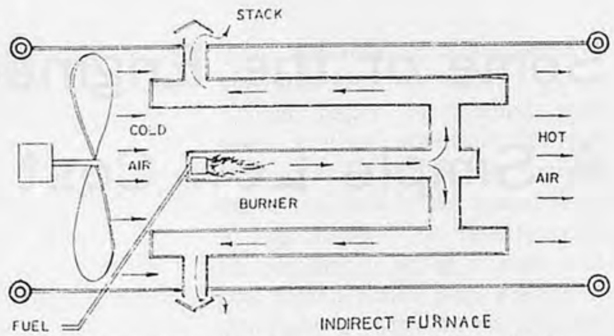

Fig.2 Schematic drawing of an indirect fired heater (Note : Liquid fuel shown)

The Availability of Heat from Rice Husks

From each 100 kg of Paddy approx. 20 kg of rice husk are obtained when it is milled the free volume is approx. 6 cu. ft. but can be compressed to approx. 2 cu. ft. When burnt this liberates 220,000 to 264,000 Btu. (Assuming complete and efficient combustion)

The Designs of Simple Furnaces for Burning Rice Husks

Provided rice husks are burnt with complete and efficient combustion the flue gases are clear and do not contain noxious fumes. Tests when using these flue gases to dry / paddy have not indicated that the colour and odor of the milled rice changes appreciably after drying. To obtain complete and efficient combustion the best method appears to be to start with a hot fire and add the new fuel in small and regular qualities this way minimum smoke is generated. The appearance of the ash indicates the efficiency of combustion, completely burned husks will be white if not completely burned they will be black.

Some Designs of Furnace

Furnaces can be of two main types

(a) Direct heated in which the flue gases are used for heating **(Fig.1)**

(b) Indirect heating in which some form of heat exchanger is used **(Fig.2)**

The direct heating is the most efficient and simplest but there is the possibility of contamination by the flue gases. The indirect heating is less efficient and more complicated but there is no possibly of contamination by the flue gases.

Designs of Rice Hull Furnaces

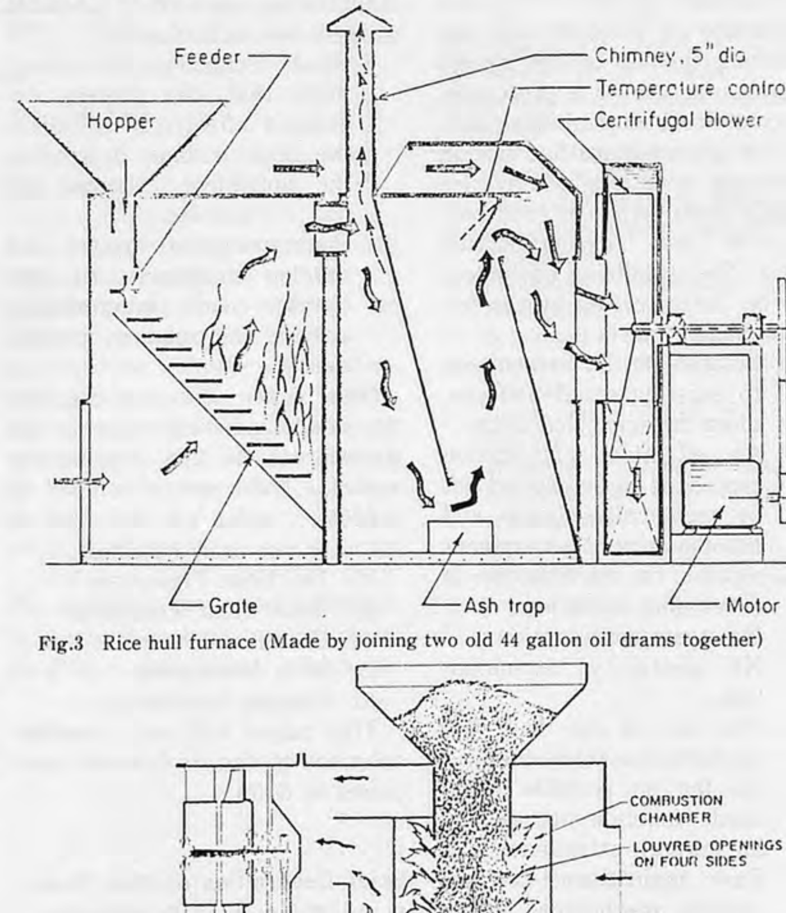

Fig.3 Rice hull furnace (Made by joining two old 44 gallon oil drams together)

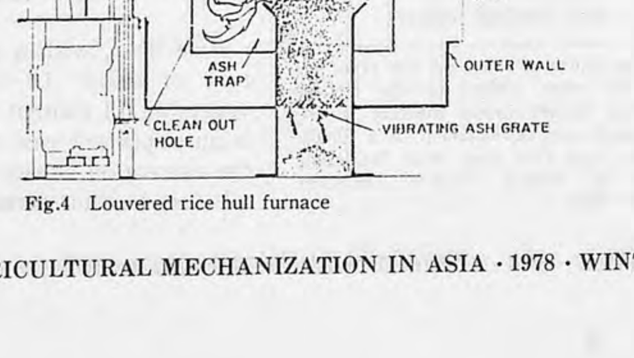

Fig.4 Louvered rice hull furnace

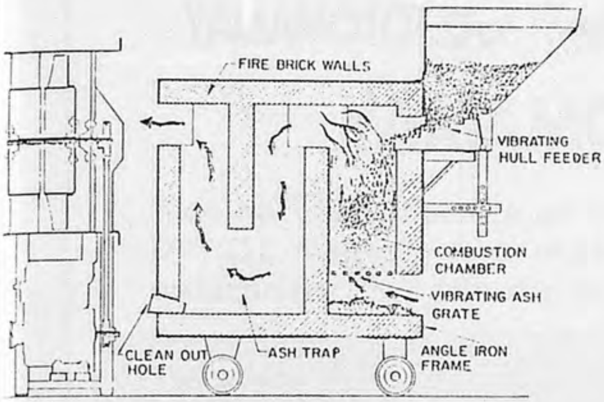

Fig.5 Rice hull furnace made of fire bricks

Possible designs of equipment for stabilizing rice bran.

(A) Dry heat process

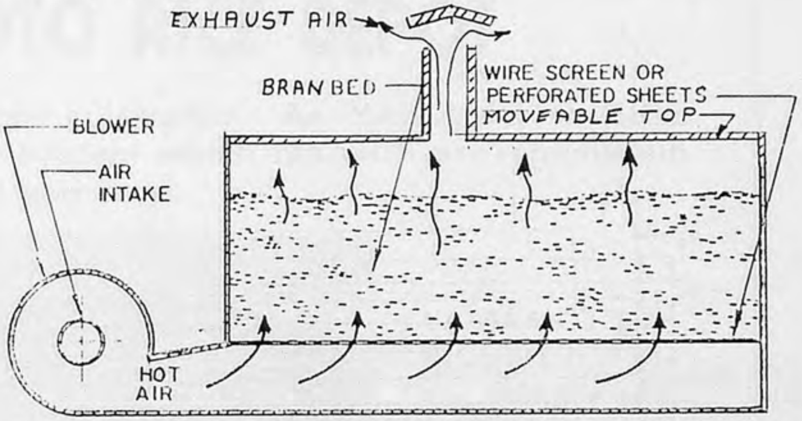

Fig.6 Flat bed type stabilizer (Some hand driven stirrers could be added)

(B) Moist heat treatment

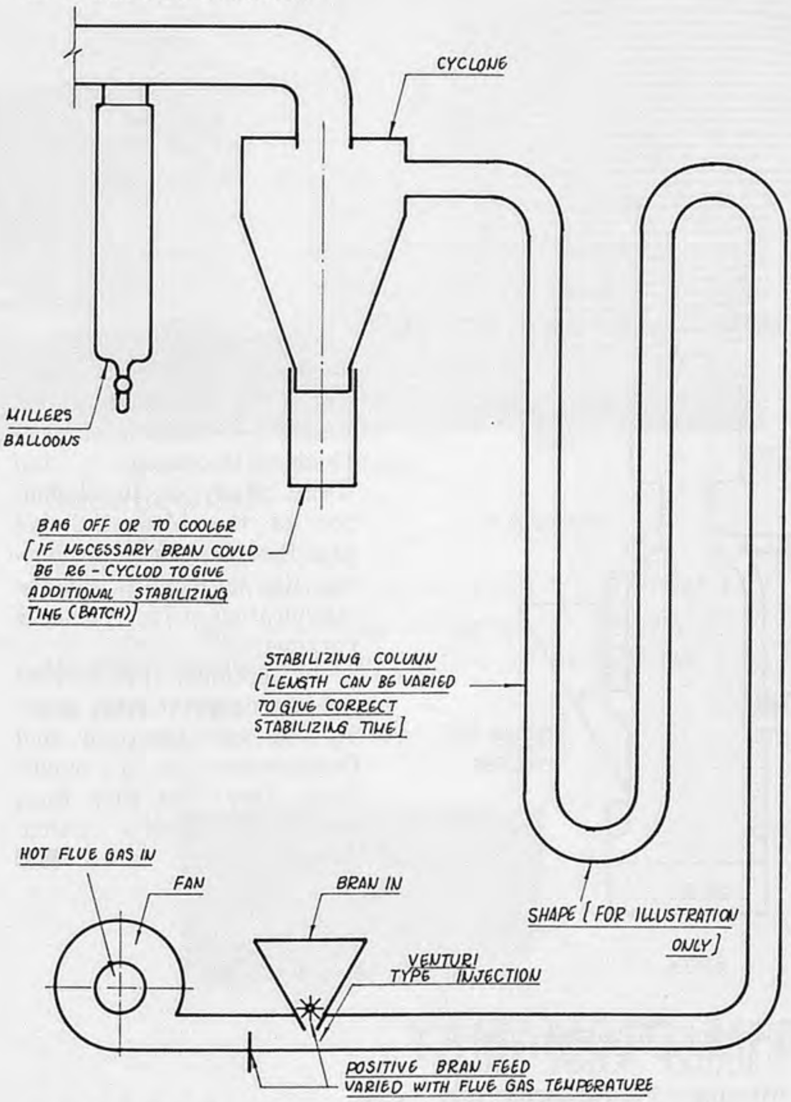

Fig.7 Column of blown hot flue gases type stabilizer

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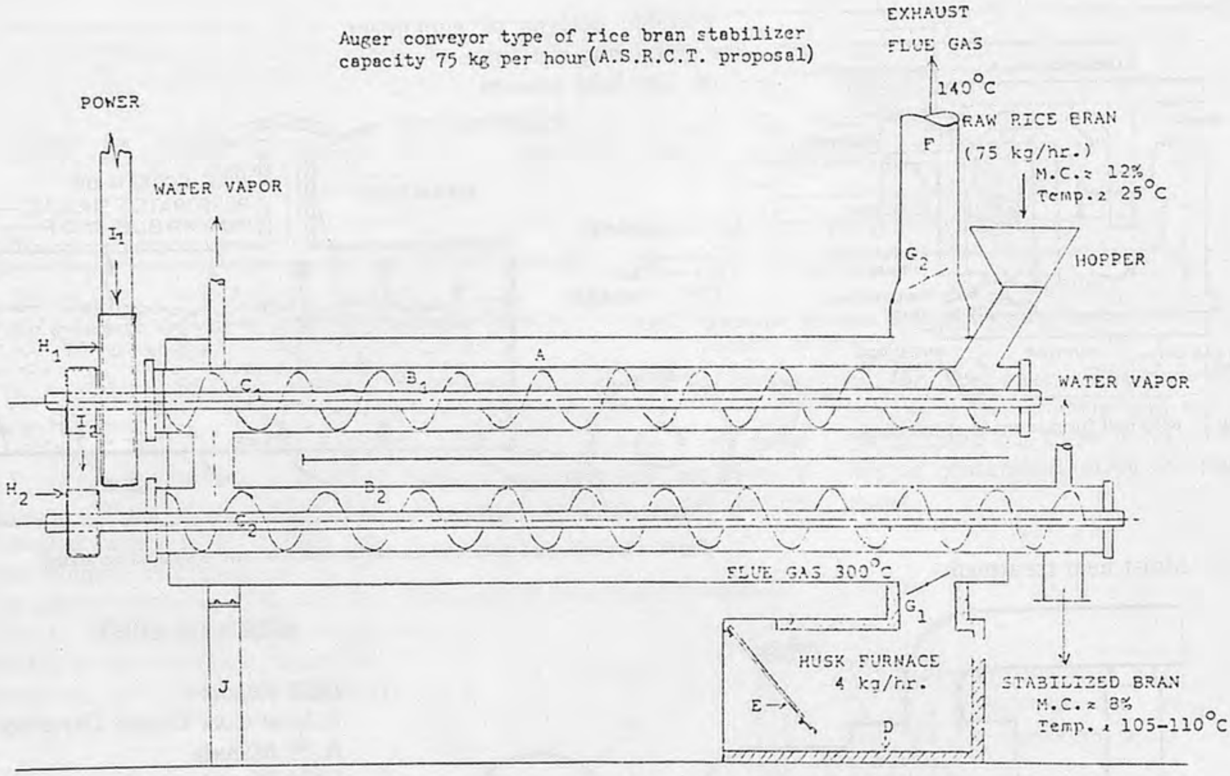
NOTE

This paper is based on one presented by the same author to the UNIDO Ad-hoc Expert Group Meeting on the Research and Development of a SmallScale, Low Cost Rice Bran Stabilizing Unit at Vienna, Austria December 6—10—1976. UNIDO within its work program for 1976/77 has initiated a global program of research and development geared to the design and manufacture of a small-scale, low cost rice bran stabilizer suitable for use as well as manufacture in developing



A = flue channel; B_1, B_2 = pipes; C_1, C_2 = shafts with conveyor blades; D = fire brick; E = grade; F = chimney; G_1, G_2 = Dampers; H_1, H_2 = driving pulleys; I_1, I_2 = belts; J = supporter

Fig.8 Auger conveyor type of rice bran stabilizer capacity 75 kg per hour (A. S. R. C. T. proposal)

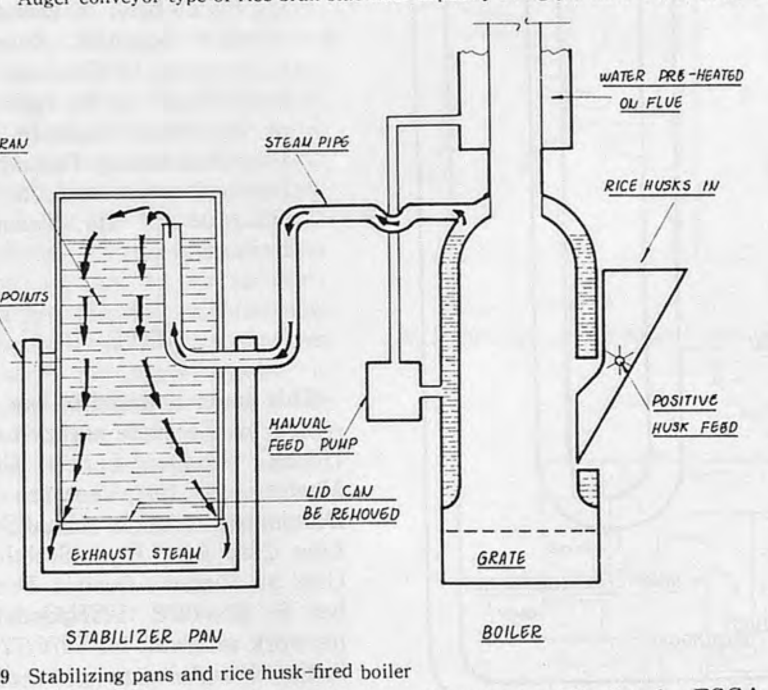


Fig.9 Stabilizing pans and rice husk-fired boiler

countries where rice constitutes a major element of diet and agricultural production.

The activities have included :

—31 August—6 September 1976 Bangkok Thailand ESCAP/UNIDO Expert Group Meeting on Research and Development of A Rice Bran Stabilization Unit

—30 November 1976 completion of the Applied Scientific Research Corporation of Thailand-Document the "Draft Study on the Definition of the Most Suitable Rice Bran Stablizing Technology, Its Verification and the Specification of Its Technical Parameters"

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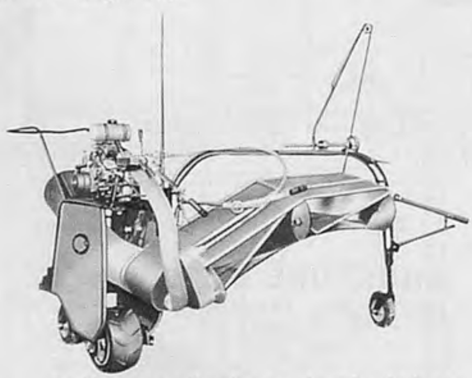

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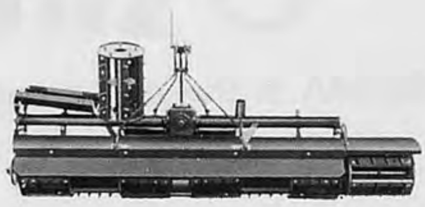

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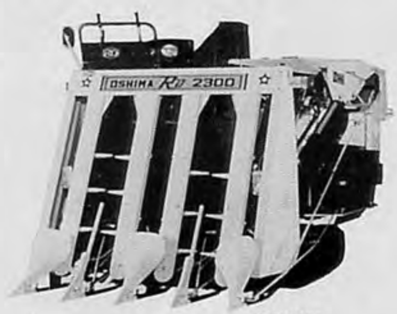

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Storability and Palatability of the Propionic Acid Treated Rice

by
Hisamitsu Takai
Institute of Agricultural Engineering
Grojordsej-15-2201, 2300 kbh. s,
Denmark

A pilot type of new dose system for chemical treatment of grain was developed at the institute. The dosing is performed by exposing the grain to the gaseous preservative, provided by a special designed evaporator, and the preservative is absorbed by the grain, cf. New Method for Conservation of Paddy Rice by means of Propionic Acid, AMA, Vol.8, No.3, Summer 1977. By this method, an uniform dosing or minimization of the dosage for suitable storability can be performed. In the experiments described in this article, evaluation of storability of the paddy rice treated with propionic acid by the new dosing method was carried out, and palatability of the acid treated brown rice was tested, but solely by Danes.

Methods and Materials

Propionic acid with concentration of 99% was used for the experiments. Paddy seed, Honenwase (Japonica) harvested in 1974 at Hasshiki, Japan, was humidified by adding water to obtain a desired moisture content for the experiments. In the measurement of the moisture content, the rice was ground, and afterwards the moisture content was determined by oven method by drying at 130 ± 5°C for two hours. The acid content in rice was determined by means of titration with natrium hydroxide. Measurement of the temperature was carried out by means of resistance temperature-coils and strip chart multipoint recorder. Detection of the fungi invasion in rice was conducted by using a method socalled blotter plate culturing, and ordinary drinking water and 10% salt solution with pH level of 5.5 was used as culture fluid. Sterilization of culture fluid was carried out in autoclave–15 lbs., 121°C, 15 min. For the determination the rice sample was devided into two portions, and one them was surface-disinfected, **Table 1.** The grains placed on culture plate was stored at a temperature of approx. 30°C for 8 days, and the number of kernels yielding fungi was then determined by naked eyes.

Table 1. The Methods used for the Culture of Fungi.

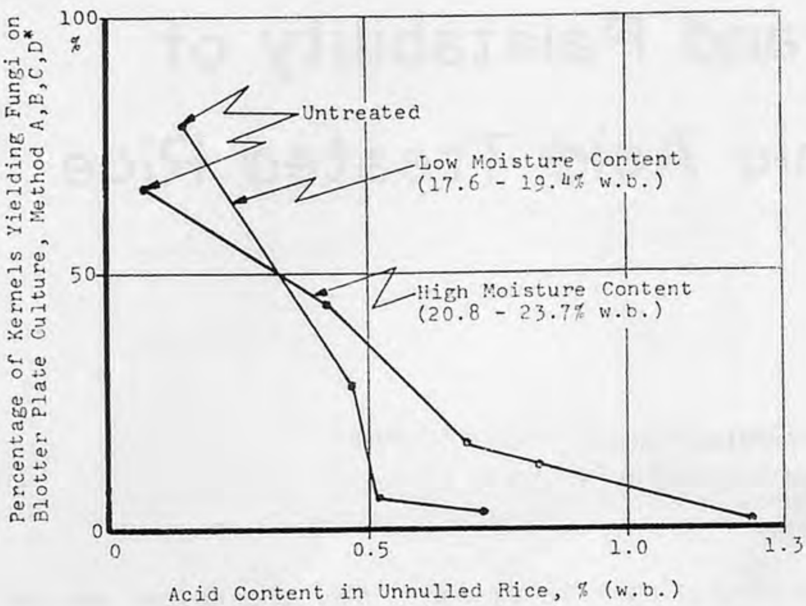
Method	Culture fluid	Tested rice
A	Water	Not-surface -disinfected
B	Water	Surface -disinfected
C	Water +10% salt	Not-surface -disinfected
D	Water +10% salt	Surface -disinfected

Storability

Two series of tests were conducted to obtain data for evaluating the storability of acid treated rice. In the first series of tests, fungi invasion of rice with different acid contents was detected. In the last series of tests, storage of rice with two different acid contents, 0.4 and 0.8% (w.b.), was experimented. Change in temperature, moisture contents, acid contents and fungi invasion were determined throughout the period of storage, in order to indicate the condition and storability of rice in silo.

Test Series 1.

The fungi invasion was detected in the rice with low and high moisture contents, 17.6–19.4% and 20.8–23.7% (w.b.), respectively, treated with propionic acid. Acid treated rice used for these tests was sampled immediately after the dosing. **Fig.1** shows the results of the tests, which indicate that untreated rice with high moisture content was less containated by fungi than the untreated rice with low moisture content. This could be caused by either postprocess or behaviour of fungi, or both. However, the difference between the efficacy of propionic acid in the rice with low moisture content and in the rice with high moisture content is considerable. For instance, the rice with high



* cf. Table 7.1.

Fig.1 Efficacy of Propionic Acid in Rice with Two Different Levels of Moisture Contents

moisture content requires adding about 0.9% propionic acid to prevent fungi invasion in order to lower the percentage of kernels yielding fungi below 10%, while the necessary dosage for the rice with low moisture content only is about 0.5%.

Test Series 2.

Rice with moisture content of 23.5 ± 0.5% (w.b.) was used for this series of tests. The rice was divided into four portions, and was stored at four different methods, **Table 2.** A portion of rice was stored in silo No. 1 without any treatment in order to determine the progress of spoilage. The rice stored in silo No. 2 was cooled to environment temperature by air without acid gas in order to indicate, whether fungi development would take place during the cooling process. Rice with low acid content (0.4% w.b.) was stored in silo No. 3, and rice with high acid content (0.8% w. b.) was stored in silo No. 4. Each silo was placed in an insulated container as shown in **Fig.2.** The rice used for measuring acid content and moisture content was sampled at two different horizontal planes in the silo, at the surface of the pile and 20 cm below the surface, and in order to obtain a representative sample, rice was sampled from different places within plane.

Due to fermentation, a rapid temperature increase occured in silo No. 1, and only 2 days after the start of storage, the temperature at point 1 reached app. 40 ℃, and after 11 days it reached 63 ℃, **Fig.3.** Activity of microorganisms was created by this temperature increase, and within 1 week of storage the rice was completely demolished. Storability of rice with high moisture content is very low, i. e. new harvested rice with high moisture content must be dried or processed within few days after harvesting, otherwise the spoilage will progress rapidly.

The temperature at point 2 in silo No. 2 increased during the cooling to environment temperature, but no considerable temperature increase occured at point 1, **Fig.4.** This formation of hot spots indicates that distribution of the cooling air in silo was uneven. However, it was observed that development of fungi occured during the cooling process, and the spoilage spreaded to all the rice in the silo during the cooling process.

In silo No. 3 the storability of the rice seemed to increase due to the acid treatment during two

Table 2. Methods Used for Storage Test.

No. of Silo	Quantity of Stored Rice	Initial Moisture Content	Condition of the Surroundings		Storage Method			Note
			Temperature	Relative Humidity	Process	Capacity of Air	Acid Content in Rice after Dosing	
	kg	%(w.d.)	℃	%		l/s-100 kg Rice	%(w.b.)	
1.	95	23.5	30.5 ±1.5	70 ±3	Non	–	Untreated	Control No. 1
2.	43	23.5	30.5 ±1.5	70 ±3	Cooling	5.8	Untreated	Control No. 2
3.	70	23.7	30.5 ±1.5	70 ±3	Acid Treatment	5.8	0cm * :0.33 20cm ** :0.43	Low-Acid Content
4.	60	23.5	30.5 ±1.5	70 ±3	Acid Treatent	5.8	0cm * :0.75 20cm ** :0.83	High-Acid Content

* Rice at pile surface, ** Rice at 20 cm below pile surface.

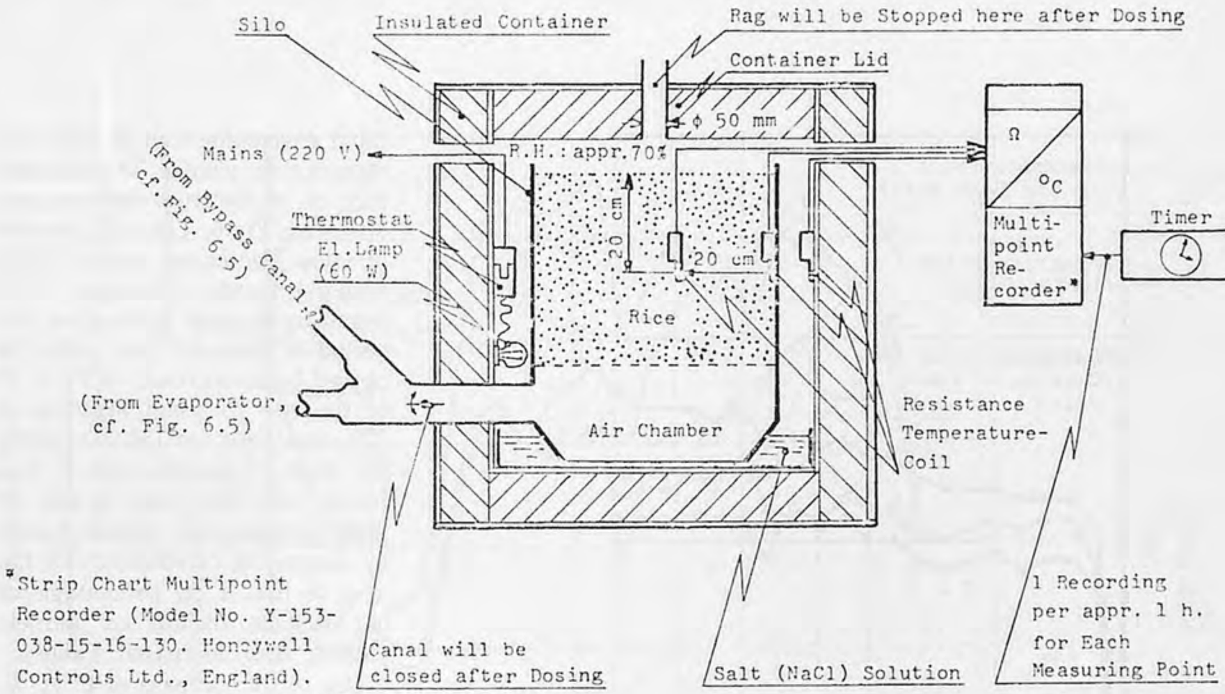


Fig.2 Test Set-up for Test Series 4 (Storage Test)

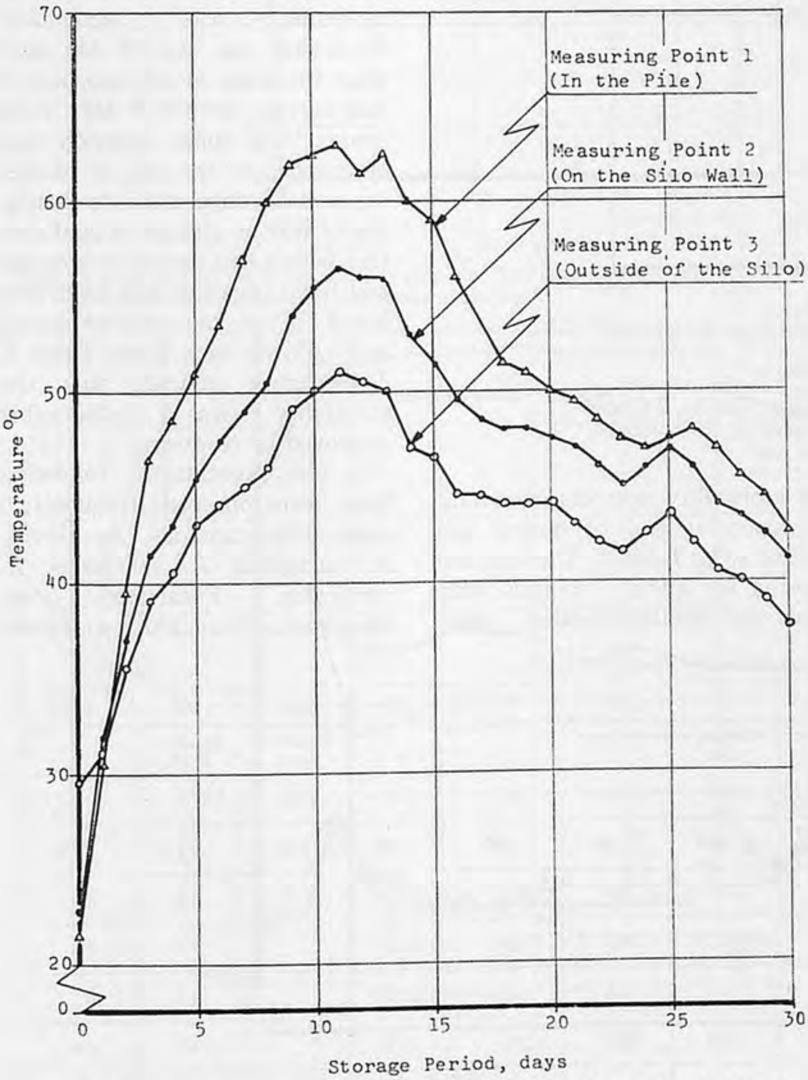


Fig.3 Change in Temperature of Untreated Rice in Silo No. 1 (Due to fermentation, a rapid temperature increasing occured. Rice was completely demolished by fungi within one week of strage.)

days. The percentage of kernels yielding fungi was 44% at the end of dosing, and spoilage by fungi was slightly delayed. The fungi development in the silo became Visible after 2 weeks of storage. As Fig.5 shows, the acid content in the rice sampled at 20 cm below pile surface increased after the dosing. This could be caused by increasing fat acidity value (F. A. V.) of the rice, which means decreasing of the storability. After 13 days of storage, the temperature at point 1 began to increase, and indicates that the spoilage is in progress. That means that the low acid content of 0.4% (w. b.) provided storability for about 10 days of storage.

As the temperature and relative humidity of the air surrounding silo No. 4 was about 30 ℃ and 70% respectively, the moisture content in rice decreased after the dosing was performed, Fig.6. Especially, the moisture content in the rice at the pile surface decreased considerably, and reached below 14% (w. b.). Moisture content of 14% permits a satisfactory storage without acid treatment. That is to say, only less merit can be found in the discussion of the efficiency of propionic acid in the rice at pile surface. Therefore, only the rice

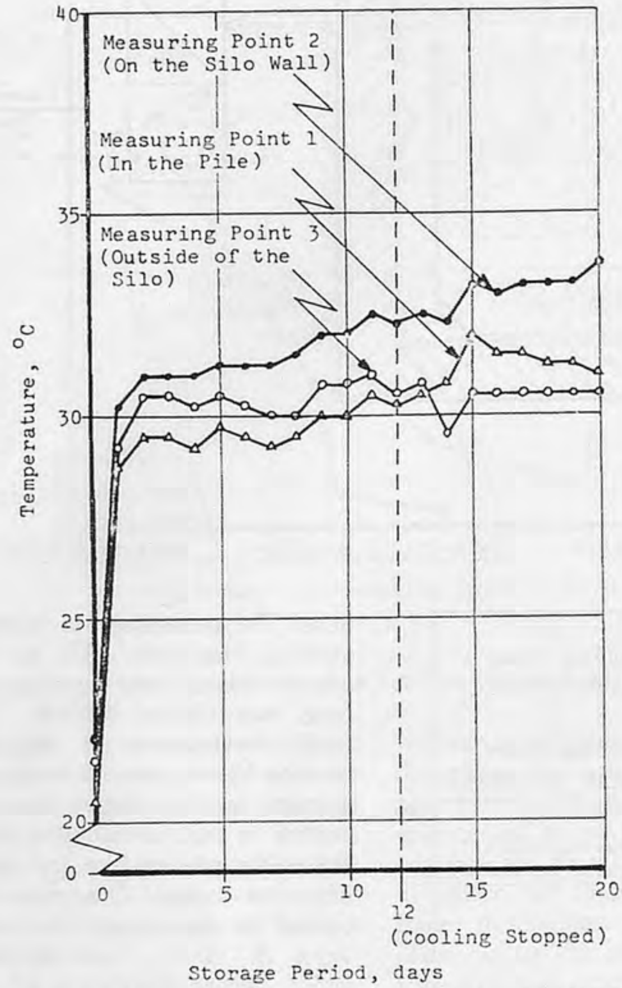


Fig.4 Change in Temperature of Untreated Rice in Silo No. 2 (Under cooling to ambient temperature, development of fungi occured, and the spoilage spreaded whole rice in the silo)

at 20 cm below the pile surface is considered in the following discussions.

As a result of dosing during 12 days, considerable improvement of storability was obtained-fungi invasion at end of dosing was about 13%, **Table 3**. The rice was stored for about 5 months without any spoilage-neither visible fungi development in the silo nor remarkable change in temperature or in moisture content was observed, **Fig.6**. The acid content in rice decreased about 0.2% within 4 months of storage, but it began to increase again after this period of storage. This could be caused by an increase of F. A. V. of the rice. A fungi invasion of 32% was detected 132 days after the start of storage, and it was found that this high grade of fungi invasion was caused mainly by decreasing of efficiency of the acid in hull, i. b. percentage of not surface disinfected kernels yielding fungi increased, **Table 3**.

Due to the increase of F. A. V. and fungi invasion, the need of re-dosing was recognized. Re-dosing was started 146 days after the start of storage, and it was carried out for 9 days. Acid content and fungi invasion was determined at the end of re-dosing and 30 days after re-dosing. There was no change in acid content within this period of storage, and fungi invasion was held very low-2.3% at the end re-dosing and 1.6% 30 days after, **Table 3**. These data indicate that the storability was considerably improved by re-dosing.

In the experiments, following fungi were observed frequently : Aspergillus candidus, A. Flavus, A. fumigatus, A. ochraceus, A. versicolor, Fusarium poae, Mucoracea, Penicillium sp. (green

Table 3. Fungi Invasion in Rice Sampled at 20 cm Below Piel Surface. Silo No.4.

Storage Period	Days	Control**	12	21	42	132	146	155	185
Process		–	Dosing End				Re-Dos. Start	Re-Dos. Start	–
Moisture Content	(w.b.) %	23.7	21.0	17.9	19.0	16.2	16.0	17.7	–
Acid Content in Unhulled Rice	(w.b.) %	(untreated) 0.07	0.83	0.88	0.86	0.65	0.80	0.73	0.73
Fungi Invasion, Percentage of Kernels Yielding Fungi within Culturing Method. (Number of tested Kernels)	A * (200) %	100	31.1	14.0	14.7	100		4.5	3.0
	B * (200) %	96.5	6.7	18.3	10.0	21.5		1.0	2.5
	C * (200) %	39.0	2.5	4.5	6.5	12.0		2.5	0
	D * (200) %	32.0	17.0	19.5	1.0	0.5		1.0	1.0
	A+B+C+D %	66.9	12.6	14.0	7.8	32.3		2.3	1.6

* cf. Table 1. ** Only for comparison (The data obtained in test series 1)

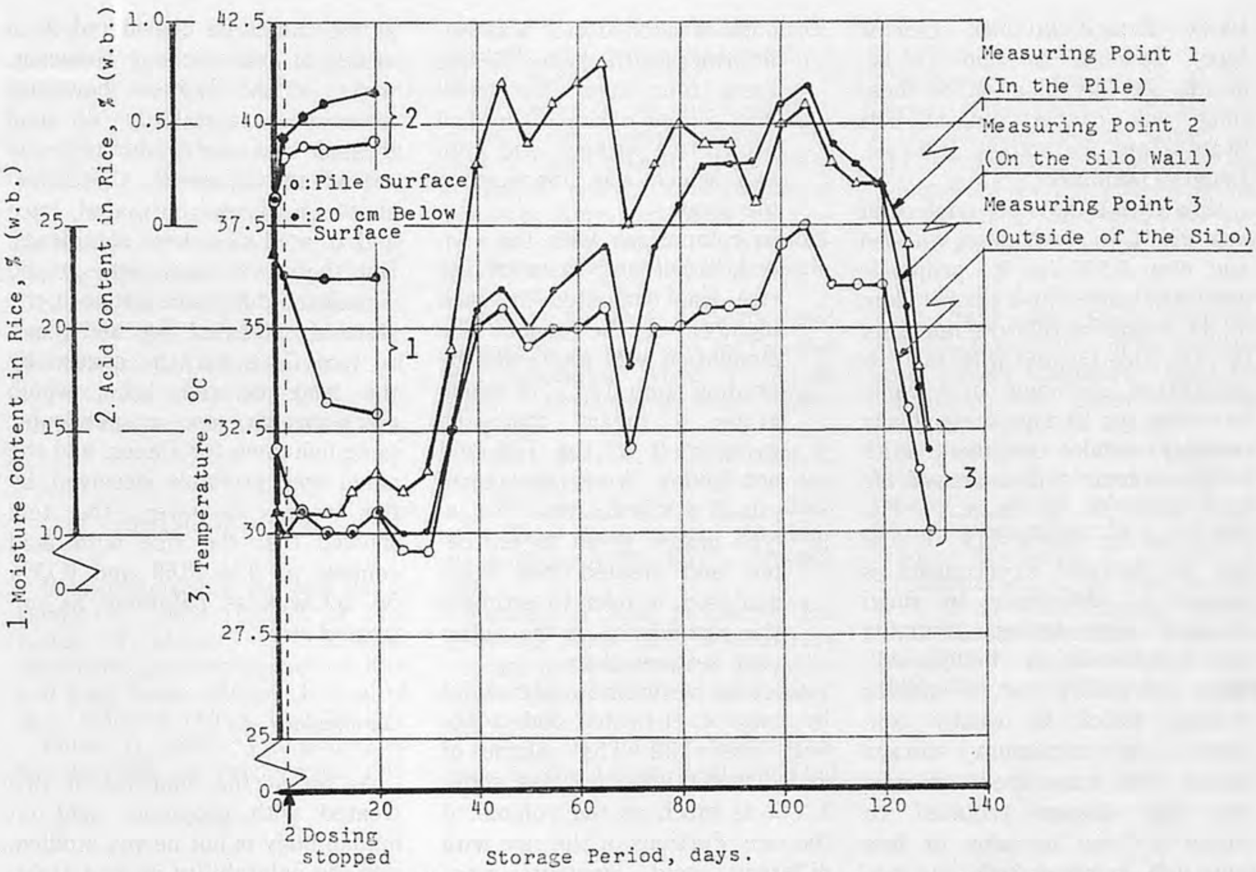


Fig.5 Storage of Low Acid Content Rice (Silo No. 3) (Due to acid treatment, spoilage by fungi was slightly delayed, Development of fungi became visible after two weeks of storage.)

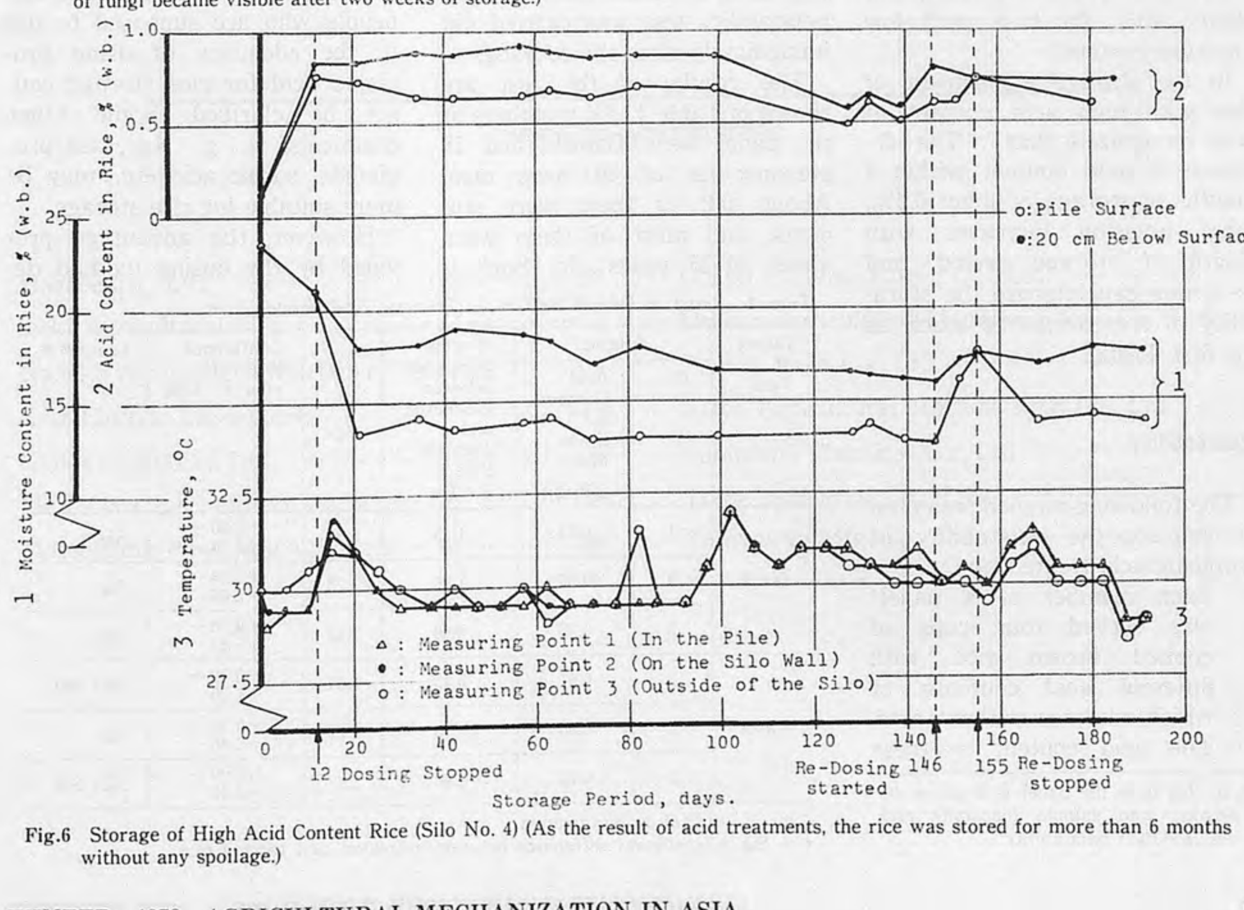


Fig.6 Storage of High Acid Content Rice (Silo No. 4) (As the result of acid treatments, the rice was stored for more than 6 months without any spoilage.)

type), Penicillium sp. (yellow type), Spicaria sp. and Trichoderma sp. Identification of these fungi was carried out at The State plant Pathology Institute, Lyngby, Denmark.

Rice with a moisture content of app. 23.5% (w. b.) treated with 0.4 and with 0.8% (w. b.) propionic acid, was stored at a temperature of 30 ℃ and a relative humidity of 70% Rice treated with the low percentage propionic acid could be stored for 10 days without any spoilage, while treatment with 0.8% propionic acid increased the storability to 5 months. The difference in storability of the rice in the two experiments is caused by difference in fungi invasion after dosing. Assuming that fungi invasion of 10% indicates storability for 6 months storage, which is usually considered as mimimum storage period, the experiment showed that the dosage required to obtain a fungi invasion of less than 10% is about 0.9% for rice with high moisture content, and about 0.5% for rice with low moisture content.

In the storage experiment of rice with high acid content, it was recognized that : The decrease of acid content within 4 months of storage is about 0.2%, fungi invasion increases with length of storage period, and re-dosing can improve the storability of stored rice as much as the first dosing.

Palatability

The following method was used to indicate the palatability of propionic acid treated rice :

1) Each member of a panel* was served four cups of cooked brown rice with different acid contents, of which one was without acid. The acid content in these cups of cooked rice was not informed to the panel. Beside these four cups, the panel was served a cup of cooked brown rice without acid, control, which was informed to the panel.
2) In comparison with the control, smell and taste of the rice was evaluated by each member of the panel. The evaluation was expressed by grading from 0 to 5, of which grade 0 meant that the taste/smell of the rice did not differ from the taste /smell of the control.
3) The grades given to untreated and treated rice were analysed, in oder to estimate the significance of the difference between them.

Cooking of rice was carried out by help of el-heater and a pot with heavy lid. The volume of added water into rice was about 1 1/2 as much as the volume of the rice. Portions of the rice with different acid content were cooked at the same time, and the palatability test was carried out immediately after the cooking.

The results of the test are shown in Table 4. All members of the panel were Danish, and 18 persons out of 20 were men. About half of them were students, and most of them were about 20-25 years old. Such a panel cannot be considered as a model of real society. However, parts of the Danish viewpoint about the palatability of acid treated rice were obtained. As regard to the smell, the differences between untreated rice and treated rice were significant. But there was very little or no significant difference between the taste of untreated rice and treated rice. This may be caused by the taste of rice bran, which gives brown rice a particular taste unknown for Danes, and the panel was probably deceived by this taste. However, the test showed that the rice with acid content of 0.51, 0.66 and 0.75% (w. b.) was as palatable as untreated rice.

※ In this case the panel is a group of persons who sample foodstuffs and evaluate their palatability

Conclusion

As far as the influence of rice treated with propionic acid on human body is not deeply studied, and the palatability of acid-treated rice is not evaluated by the people who are supposed to use it, the adequacy of using propionic acid for rice storage cannot be clarified. Some other chemicals, e. g. Na-, Ca-propionate, sorbic acid etc., may be more suitable for rice storage.

However, the advantage provided by the dosing method de-

Table 4. Result of Palatability-Test for Propionic Acid Treated Rice.

Object of Test	Sample		Average Difference between Untreated and Treated Rice $\bar{D}$	S_D	Confidence Interval at α * =0.05	Judge**
	No.	Acid Content in Brown Rice %(w.b.)				
Smell	1	0.51	1.45	1.39	+0.80— +2.10	Sig.
	2	0.66	1.85	1.73	+1.04— +2.66	Sig.
	3	0.75	0.80	1.32	+0.18— +1.42	Sig.
Taste	1	0.51	0.45	1.61	−0.30— +1.20	Not Sig.
	2	0.66	1.00	1.89	+0.12— +1.88	Sig.
	3	0.75	0.60	1.47	−0.09— +1.29	Not Sig.

* α =Level of significance
** Sig. =Significant difference between untreated and treated rice.

scribed in this report would be the same even if other chemicals are used, and the treatment with gaseous preservative provides that : Perfect coating of grain with the preservative can be carried out, re-dosing can easily be performed, and hence the dosage can be minimized.

Since the dosing method is based on gas sorption principle, the system can treat any sort of hygroscopic materials, i. e. rice, barley, maize, peanuts, beans, etc.

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INDEX TO ADVERTIZERS

Focus on Agriculture in India

by
B. K. S. Jain
Marketing, Management & Agro Consultants
7, Neeltarang, 208, Savarkar Marg
Bombay-400016, India

An important feature of the budget proposals presented to the Parliament is increased allocation for development of agriculture. Allocation of funds is only part of the gigantic task ahead to pull our agiculture out of the rut. This is the appropriate time to have a national debate on the course of agricultural development. Now that we have a new government both at the centre and the states, this is the correct time to put forward views for consideration of our political leaders and policy makers.

Traditional system of farming has its limitations. If we have to increase production and productivity, there is hardly any alternative to modernising agriculture. There are cartain misgivings on such a step. The main fear is that modernization may displace labour. Experience in India so far has been that modernization, in fact, increases the labour requirements because of higher yields and cropping intensity. To students of agriculture, modernization is an opportunity to generate more employment.

Modernization does not mean tractorization or indiscreet use of tractors under all farming conditions. In fact, it will call for harnesting of all possible resources, so as to encourage use of seeds of high yielding varieties, fertilizers and manures, pesticides, proper irrigation, cultivation and harvesting practices and careful post harvesting operations. Accuracy and timeliness have become more important in agricultural practices ; it calls for mechanization. Mechanization, in fact, means a better operation faster. It means employing of better equipment, including hand-tools and animal drawn implements. Today, our need includes not only a good bullock cart but even a good sickle and a better sugarcane harvesting knife. This is all a part of modernization of agriculture. Let us, therefore, have no fears about it.

A study of the holding pattern shows that we have to tackle a three tier system in agriculture. In **table 1.** we have the latest data on operational holdings.

Number of holdings are of primary interest to social workers and politicians as it is here where the votes are. But we cannot overlook the area under cultivation under each tier. There is no doubt that the small farms should receive our biggest attention and allocation of funds ; consolidate their holdings and prevent further fragmentation. The problems of medium and the so called 'large' farms also require attention and a different approach. It is these farms that generate surplus production. It is here that there is a greater potential to substantially step up production. In the textile industry, we have handloom, powerloom and the mill sectors. All the three have a place in our economy. Then, why not a similar attitude to the three tier agriculture ?

We have severe power shortage in the industry ; we suffer from this is in the agricultural sector as well. Power input in our agriculture is grossly inadequate. A worldwide study on correlation

Table 1. Operational agricultural holdings

Holding size.		Area (Hectacres)	% Number	% Area under cultivation	
1		2	3	4	
1.	Small	Upto 4	85	40	
2.	Medium	4 to 10	11	26	
3.	Large	More than 10	4	34	
			100	100	
		Total	70.5 million holdings	145	million hectares
		Area under irrigation :		45	million hectares

between power input and optimum yields has concluded that there ought to be 0.8 HP per hectacre. For our conditions of multi-cropping in India, let us aim at 1 HP per hectacre. In Japan, the power input is 3 HP per hectacre and in most of the countries in Europe and America it is 2 HP per hectacre. It is estimated that we have at present only 0.4 HP per hectacre. We, therefore, must multiply the power availability $2\frac{1}{2}$ times. Obviously, this cannot be done by raising more bullocks and raising more men. We do not have any escape from increasing use of mechanical power, be it in the form of engines, motors, power-tillers or tractors. It will greatly help if we accept this basic fact.

Another important point which needs stress is that agriculture must be treated like a respectable business. Farmers should not be on doles nor agriculture should persist on subsidies. Our pricing policies in relation to agricultural inputs and the farm produce require careful consideration. We must ensure that input supplies are properly priced and that incidence of taxation both by the Centre and the States is on a rational basis. A farmer puts in lot of efforts, time and money in raising the crop and it is but natural that he receives a fair price for the crop.

There is a case to substantially reduce, if not completely exempt, all Central taxes and levies on agricultural inputs — on items like fertilizers, pesticides, pump-sets, tractors, seeds, tools and implements etc. If the Centre makes a beginning, the States will follow suit, in regard to State taxes and levies. The object is to reduce input prices and consequently the costs of operation. This has become more important in view of the Governments' reluctance to increase the price of the farm produce.

The Farm Worker

Having discussed in general terms certain important aspects of agriculture, we now deal with some specific suggestions requiring urgent attention. It is a welcome development that the Government has expressed concern for the well being of the farm worker. In fact, in many ways the industrial worker is much better off. Industrial workers are better organized and have over the years considerably improved their lot. One area of concern for the farm worker is to improve his productivity. He must have opportunities to improve his skills. Under today's technology, traditional hereditary skills may be an advantage, but must be supplemented by proper training in modern methods. This also applies to agriculture.

The Government must establish a National Institute for Training in Agro-Services (NITA). This could be on the lines of the National Institute for training in Industrial Engineering in Bombay. If required, agencies like ILO, UNIDO, FAO, ESCAP, ADB, World Bank and others may assist on an important project like this. The end-use is to train blue collarred workers for agro services and farm operations. The rural youth will be exposed to modern methods of cultivation and will receive training in areas like seed-bed preparation, sowing, irrigation practices, application of agricultural chemicals (fertilizers and pesticides), operation and maintenance of farm equipment, harvesting and post-harvest operations. By such training, we will, in fact, add value to the man. If an unskilled farm labour today gests Rs 3/- a day, by turning him into a pump-set mechanic, he may be able to earn a wage of about Rs 10/- a day. This should generate more employment and keep the rural youth away from migrating to towns. The training will cover village artisans, craftsmen etc.

A beginning will have to be made with development of trainers and training material. In view of our prevailing literacy levels, lot of audio-visual material will have to be developed such as films, models, slides, posters, illustrative booklets etc. Let us, therefore, have an apex institution and once the training material and a nucleus of trainers is ready, such an institution can be organized at a State level. Subsequently, training can be decentralised to a district level and later to the taluka/tehsil level. Expansion of the project will have to be gradual, taking into account availability of trainers and the training material. Training will be required on a mass scale. Some ITIs can be converted into Agro-technics and we should make use of the available infra-structure.

Though there are institutions offering diploma and degree courses in various disciplines, the underlying need is for proper training of field workers. Trained workers will mean better farm operations, higher bfficiency and output, less down time and consequently reduced costs of operation. There are over 2.5 lakh tractors and 50 lakh pump-sets in use. Every year about 35,000 tractors and 5 lakh pump-sets are added to this population. Therefore, the need for imparting proper training in operation, maintenance and repairs of the equipment assumes high priority.

ILO have available some material in regard to farm workers through their publications like Code of Practice, Manual on Safety and Encyclopaedia on Occupational Health and Safety. There is not much material available on vocational needs as relevant to our own agricultural practices. In spite of the importance of agiculture to us as a nation and the fact that 80% of our people live in villages, over 70% are engaged in agriculture and half of our national income accrues from agriculture, we have not been giving attention to the main element of our agriculture, the farm worker. A subject like this is of great national importance and requires to be studied in depth. The primary objective is to study the conditions with a view to improving the productivity. The lot of the farm worker needs to be looked into and improved—this is what the new Government is committed to. Now that more funds are being made available to agriculture, an action plan like the one suggested here should be given the highest priority.

Model Farms

There are several organizations dealing with agricultural inputs and output. They should be encouraged to go into modern farming. The can develop model farms which will be beacon lights. Small farmers, in particular, benefit from such establishments, if properly run. Care will have to be taken that this facility is not misused for converting black money into white or vice versa. We will have to be selective in our approach and get only genuine parties interested in good quality farming. Farming by these institutions will also generate employment. Moreover, this will provide these institutions with practical farm laboratories for their reseach and development work. Manufacturers, distributors, dealers, educational institutions and all others concerned with agriculture should be actively involved in farming operations. Under suitable arrangements, lands difficult to bring under the plough can be developed too. They should be encouraged to offer agroservice like custom work, hiring and adoption of villages. The budget proposal to allow expenses on rural development as a deductible expense is a good step.

We have large number of trusts, religious and othewise, with activities in the form of Goshalas, Gopalan Samities and Pinjrapol. Trusts like the one at Patan in Gujarat and the other at Nathdwara in Rajasthan have vast tracts of land. These lands could be developed for agriculture. It will call for investment. This will enable the trusts not only to contribute towards greater production but will also rid them from the ritual of begging on a recurring basis. They should be encouraged to raise commercial loans to develop farming on their lands.

Though some progress has been made by input suppliers to achieve deeper penetration into rural areas, proper organization of logistics has hampered on accelerated pace. Infra-structure facilities have to be developed by way of communications and adequate overnight halting facilities for travelling rural salesmen and extension workers. Fuels and lubricants have to be supplied in quantities required and at the point and time of use. An industrial consumer receives lot of attention from the nationalized oil companies, but the rural consumer has hardly received any service. It is estimated that fuels and lubricants worth more than Rs 300 crores a year are used only on farm prime-movers. This figure will substantially increase if we add kerosene and other items. There is an urgent need for the Petroleum Ministry to organize a Farm Fuels Advisory Service. World over, the farm sector receives special attention from the professional petroleum marketeers. Such a service will not only ensure adequate supplies but will also prevent adulteration. It will also make rural population energy conservation conscious.

Finance

Agricultural banking is the term now being used to cover financing of the farming operations. On a national scale, a rough calculation shows that the total annual investment in agro products and services works out to about Rs 10,000 crores. Some major components of agricultural production inputs needs are :

Input.	Rs crores-Annual investment
Fertilizer	1,500
Seeds	300
Farm equipment	1,000
Pesticides	300
Irrigation	1,000

Since the aggregate credit requirements cannot be met by the organized banking sector, we obviously have to determine priorities. Credit policy therefore, should used as an instrument to influence farm production.

Another problem has been the recovery of loans. Now that the nationalized banks have gone about financing the agriculture in an organized manner for nearly decade, it may be time to take stock of the situation. We need to study the profiles of the rural borrowers with a view to determining their credit needs as well as their ability to repay. We will also have to work out ways and means to accelerate repayments.

Another area where the scope of improving services is professional underwriting (insurance). While the industry receives lot of underwriting support, the farm sector does not. The situation calls for innovations. Though the General Insurance Corporation of India has made a start with pumpsets, a lot needs to be done.

Some items which are required to be looked into are Crop insurance, Livestock insurance, Insurance of farm structures, Composite insurance policy for the equipment, the owner and the operator, and Comprehensive insurance cover for agricultural inputs from factory to the farm.

The subject of underwriting services to the farm sector needs to be studied in depth.

Safety education is another area GIC must promote. Arousing safety consciousness in rural areas has assumed importance with spread of mechanization and growing use of chemicals, pesticides and fertilizers. World over, safety movements are promoted and financed by insurance companies. Our nationalized insurance Companies GIC and LIC must come together with a more active programme of services to the agro sector.

Policies on farm financing must encourage agro-industries. We should take a 'systems' approach. Financing/banking should cover not only the crop production but also the processing of the farm produce. A scheme of incentives may have to be worked out to promote industries and other allied vocations in the field of agriculture, subh as poultry, piggery, dairying, horticulture etc. We trust some of these points will excite the policy makers in giving due attention to the farm sector. We should not be content with the figures on advances to the agriculture sector, outstandings, number of rural branches of the banks, but should ensure that our scarce resources are better utilized to increase productivity and generate more employment.

Rural Marketing

Rural marketing has to be properly organized both for the inputs and the produce. Co-operatives have, in some sectors, achieved an element of success, but the situation calls for a more dynamic result oriented approach. One has heard of Sears Roebuck and the important role they have played in revolutionizing agraian economy in the USA. Adaptation of Sears Reobuck approach to our own conditions can be to our great advantage.

There is a need for a chain of stores catering for agricultural inputs, daily needs and essential commodities. A start has been made with developing a petrol pump into a multipurpose distribution centre This activity has to be multiplied fast as a petrol pump can be an importance base of operations for a wide variety of products and services.

Price support policies should be made known to the farmers well before the sowing season. It is only then that they will be persuaded to go in for the crop we want them to grow.

A proposal for an integration between the procurement of farm produce and the supply of inputs requires examination. If Food Corporation of India does large scale buying of wheat, instead of paying entirely in cash, can part payment be made in kind through agricultural inputs? This may mean working out a scheme involving such conmodity corporations, input suppliers, farmers and financing institutions.

A case requiring urgent study is the groundnut cultivation in Gujarat. The farmer does not get a good return. It is this industry and trade which corner the produce. Why can't the Government be hold, strike at the root and once for all get all concerned a fair share instead of holding the farmer and the consumer to ransom every year ? One alternative may be to organize tank farms and regulate the supplies right at the source.

In industry, we have sick units which are receiving some attention and given special treatment. Similarly, there are sick units in agriculture too. There are a large number of farms whose output can be substantially increased through proper managemet. Farm management has been confined to our Universities. Means have to be found to get the farmer to take interest in farm management movement. Sick agricultural units require handling with care and there is a need for 'clinics' to look into these cases. Their problems are technical, managerial and financial.

Technology

Development of the Agricultural Engineering discipline will greatly accelerate the pace of modernizing agricuture. Major fields of this discipline are :

i) Farm power and machinery, tools and implements for far operations from seed bed preparation to harvesting.

ii) Soil and water engineering, including land development, soil and water conservation, irrigation, drainage, watershed management, command area development, surface and ground water development.

iii) Post harvest technology, including handling, storage, processing and bio-engineering (also equipment for poultry and dairy engineering etc.)

iv) Farm stead including buildings, structures and layout.

v) Rural electrification.

vi) Rural development, including water supply, sanitation, communications, recycling of agricultural wastes and environment.

vii) Rural industries and agro-industrial development.

This discipline has not received

its due recognition. Technology is as important an input as the seeds, fertilizers, pesticides and irrigation. It is imperative that larger funds are made available to this area and the agricultural engineering set up at the Centre and in the States is properly integrated and re-organized. Agro-Industries Corporations, if properly managed, can provide excellent support to agro development.

Agriculture offers a great export potential for agricultural commodities, agro-based products and processed foods. Though as a short term measure we may put restrictions on exports, but as a long range plan, we must develop agriculture with a view to not only meeting our own requirements but for developing substantial export business. We have the resources and technical skills. What is really required is proper motivation, sound policies and clear direction. Besides, traditional export, we can develop export of tapioca and hops, fruits, flowers, vegetables and seeds, citronella oil, menthol, dehydrated and pre-cooked dals, salted peanuts, processed foods, animal feeds and medicinal plants for the pharmaceutical industry.

Let us conclude on the thought that agriculture will require a dynamic unconventional approach calling for new strategies. Though there is lot of scope for application of traditional skills and knowledge, but new techniques and modern methods will have to be employed. Our Agricultural Universities have done lot of useful work, but this work has remained within their promises. It is only through extensive training and fast spreading of education that we will be able to take development to the farmer's door-step.

We have only made a beginning by committing larger funds for development of agriculture. A lot of work has to be done by all concerned in the government, the academy and the industry to evolve strategies to accelerate the pace of agricultural development. Let us remove all the impediments from agriculture. In fact, agriculture should receive all encouragement. Agriculture is an industry—our biggest industry. Climate is very favourable for a new approach to agriculture as it is expected that the new government will be more receptive to new ideas. Let us sincerely hope that our political leaders and policy makers will shed all the fears and reservations and will be open to new ideas. Only then our agriculture will improve. If we talk of modernizing the industry, why not modernize agriculture ?

■■

The Present Status and Research on Farm Mechanization of Sandy Land Agriculture in Japan

—— For cooperative activity in arid land agriculture development ——

by
Akira Ishihara
Professor
Agricultural Machinery Institute,
Faculty of Agriculture
Tottori University
Toyama-cho, Tottori-shi, 680Japan

Introduction

The research on farm mechanization of sandy land agriculture, especially sand dune fields, by the research group of Agricultural Machinery in Tottori University (most materials belong to the Institute of Agricultural Machinery) had its beginnings more than thirty years ago. The agricultural conditions for sandy land resemble very much those for arid land farm mechanization in regard to water scarcity.

Therefore, this kind of research is a very unique one in Japan. Since that time, the very hard manual labour of farmers and the hard works by animal power have developed gradually to the power farming by using the small tractor, and further on the large tractor farming. Therefore, our research problems also gradually have changed and expanded in even so many phases of farm machinery and farm mechanization in sandy land area in Japan.

In this paper, the author introduces the present status and research on the farm mechanization of sandy land in Japan. The author believes that these informations are very effective and useful for cooperative activity in the field of arid land agriculture developing in the world in the future.

Speciality of Sandy Land in Japan

Area of sandy land

Japan consists of four main island-Hokkaido, Honshu, Shikoku and Kyushu-in addition to a number of island chains and thousands of smaller islands and islets. The archipelago, lying off the eastern coast of the Asian continent, stretches in an arc, 3,800 kilometers long. It covers an area of 377,384 square kilometers (**Table 1**).

Table 1. Area of main island (km²) in Japan

Island	area
Hokkaido	78,513
Honshu	230,722
Shikoku	18,772
Kyushu	41,993

Japan's total land area is about one-twenty-fifth that of the United States, one-ninth that of India, and one-and-a-half times as big as that of the United Kingdom. In terms of world land area, Japan occupies less than 0.3 per cent.

In this area, there are about 240,000 ha of sand dune land. Almost all of it is to be found on the Japan sea coast. About 80,000 ha of it is being used for agriculture. Distribution is shown in **Fig.1**.

Tottori great sand dune is a womanly undulating sand plain, 16 km long from east to west and 2.5 km from south to north (**Photo.1** and **Photo.2**). The dune has about 30 sunken places, large

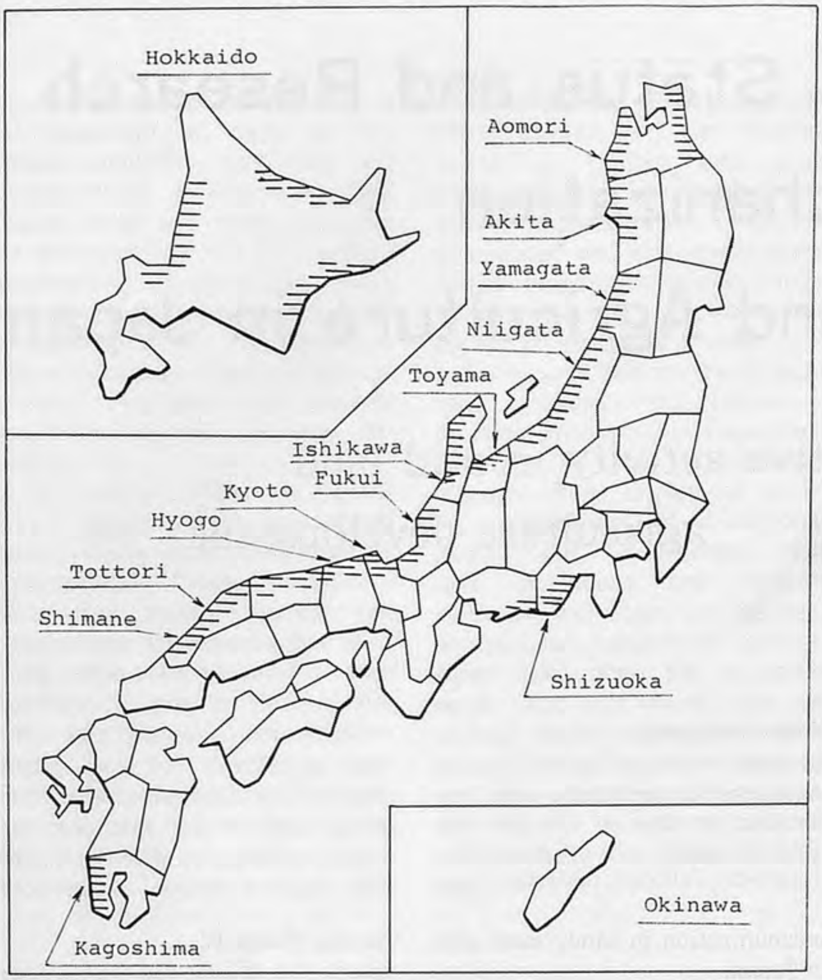

Fig.1 Distribution of sandy land in Japan

Table 2. Composition of sand dune soil in Japan

Name of sandy land	Coarse sand (%)	Fine sand (%)	Very fine sand +Clay (%)
Hokkaido Teina	83.0	15.9	1.1
Aomori Byobuyama	93.3	5.6	1.1
Yamagata Shonai	92.2	5.7	2.1
Niigata Shimoetsu	95.3	2.1	2.6
Ishikawa Kawakitadai	96.8	1.5	1.7
Shizuoka Enshunada	77.9	20.8	1.3
Kyoto Tango	92.8	2.1	5.1
Tottori Hamasaka	88.5	9.5	2.0
Shimane Ezu	94.1	4.9	1.0
Kagoshima Fukiage	65.5	33.2	1.3

and small, the biggest one of them being 200m in circumference and 25 m deep. The sand pattern, made by the wind, shows the creative beauty of the mysterious nature. Tane-ga-ike, the traditional pond near the entrance of this dune, is surrounded by green old pine trees and old cryptomeria, which stand in marked contrast to the rose colored dune.

Soil of sandy land

The composition of sand dune soil is not necessarily uniform. The compositions of most sand dune soils in Japan are shown in Table 2.

As shown in this Table, almost all areas consist of coarse sand, while very fine sand + clay makes up for 2-4%.

Climate and soil temperature of sandy land

The islands of Japan are situated in the temperate zone and at the north eastern end of the monsoon area which reaches as far as India from Japan through Korea, China and South East Asia. The climate is generally mild, although it varies considerably from place to place, largely due to the continental air currents from the north west, dominating the winter weather, and the Oceanic air currents from the south east in the summer months.

The four seasons are clearly

Photo.1 Tottori sandy land.

Photo.2 Protection for sand scattering.

distinct. Summer, which is warm and humid, begins around the middle of July following a rainy season which usually lasts for about a month.

Except in northern Japan, the winter is mild with many sunny days. Spring and autumn are the best seasons of the year with balmy days and bright sunshine, although September brings typhoons which may strike the inland with torrential rains and violent winds.

Rainfall is abundant, ranging from 1,000 mm to 2,500 mm a year. Snow is heavy in the northern parts of the country and in the interior mountainous regions in winter, providing superb sites for winter sports. Tokyo, the capital city, on the other hand, enjoys a relatively mild winter with low humidity and an occasional snowfall in contrast to the high temperatures and humidity of the summer months.

Japan also enjoys many hours of sunshine throughout the year with Tokyo having an average of 2,019 sunlight hours per year.

The combination of plentiful rainfall and a temperate climate produce rich forests and a luxurious vegetation which appear to cover the entire country side.

However, in the sand dune land temperatures raise to more than 40°C.

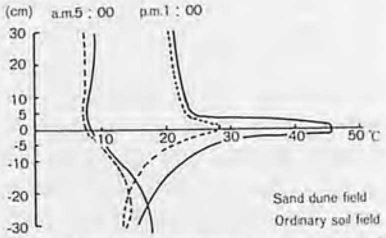

Fig.2 Vertical variation of the land temperature and the atomospheric temperature on sand dune field and ordinary soil field. (I. Sato) (April 25-26, 1959)

Fig.2 shows the vertical variation of land temperature and atmospheric temperature for sand dune field and ordinary soil field.

In sand dune areas, seasonal winds are strong. Especially from December to April, average wind velocity reads 6.4-7.3 m/sec (at Shizuoka) and 4.5-5.8 m/sec (at Tottori).

Distinctive Features of Cultivation and Appropriate Crops in Sand Dune Fields

When planting crops in sand dune fields, there are likely to be some difficulties. Especially, scattering of sand by the wind, damage from drought, decrease of fertility are the most important problems.

However, we can also find some points of advantage for cultivation of certain crops in sand dune fields :

(1) In early spring, the land temperature rises, therefore intensive cultivation is easy to be done.
(2) Cultivating work in sandy soil is not hard, therefore it is possible to use machines even if it is or immediately thereafter.
(3) Cultivation and management, especially transplanting and weeding can be easily done.
(4) Root crops grow up very well, because air ventilation and drainage are good in sand.
(5) Root crops are normally shaped, and have few fine roots.
(6) Harvesting, washing and processing is an easy job, and cleanliness of root crops is excellent.
(7) The degree of permeability for rain and irrigation water is high, therefore the water doesn't flow away on the surface.

By applying the above characteristics of sand soil, the following kinds of cultivations have been selected :

Horticultural crops
- Fruits —— Grapes
- Vegetables —— Yams, Baker's garlic, stoneleek, Carrot, Radish, Taro, Asparagus, Cabbage, Strawberry, Water melon
- Flowering plant —— Tulip Gladiolus, Crocus, Airis, Amaryllis
- Special crops —— Tobacco
- General crops —— Sweet poteto, Upland rice plant, Barley, Wheat, Oats, Rye, Forage crops

Characteristics of Sand Soil and Farm Work in Sand Dune Fields

In sandy land, especially in sand dune fields, the surface soil is not different from the sub-surface soil, and doesn't contain a conglomerate of clay. Therefore, as far as farm machine work is concerned, land leveling is not so difficult and land reformation is easier than with ordinary soil farm land. Drainage is also good and soil aiffusion for implements is small, therefore machine work is possible in spite of rainy weather.

Reasoning along these lines, the general conditions for mechanization in sand dune fields are not so difficult. Manual work in sand dune fields is also sometimes easier than in the case of ordinary soil fields. The physical properties of sand soil have some distinctive traits.

They are as follows :

True specific gravity	2.63
Apparent specific gravity	1.42
Porosity	46%
Non-capillar porosity	80%

and the characteristics of soil water are as follows,

Max. water content	25 - 26%
Field water content	6 - 7%
Withering coefficient	2 - 3%
Effective water content	3 - 4%

As shown above sand soil has a low capacity of keeping water.

In sand dune fields, the most important phases for which mechanization is in demand, are tillage, harvesting and transportation.

Photo.3 Sinking of power tiller's rubber tires in sand dune field.

Photo.5 Half crawler and screw tine of power tiller in sand dune field.

Photo.7 Plowing in sand dune field with large tractor.

Photo.4 Steel wheel of small tractor for sand dune field.

Photo.6 Strake attached rubber tire of large tractor for sandy land.

Photo.8 Planting the Tulip bulbs with self-propelled-planter "Nobel" attached crawler made in Holland. Building is the Sand Dune Ressarch Institute in Tottori University.

The Use of Tractors on Sandy Land

When using rubber tire wheels on sandy land, the slippage is enormous and machines often get stuck, therefore it is impossible to use rubber wheels only (photo.3). The steel wheel, especially the spike wheel turned out to be an improvement (Photo.4 and Photo.6). Also, low pressure wide size rubber tire wheel were introduced. As another solution, the crawler type or the half crawler type are applied (Photo.5 and Photo.8). Since not only drawbar horsepower but also stability of the tractor body are important, girdles or strakes are attached to rubber wheels.

For small type tractor

The relation between the tractive force and the slip of small type tractor in sand dune field are shown in Fig.3.

As shown this Fig.3, the tractive force is boosted by using the low pressure wide rubber tire. However, the crawler was more effective for increasing the tractive force of tractor. In this case,

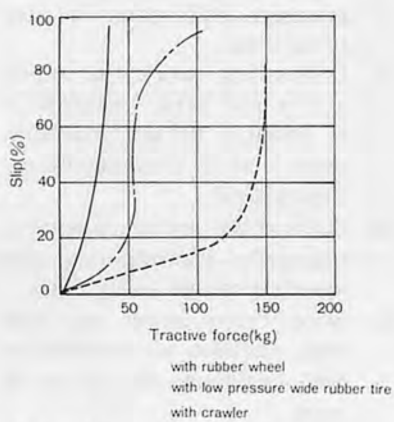

Fig.3 Relation between tractive force and slip of small type tractor in sand dune field.

tractive force is about 120 kg on 20% of wheel slippage.

For large type tractor

The relation between the tractive force and the slip of large tractor in sand dune field are shown in Fig.4.

As shown in the above Fig.4, the tractive force of tractor is large in ordinary soil field, being about 450 kg on 20% of wheel slip. But, when used on sand dune field, the tractive force of this tractor decreases rapidly from 450 kg to only about 20 kg 20% of wheel slip. This difference is very large. However, by attach-

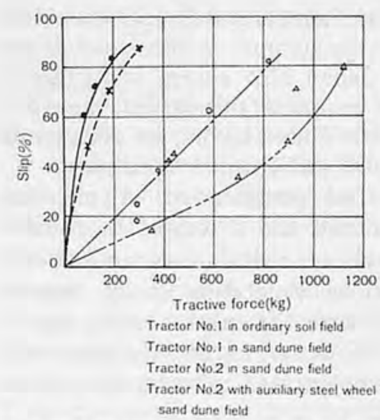

Fig.4 Relation between tractive force and slip of large type tractor in sand dune field.

ing auxiliary steel wheels to the rubber tires, tractive force is increased again, from 20 kg to 200 kg on 20% of wheel slip. Therefore, this kind of auxiliary steel wheels is very useful for rubber wheel tractors in sand dune field.

Mechanization of Tillage Work

Generally speaking, tillage may be defined as the mechanical manipulation of soil for any purpose. In agricuture, some of the objectives of tillage are :

(1) To develop a desirable soil structure for a seedbed or a rootbed. A granular structure is desirable to allow rapid infiltration and good retention of rainfall, to provide adequate air capacity and exchange within the soil, and to minimize resistance to root penetration. A good seedbed, on the other hand, is generally considered to imply finer particles and greater firmness in the vicinity of the seeds.
(2) To control weeds or to remove unwanted crop plants (thinning).
(3) To manage plant residues. Through mixing of trash is desirable from the tilth and decomposition standpoints, whereas retention of trash in the top layers reduces erosion. On the other hand, complete coverage is sometimes necessary to control overwintering insect or to prevent interference with precision operations such as planting and cultivating certain crops.
(4) To minimize soil erosion by following such practices as contour tillage, listing, and proper placement of trash.
(5) To establish specific surface configurations for planting, irrigating, drainage, harvesting operations, etc.
(6) To incorporate and mix fertilizers, pesticides, or soil amendments into the soil.
(7) To accomplish segregation. This may involve moving soil from one layer to another, removal of rocks and other foreign objects, or root harvesting.

As for soil preparation in sand dune land, deep tillage is necessary. For instance, about 20-30cm deep tillage for Baker's garlic, tulip, sweet potato, and about 80-100cm deep tillage for yams.

In Fig.5, the relation between the soil hardness and water in sand dune fields are shown. This

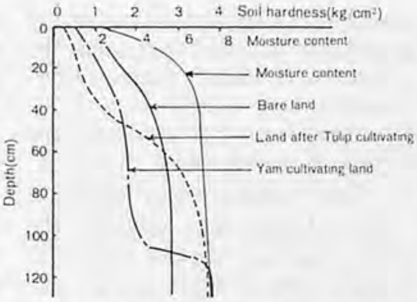

Fig.5 Relation between the soil hardness and water in sand dune field.

data have been measured at the field of the Sand Dune Research Institute, Tottori University.

The tillage method by using machines in sand soil are classified as follows :

(1) In case of 20-30cm deep tillage

This tillage is used for tulip, water melon, Baker's garlic. On land without slope, the rotary tiller for the walking type power tiller and the ridging type large tractor is mainly used. On the other hand, on slopes, the Japanese plow and the mouldboard plow are used (**Photo.7**).

(2) In case of 30-40cm deep tillage

This tillage is applied for radish, carrot. One method is double plowing by using Japanese plows or mouldboard plows. Another method is tilling by using screw type tine of about 50cm lenght (**Photo.5**).

(3) In case of 80-100cm deep tillage

This tillage is used for yams. This tilling is possible by using long screw type tine. The length of this tine is about 70-100cm. Recently, the trencher is being used for not only digging but also for deep tillage.

Mechanization of Harvesting

In sand dune fields, mainly root crops are cultivated. Therefore, the digging machine in order to harvest the root crops is most important as harvesting material. Also, digging in hot sand land of more than 40°C in summer is a very hard work for farmers.

During the long history of the development of sand dune agriculture, farmers have worked by hand or by using only hand implements. However, recently farming machines have been gradudlly introduced.

Next, the author classified mechanical digging methods as follows :

(1) Small tractor pulled type digging machine

This type of digging machines has many varieties. After practical investigations, the author classified the cultivator type-, the plow type-, the elevator type- (**Photo.4**), the vibration type-, the screw type-, the wing blade type- (**Photo.9**), the fork type-digging machine. These types of machines are used for digging the bulb of flowering plants, sweet potato and Baker's garlic. Their mechanism consists of only digging up of the surface.

(2) Large tractor pulled type digging machine

This type of digging machines are driven by tractor PTO, therecore the power is stronger. Most of this type of

Photo.9 Wing blade type digger of small tractor for Baker's garlic.

Photo.10 Elevator type digger of large tractor for Tulip bulbs.

machines are the elevator type-digging machine (Photo.-10). These types of machines are used for digging the bulb of flowering plants.

(3) Trencher type digging machine

The digging harvest for deep root crops as radish and burdock is difficult when using elevator type digging machines. Therefore, when digging needs more than 50 cm, the trencher type machine is used.

(4) Large tractor pulled type digging harvester

This type of machine can not only dig up but also selects from sand and soil, and has a box-like receiver as is the case case with the potato harvester. This means that, it is possible to operate automatically. This type of machine is used for digging the bulb of flowering plants.

(5) Self-propelled digging machine

This type of machine also can handle all digging processes automatically. By exchanging harvesting attachment to planting attachment, planting work is also possible with this machine. This type of machine is used for digging the bulb of flowering plants (Photo.11).

(6) Other special methods for digging works

The pressed water injection method for yams digging, the net planting method for tulip bulbs and Baker's garlic are special digging methods that are developing.

Mechanization of Transportation

On sand dune fields, the transportation work of the materials and harvesting crops is one of the most difficult works. The transportation on the fields is being done now by the farmers manually, and not yet mechanized.

But, on field roads some machines are used :

(1) Agricultural truck

Middle type trucks, with a carrying capacity of 350 kg, are used.

(2) Small type tractor pulled trailer

This trailer is the general transportation method (Photo.-13). The small type power transporter also is being commonly used (Photo.12).

(3) Large type tractor pulled trailer

This trailer is also used by many farmers.

(4) Power transporter

This machine has two kinds, a six wheels type and an eight wheels type. The six wheels type has an air cooled four cycle 7.5 PS/2,000 rpm engine (Photo.14). All six wheels are driven by engine. Max carrying capacity is 500 kg. This machine can be used on slopes up to 30 degrees. This machine is very useful in sand dune fields and on field roads in sand dune areas.

Mechanization of Other Works

The asphalt barrier machine Photo.15) is not immediately related to cultivation of crops. However, it is very useful for preparing the soil and keeping up field conditions of saline soil in sandy land.

Liquid asphalt is injected into the soil at a depth of 60–100 cm (Photo.16). An asphalt berrier

Photo.11 Self-propelled-digging-harvester "Nobel" for Tulip bulbs made in Holland.

Photo.13 Trailer of small tractor attached half crawler for transportation in sand dune field.

Photo.15 Asphalt barrier machine for sand dune field.

Photo.12 Three wheels type power transporter in sand dune field.

Photo.14 Self propelled six wheels power transporter for sand dune field.

Photo.16 Asphalt injection nozzles of the asphalt barrier machine.

of 3 mm thickness is formed in sandy soil. Thanks to this barrier, salty water from the underground is cut down, and irrigation water infiltrating from the landsurface can be held longer in sandy soil. The performance of this machine is one hectare per hour, at a speed of 1 m/sec with a three meter wide injection.

Scientific Reports in Regard to the Farm Mechanization in Sandy Land

Here, scientific reports about the farm mechanization on sandy land agriculture in Japan are shown. They were published during 1960—1976 by the research group of agricultural machinery in Tottori University. These reports are very effective and useful for the development of arid land agriculture.

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Tillage and Seeding Practices for Arid Lands of Rajasthan(India) —A Pers pective

by
R.C. Yadav
Junior Agricultural Engineer
R.P. Singh
Chief Scientist
Central Arid Zone Research Institute
Jodhpur-342003, India

Mechanical manipulation of soil, known as tillage in common parlance, is designed to improve the soil tilth which mainly involves the physical condition of the soil conducive to plant growth. Requirements of tillage vary widely with the topography of the land surface, soil type, climate and the stage and condition of the crop. So far precise methods for evaluating the tilth produced by an implement are not available. Lack of knowledge on the tillage requirements for different crop plants, further adds to the problem.

Arid zone soils are mainly wind blown aeolian deposits with more than 85 per cent sand and as such are cohesionless and non-plastic in property. Frictional resistance, resistance to compression and resistance to shear affect the force required to operate an implement in these soils. Further, moisture conditions and presence of colloids dominate the active force of all soil classes. Tillage may consist of ploughing, disking, harrowing and cultivation. These operations are to be performed with a definite objective under a given situation. Some of the common situations and the appropriate tillage and seeding practices found useful and suitable modifications required in the existing tillage and seeding practices are discussed in this paper.

Tillage

Conservation Tillage

In the arid zone, after the harvest of winter season crops in March and sowing of rainy season crops in June/July, the wind velocity is very high (20-25 km/hr), which causes serious losses of soil through wind erosion. Conservation tillage, which can stop the soil loss, is therefore of utmost importance for the arid lands. Stubble mulching is known to be an effective practice which reduces hazards of wind erosion. There is need to evaluate and select appropriate tillage implements for this purpose. Studies conducted in Canada (Anonymous 1966) indicated that tillage implements differ widely in their ability to produce clods and capacity to conserve surface trash. The efficiency of different tillage implements in reducing the surface trash (percentage) have been found thus : surcace cultivators 10 ; heavy duty cultivator with attached rod weeder 15 ; heavy duty cultivator 20 ; one way disc 50 ; and inverting implement (mould board plough) 100. The above studies further revealed that a field on which at least surface clods are larger than 1.0 millimeter resists most strong winds. Anderson (1961) reported trash reduction with subsequent operation increased with the use of same implements and decreased when used in different combinations. With the use of disc tools, Anderson (1964) reported maximum trash conservation when disc machine operated at moderate speed, shallow depth and narrow pan angle. During primary tillage maximum conservation is reported to likely occur when the clearance between the top of stubble and the spacer pool on the machine is within the range of 0 to 5 cm. These factors other than concavity of disc which is an implement characteristic are within the operators control and may be put in practice for stubble mulching without any difficulty.

Singh et al (1973) reported that

plough plant (seeding direct without prior seed bed preparation) gave yield as good as other tillage methods, saved Rs 39/- to Rs 83/- per hectare and is a suitable practice in sandy arid plains of Rajasthan. with this practice the problem of weed control may be severe which can be reduced by appropriate chemical treatments.

Emergency Tillage

When soil starts blowing due to wind erosion an emergency tillage operation is required to reduce or stop the surface soil from drifting by increasing the degree of surface roughness thereby reducing surface wind velocity. A small reduction in wind velocity can be quite effective since the erosive force of wind varies as cube of its velocity (ARS, 1961). The study indicated that saltating particles seldom reach a height of 30 cm. The emergency tillage is the ripping of rough strips in the field at right angles to winds in order to temporarily halt the surface movement by saltation and surface creep. To produce rough and cloddy surface chiseling at an interval of 0.3 to 1.8 meters and strip listing at an interval of 1.8 to 6.0 meters are effective (Anonymous 1966). The operation for emergency tillage should always be started from wind ward side.

Deep Tillage

Seed bed preparation for rainy season crops involves preparation of soil surface to store maximum moisture and to reduce subsequent requirement of other tilleage operations specially when time for sowing is very much limited besides improvement in soil tilth. Mould board ploughing 20-25 cm deep followed by disking resulted in the highest yield (24.5 q/ha) of maize grains (Ganga 5) on silty loam soil at Dehradun, U. P. (India) (Anonymous, 1973). Mould board ploughing before rains and across harrowing before sowing and sowing with improved seed drill with 'V' shape packers resulted in maximum grain yield of pearl millet (36 q/ha) during the wet year (437 mm) of 1973 at Jodhpur, Rajasthan, India (Anonymous, 1973). This indicates that deep ploughing could be helpful in obtaining high yield under specific situations.

Effect of surface barriers on reduction of evaporation during falling rate drying are insignificant and water losses in long run will depend on decreasing diffusivity or conductivity of soil profile in the depth. Hillel (1971) mooted a concept that deep tillage is effective in reducing water loss by way of increasing range of variation of diffusivity ; changing water content decreases diffusivity at lower level which, in turn, reduces the rate at which the soil can transmit water upward the surface. This effect needs to be investigated in the arid zone soils and climate where it may be effective as soils remain dry for a very long period for lack of soil moisture consequent to insufficient rains.

Tillage for avoidance and amelioration of crust formation

Crust formation is a serious problem on the rainfed arid lands of Rejasthan. Seedling emergence is impeded as a consequence of crust formation following rains after seeding. Further, a crusted or compacted soil generally gives rise to high rate of run-off because of low infiltration rate. Anderson (1974) reported the work of other investigators on the value of plant residue mulch for preventing surface crusting. The possibility that the texture composition of the surface soil could be changed by ploughing deep and inverting soil layer has been considered. Here mould board plough fulfils the need of operational requirements. However, this form of amelioration requires a careful investigation of soil layers with a view to ensuring that proper components are available. Burwell and Larson (1969) reported that proper tillage specially on the contours can increase infiltration and surface storage capacity thus reducing run-off and mitigating affects of crust formation.

In soils which have a tendency to crust, compaction of the soil below the seeding zone results in faster emergence (Stout et al 1961 ; Tarasenko 1968). Prihar (1974) while studying the effect of soil compaction below the seed observed that a moderate compaction enhanced emergence rate and total emergence of corn. Soil moisture tension, planting depth and plant species effect emergence at specified soil strength (Prakar and Taylor, 1965). They observed that plants acting jointly can lift the entire crust segment and emerge, where as single plant cannot. Burwell and Larson (1969) studying root and shoot growth in both a hetrogenous and homogenous soil observed that lack of anchorage in loose layers may hinder roots or shoots from penetrating stronger layer or crust. They suggested the need for a firm bed below the seed and a firm soil around the seed. To overcome the crusting problem, seeding machinery should have a component to compress the bed of the opened furrow before seeding and a concave roller to compress the seeded rows from the sides leaving the top of soil loose enough for emergence.

Preliminary investigations carried out on crust formation and its amelioration at the Central Arid Zone Research Institute, Jodhpur (India) have shown that the mechanical means of breaking the crust, is most effective for row crops (Gupta and Yadav, 1974).

Rolling cultivators e. g. rotory hoe, rolling drums with spikes, bullock drawn rotory chaffers may do an effective job of breaking crust into segments that permit seedling emergence.

Surface cultivation for reducing evaporation

Under annual field crops the soil surface may remain largely bare throghout the periods of tillage, planting, germination and early seedling emergence, during which most of the moisture from surface layers is depleted. Bonds and Willis (1969) reported that any surface treatment such as covering or mulching which modify the surface energy balance and reduce the net energy available for evaporation, can reduce the evaporation during constant rate stage of drying. They reported similar effect of application of materials which lower the vapour pressure of water or shallow cultivation designed to produce soil mulch or dust mulch at the surface. Thus they concluded that surface mulches effect during constant rate stage of drying by way of maintaining more moisture in surface layers and redistribution resulting in to downward movement of moisture

Fig.1 Square-rod weeder for sub-surface cultivation

Fig.2 Sweep cultivator for sub-surface tillage

where it is less likely to be lost by evaporation.

Talasma (1963) found that tillage reduced evaporation rate by half and decreased suction below the tilled zone. He attributed these effects to the formation of layered condition and to the resulting shift in actual evaporation zone. Gardner (1958), Gardner and Fireman (1985) showed that a dry layer at the surface reduces steady evaporation rate in hyperbolic relation to its thickness. Suitability of various surface tillers like sweep cultivators, wide blade harrows and spring tine and spike tooth harrows in reducing evaporation should be investigated.

Tillage for controlling weeds

Tillage operations are required for weed control in standing crops and in the field left fallow during the rainy season for conservation of moisture for use of subsequent winter season crops.

For inter-culturing operations in row crops, precision tiller and sweep cultivator are effective and economical. Under conserved soil moisture condition, rod weeder (Fig.1) and sweep cultivator (Fig.2) can be used with advantage. There is scope for the development of wide blade sub-surface tiller to be used for conserved soil moisture conditions as fields are relatively stone free in

Fig.3 Bukkhar cum ferti-seed drill developed at CAZRI Jodhpur

this region. Bukkhar plough (Fig.3) which is within the reach of small farmers needs evaluation for its effect on weed control with other improved implements.

The new emerging concept of an year-round tillage for effective weed control needs a fair trial under arid zone conditions. However, there is risk of wind blowing during fallow periods in the event of clean cultivation and as such practices like emergency tillage will assume greater importance.

Seeding Practices

Establishment of optimum and uniform plant population is an important aspect of crop management for getting full benefit of inputs like land, fertilizer and available water. The seeding requirements vary with the crop, season and availability of moisture in the soil. Under most situations seeding behind the country plough (Fig.4) has been the common practice. Where presowing irrigation is given or when the soil has adequate moisture in the seeding zone, 'Kera' method of sowing is resorted to. The method consists in opening furrows by a country plough and drilling seeds manually behind the plough in the opened furrows. Planking is done to cover up the furrows and compress the soil around seeds with a view to establishing a thorough soil-seed contact. 'Pora' method of sowing is a more common practice on

Fig.4 Seeding behind country plough equipped with seed tube

Fig.5 Seeding in furrows opened with country plough and planking afterward

drylands. Seeds are drilled by a manual labour in the moist zone in the opened furrows with the help of a bamboo or iron tube fixed behind the handle of the country plough (Fig.5), such that there is a thin soil cover over the planted seeds. Planking is not resorted to in this case after the seeding operation is over. Some farmers also use tyne cultivator provided with a conveying tube fitted with funnel at the mouth for receiving seed metered by manual labours. For different set of conditions the requirement of seeding machineries differ with the season.

Seeding machineries for sowing in the rainy season

Rainfall in the arid zone is very much erratic besides being scarce. Soil moisture in upper layers is evaporated very fast thus leaving very limited time for seed bed preparation and seeding. Seeding operations are therefore to be completed within a limited period (one to two days). Crops sown behind the country plough are likely to result in uneven establishments in the absence of precise control on metering and depth of seed placement. A seeding machinery which has a uniform metering device and has furrow openers which can work at desired depths will overcome this problem upto some extent. Placement of seeds in moist zone, maintenance of better moist soil-seed contact leaving about 2 cm soil over seeds and placement of fertilizer in relation to seeds has significant influence on the germination of seeds and growth of seedlings. Studies conducted by Yadav and Gupta (1974) on the influence of different post-sowing compression in loamy sand soil indicated that compression of seeded rows with narrow iron wheel before covering results in significantly higher emergence of sunflower and mustard seeds over control (only covering). Observations recorded on the calibration of seed drills indicated that sliding collars of fluted rolls maintain wider gaps which release higher rate of small seeds than the recommended rates. Thus for sowing small grains at recommended rates, appropriate modifications for reducing the gaps will have to be made in seed drills.

As regards furrow openers, a single and double disc type furrow openers (Fig.6) are effective in shallow seeding. A shovel type furrow opener(Fig.7) gets clogged when used for deep furrow opening. In loose and friable soil a boot type furrow opener (Fig.8) may be suitable. The data on seedling emergence, grain and dry matter

Fig.6 Single and double disc furrow opener for shallow seeding

Fig.7 Shovel type furrow opener

Table 1. Effect of post-sowing compression on germination and emergence of seedlings (Yadav and Gupta, 1974)

Treatment	% emergence	
	Sunflower	Mustard
1. Control	20	47
2. Pressing of entire plot (Roller)	36	40
3. Pressing the seeded rows with iron wheel before covering	80	83
4. Pressing the seeded rows with pneumatic wheel before covering	32	60
5. Inter-row compression (Roller)	32	56

Table 2. Seeding emergence, coefficient of variation, coefficient of velocity of emergence, grain and dry matter yield as influenced by seeding machineries. (yadav, 1977)

Treatments	Final emergence no./ per metre row length	C.V. of seedling emergence (%)	Coefficient of velocity of emergence(%)	Dry matter yield (q/ha)	Grain yield (q/ha)
1. Shovel t ype drill	11.3	55	22.9	38.44	8.28
2. Shovel type drill with narrow iron press wheel	23.1	60	23.8	43.49	9.50
3. Disc type drill	3.0	182	33.2	25.43	4.10
4. Disc type drill with semi-pneumatic press wheel	8.0	25	27.5	45.58	10.59
5. Hoe type drill with 'V' shape solid press wheel	26.0	45	30.3	45.54	11.95
SEm ±	1.7			4.03	0.69
CD 5%	5.2			13.74	2.34

Fig.8 Boot type furrow opener for loose and friable soil

yields as affected by different seeding mechanisms are set out in Table 2.

Seeding machineries for planting crops in the inter-row water harvesting system

Successful crop production on drylands hinges on efficient moisture conservation practices. Inter-row water harvesting system (Fig.9) of growing dryland crops is effective in moisture conservation as also in utilizing all the available space for crops, as the inter-row spaces are modified to generate run-off. For adoption of this practice on large scale an implement which can open furrows and form ridges, open furrow for seed placement and compress the seeded rows with suitable device for faster emergence has been developed at the Central Arid Zone Research Institute, Jodhpur, (India) (Fig.10). Many a times two crops are grown in an inter-cropping or mixed cropping system in the inter-row water harvesting system. In order to meet the requirements of an efficient seeding machinery for the inter-row water harvesting system, the seed drill should have two boxes, one for each crop fitted with the metering device. A component for ridge compaction should be provided as an integral part of the machine.

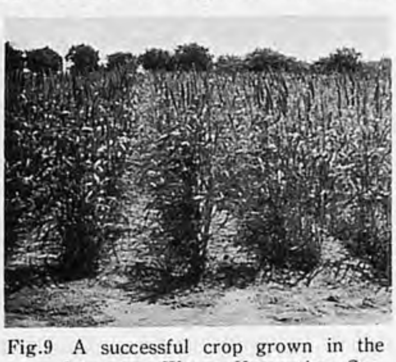

Fig.9 A successful crop grown in the Inter-row Water Harvesting System

Seeding machinery for conserved soil moisture

The precipitation received late during July and thereafter, in particular, the rainfall received towards the fag end of the rainy season (June end to September) may have to be conserved for growing a successful winter season crop on stored soil moisture. As evaporative demand of atmosphere is high, upper soil layers (0–10 cm) get dried due to evaporation. For seeding crops under such conditions, wide furrows should be opened first, followed by seed placement in the moist zone, and compression of the seeded rows with an appropriate packer thereafter. Job of deep furrow opening can be conveniently done with a suitable lister. Other components such as seed metering, furrow opener for seed placement and compression of seeded rows may be eval uated as available with different seed drills to suit the requirements of this situation. The job of seeding winter season crops on conserved soil moisture, with assured uniform plant stand, can be achieved by the ridger cum seeder developed at this Institute (Fig.10).

Summary

Arid zone soils are mainly wind blown aeolian deposits and being cohesionless and non-plastic in nature, are subject to wind erosion. Conservation and emergency tillage have an important role to play in reducing or stopping the surface soil from drifting. Stubble mulch farming and plough plant practices are of special advantage to arid zone situation. Mould board ploughing before rains and across harrowing before sowing and sowing with improved seed drill with V-shape packers has resulted in maximum yield (36 q/ha) of bajra grains at Jodhpur.

Crust formation is a serious problem on arid rainfed lands of Rajasthan. The work done so far in India has not even touched the

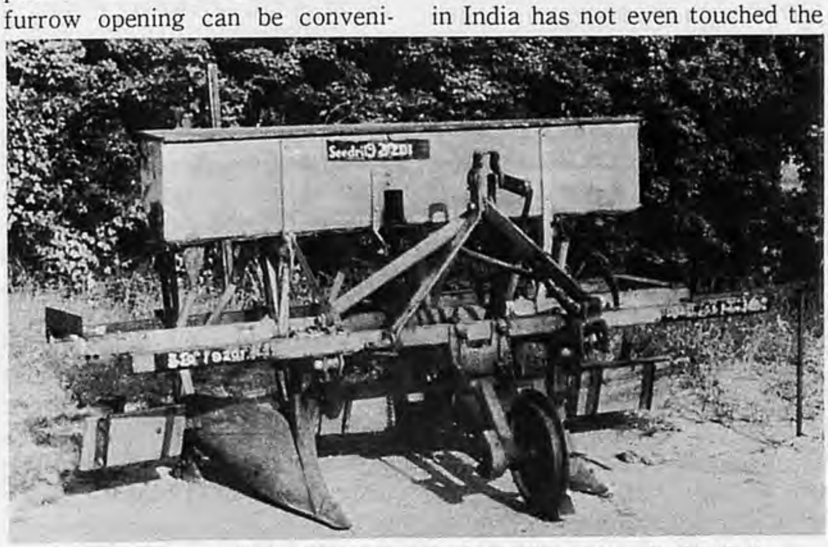

Fig.10 Ridge-furrow drill for inter row water harvesting system developed at CAZRI Jodhpur

fringe of the problem. Lot of research efforts have to go into solving this complex problem. Avoidance and amelioration are the two aspects of crust formation which have to receive the attention of the research workers.

One of the principal reasons of low yields of crops in the arid zone is that the crop establishment is neither optimum nor uniform. Seeding practices and implements which can ensure uniform crop establishment are called for. Special machinery/equipment for making and planting in the inter-row water harvesting system will have to be desinged. Suitable listers which can open deep and wide furrows, with arrangement for placing seeds in the moist zone, with a thin soil cover, are required for seeding winter season crops on conserved soil moisture.

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Machinery & Equipment for Intensive Fish-Breeding

by
W.S. Weil
Agricultural Engineer
Member of a Kibbuz
Maayan Zwi
D.N. Hoff Hacarmel, Israel

Introduction

To start off, I would like to emphasize that I am not a specialist on actual fish breeding. We have developed together, over the years, the crew working in the fish ponds and the people working in the workshop, a number of machinery and equipment which I would like to describe in the following. I shall, first of all, give a general description and then describe all the equipment more in detail.

Area and Water

The ponds cover an area of aproximately 250 ha brutto, which includes : embankments, water channels, reservoirs, etc. Almost the whole area consisted in the past of one large salty swamp. Except about 40 ha, constructed along the sea-shore on sand. This latter area was heavily manured, after construction, and with the placing of fish into the ponds and the development of plankton, was completely "water-proved."

All the outlets of all the ponds are connected to one system of water channels, which lead to two large pumping stations. The whole area is covered by a large diameter, underground, asbestos-cement piping network, which can supply water from the pumping stations to every pond. Whenever water is let out of one pond it is collected in the water channel and can be pumped back into the same pond or any other pond.

All the ponds and reservoirs are filled to the top during the winter, during the rainy season, from a small stream which only carries water after heavy rains. Half the water of two reservoirs, having sweet water (200mg/l), is used during the summer months for fruit plantation irrigation and at the same time for breeding fish. All the other ponds contain brackish water (above 1000mg/l) through evaporation and salty sub-surface wells. One pond is used as general water supply reservoir for the ponds, as it is full of sub-surface salty wells. The evaporated water, during the summer months, is replaced from the brackish underground wells and the water from the water channels. By having all the ponds connected through the water channels, no water is lossed, except through evaporation.

Fish

We are breeding four species of fish : carp, silver carp, St. Peter's Fish (Delapia Calilee) and grey mallet. All the four species are in almost every pond, usually in two sizes.

We are breeding carp and silver carp ourselves. Delapia breeds by itselve anywhere and everywhere, in such a way, that it is almost impossible to control and that it interferes with planned and organized breeding. To overcome this, we used to sort all small fish, separate the male from the female. Throw the male back into the pond and destroy the female. The males then grew very much faster. This, of course, required an enormous amount of hand labour. Then, one of the research stations arrived at a revolutionary solution : they crossed two different species of Delapia (Calilee and African) and the result was about 80% of males and the females did not breed.

The grey mallet is a sea fish and will not breed in the ponds, although trials and research has been going on for years. They breed in the sea, and then as fingerlings (2 g) they come during winter storms to protected bays and stream outlets to find protection, where we catch them, breed them for a month in large containers with fresh water and then grow them in the ponds.

Management

All the ponds are emptied once a year, at least, usually twice, sometimes even three times. The water is let out through a concrete lock to the water channel, which connects all the ponds. The floor of the pond is constructed to a slope and all the water and fish collect in the " fish-hole ", which is the lowest part of the pond, near the concrete lock and over which the water-inlet is situated.

This will give you a general idea, but through the more detailed description of the equipment and machinery, you will get a more complete picture.

One person is kept busy to keep the exact records of each and every pond and by planning all the operations : when and where and how to feed ; which pond to empty ; where to distribute the fish which are as yet not ready for marketing ; where to thin out the number of fish and what to do with them ; etc., etc.

A monthly plan of activities is drawn up and copies distributed to every member of the crew, working in the ponds, so that everybody knows exactly what is going on.

Feeding

We started off, years ago, by distributing bags of feeding stuff (millet, sorghum) along each pond. A number of bags were loaded every day into an iron boat, the boat rowed into the middle of the pond and the contents of the bags shoveled into the pond. This took a lot of time and very hard labour.

We then invented and build the " Blower ". This is a large container, build on a truck, holding feeding stuff and through a powerful fan blows controlled amounts of food into the pond, at a distance of 6 to 10 m. The operator has a list of how much food to blow into each pond and controlls the amount with the help of a stop-watch. As there is a large number of ponds, the truck used to go arround the whole area only once a day.

After that, we invented and build the automatic feeder. This consists of a steel silo, usually serving two ponds, from which extend two pipes, one over each pond. The pipe is perforated with a flexible steel auger inside it, which transports the food through the pipe, where it is distributed into the pond through the perforations. The feeder is electrically operated, not once a day, but every hour for a few minutes (depending on the amount of fish in the pond). Altogether, no more food is fed during the year, then used to be once a day with the " Blower ". We found out by this method, that the fish utilize the food more fully and yields increased considerably. Feeding stuff is the most expensive input in the whole breeding process. When the feeder operates, all the fish collect under the pipe and it is easy to catch large amounts, if thinning is neccessary.

About 90 % of the ponds are now equipped with automatic feeders, whereever we could get with the electric underground cable. When the water temperature drops below a cartain degree the fish wont eat any more and we stop all feeding, except one type of food.

We collect the refuse from a number of poultry and turkey sloughter houses by truck and tank in the late afternoons. In the very early hours of the morning the contents of the tank are tipped into a hammer mill, which grinds it into very small pieces. It is mixed with a little bit of water, collected by the same truck and fixed amounts distributed to the different ponds. This is the only food which the fish will absorb during the cold winter months.

Sorting

As I have already described, we are growing four species of fish and there usually are two sizes in each pond. Therefore, when a pond is emptied the fish have to be sorted : the big ones brought to the store-pond for marketing and the rest to be distributed to the different ponds, according to the " master plan ".

We have a small mobile sorting table, which we put next to the fish-hole and the net and where we sort the fish in to plastic containers (50 1). This requires an enormous amount of hand labour (at least 8 people). As there are from 20 to over 40 tons of fish in the ponds, the emptying of one pond, by this system, may take over one week, which not only means large amounts of labour, but, what is even more important, the loss of valuable growing days.

We have lately constructed a central sorting station, where the whole process is more automated. We only need about 4 people and can empty the whole pond in one day.

Loading

We started off with plastic containers (40 to 50 kg), which two people had to carry up on to the embankment and drop the fish into the tank on the truck or tractor-trailer.

We then invented and build the elevator. The first ones were mechanically operated and one person had to stand on the embankment to operate it. We have lately converted them all to hydraulic operation and the controlls are situated at the pond-end, so that no special operator is required.

Experiments have been going on for some time to pump the fish, with water, from the fish-hole to the tank. Progress has been made, but no satisfactorily resolution has as yet been reached. An other year or two.

Transportation

Carps have to be delivered alive to the market. We have therefore constructed a tank which can carry 5 to 6 tons of fish over long distances, without any trouble. A petrol-engine-driven air blower, blowes fresh air continously in to the water, at the bottom of the tank. The fish are loaded early in the morning by elevator from the storage pond and it may take 8 hours till they are un-loaded.

All the other fish are marketed dead, in plastic boxes (15 kg), covered with shaved ice.

For operations inside the pond area we have two smaller trucks with tanks, which can carry from 3 to 4 tons of fish and two tractor drawn tanks which have aproximately the same capacity. All of the tanks have the same air pumping arrangement as the "market tank".

One tractor drawn tank is specially used for thinnning. It has a colapsible elevator built on to it, which can reach down in to the pond to load the fish.

Aeration

This is one of the biggest problems, which took us years to solve. During the hot summer nights the fish suffer from lack of oxygene. The larger the fish population in the pond, the bigger the problem and the bigger the danger of the fish dying. We have had cases, in the past, where tons of fish died in one night, first and formost for the lack of suitable instruments to overcome the lack of oxygene, but also through human oversight.

We have now a unmber of stationary and mobile air pumping units. The stationary units are driven by electric motors, whilst the mobile ones are diesel-engine driven. They all work on the same principle : they supply a very large amount of fresh air, at low pressure, which is distributed aproximately 1 m below the water surface. This has almost altogether eliminated the loss of fish.

Detailed Description of Equipment

Concrete Lock

The concrete lock is situated at the lowest part of the pond and cast on to a horizontually situated 25" concrete pipe, which

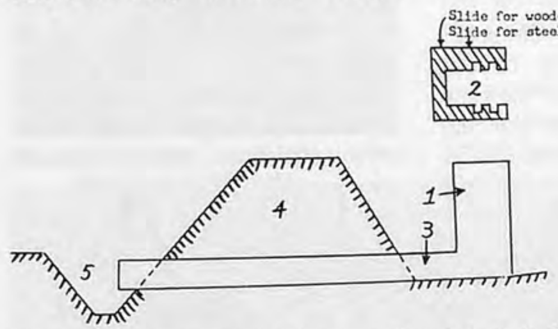

Fig.1 1. Concrete Lock, 2. View on to Top of Lock, 3. Concrete Pipe, 4. Embankment, 5. Water Channel


Fig.2 Wooden Lock Boards

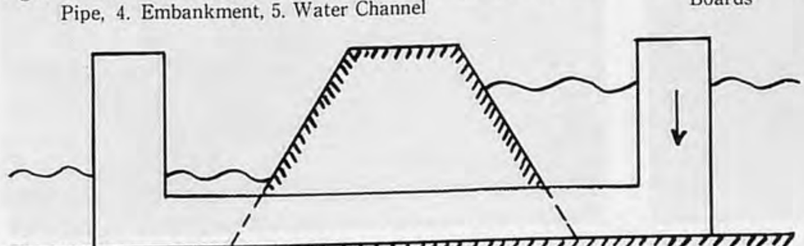
Fig.3 Inter-Connecting Locks

Photo.1 "Blower" blowing food (1. food, 2. concrete lock)

Photo.2 "Blower" blowing food (1. blower, 2. slope in to the pond, 3. concrete lock) carries the water under the embankment in to the water channel. (Fig.1). The water-level is kept in the pond through the wooden boards. (Fig.2). The water-level is lowered by taking out boards and the fish are kept in the pond, when the outlet is opened, through steel netting.

We have a large number of ponds which are inter-connected by two concrete locks. (Fig.3). This, for the simple reason to gain the all-important growing days. After a pond has been emptied it may take many days to bring in enough water throuth the central pumping stations to settle a new lot of fish. By opening the connecting lock of the neighbouring pond, the water-level of that pond is lowered to a save limit, but also, a large amount of water is diverted to the empty pond within hours, which makes it possible to settle a new lot of fish whthin a very short time.

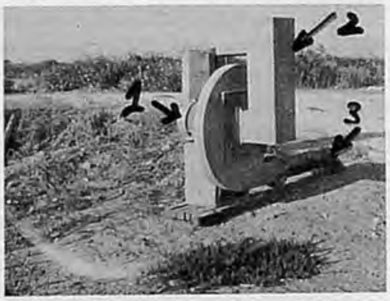

Photo.3 Stationary air blower (1. electric motor, 2. suction, 3. outlet 4" pipe)

Blower

Its a steel-sheet box, mounted on a truck, which holds aproximately 6 ton of grain. Its bottom sides are sloped towards the bottom centre, in which an auger is situated. Above the auger are shields, which can be moved closer or further away from the auger, from the outside, depending on what feeding stuff is used. At the rear of the food container is a very large fan, which is driven from the P.t.o. of the truck transmission.The auger is driven through a belt-clutch from the same axle that drives the fan. The operator engages the fan, inside the truck cab, and as soon as that reaches the proper speed, he actuates the auger through the belt-clutch, which then delivers feeding stuff in to the air stream The operator meassures the required amount with the help of a stop-watch.

In case there are only small amounts to be fed, or the truck breakes down, we have a small tractor-drawn "Blower". It works through the tractor P.t.o., but its fan is situated at the front. Otherwise, it works on the same principle as the large "Blower".

Slaughterhouse Refuse Chopper

The tank on the truck, hauling the refuse, has a door at the rear. A funnel is connected to the rear of the tank and the truck gradually tips the contents of the truck in to the hammer-mill (30 HP electric motor). The ground-up refuse is collected in a container below the hammer-mill. After the tank is empty, the truck drives below the container, a door is opened and all the ground up refuse drops in to the tank, where it is mixed with a small amount of water.

The material is distributed in to the ponds by attaching a 5 m collapsible slide to the rear of the tank. By opening the rear door a specific time, according to the required amount, the material is dropped in to the pond.

Automatic Feeder

The lay-out is usually as following (Fig.4) : one or two steel silos are situated at a suitable place between ponds. The bottom of the silo has a funnel shape with a connection to two 2½" perforated plastic pipes. The pipes are strung over pond and held in a horizontal position by a steel cable. Inside the pipes are flexible steel augers, which are driven by electric motors at the end of the pipe. The electric motors are actuated by an electronic timing device, the timing of which can be adjusted, according to requirements.

We have at the moment a new device, in a few ponds, on an experimental basis, which starts the

Photo.4 Tractor-driven "Blower" (1. food container, 2. air blower, 3. auger drive, 4. belt-clutch lever, 5. p. t. o.-drive shaft, 6. food blowing pipe)

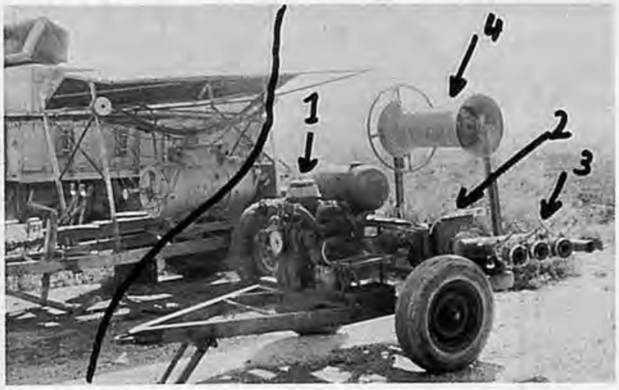

Photo.5 Mobile air blower (1.15hp air-cooled diesel engine, 2,.air blower, 3. quick-connection outlets, 4. reel to wind up pipes)

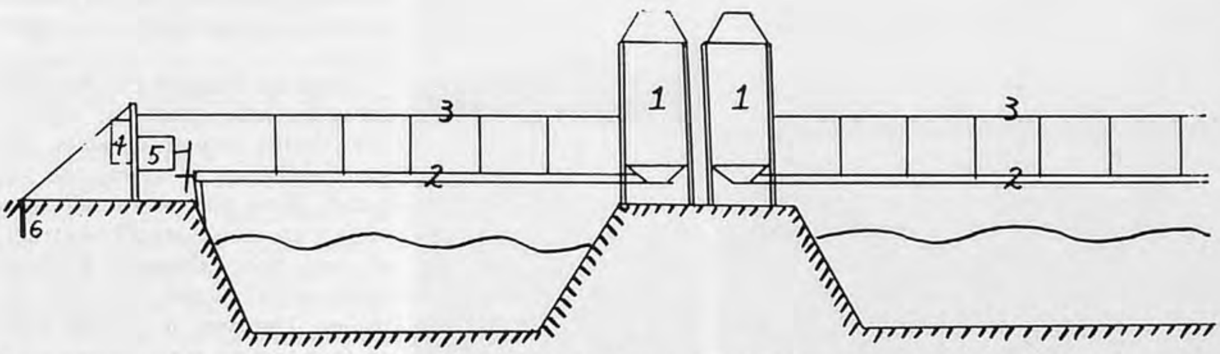

Fig.4 Automatic Feeder (1. Steel Silo, 2. Perforated Pipe with Auger, 3. Steel Cable, 4. Electronic Timer, 5. Electric Motor, 6. Cable Anker

Photo.6 Slaughterhouse refuse chopper (1. funnel, 2. hammermill, 3. container)

Photo.7 Automatic feeder (1. feeder drive, 2. electronic timer)

automatic feeder, based on strong movement of the fish under the feeding pise, which actuates an electronic switch. As soon as the fish have fed enough, the movement stops and the electronic switch cuts off the feeder. This is a trial device and only after recording the yield and the exact food input, will we decide wether to operate it in all the ponds.

The feeding stops as soon as the water temperature drops below a certain degree and the fish will stop feeding. This depends on the weather and the date changes from year to year. The trouble was that we were usually left with a certain amount of feeding stuff (pellets) in the silos. Being left in the silos over the winter, the food would spoil and a lot of money wasted. We have now constructed a mobile auger, on an axle with two wheels, which is driven by a hydraulic motor from the hydraulic system of a tractor. The auger is pulled by the tractor to the silo and two high-pressure flexible pipes connected between the tractor and the auger. The bottom end of the auger is a funnel which is put under the door of the silo. The top end is a spoute which is put over the "Blower's" food container. The hight can be adjusted by cable. After the food has been removed from the steel, silo, it is moved to a concrete silo, where it is well aired and protected during the winter months, till the spring season begins.

Mobile Sorter :

As already mentioned, we have a small mobile sorting table. It is aproximately 4 m long and has adjustable legs, so it can be errected on any place. It has a 15 cm border right arround it and an end-gate which is usually placed over the elevater. On the off-side there is room for five to

Photo.8 Food auger (1. collecting funnel, 2. hydraulic motor, 3. height adjustment)

Photo.9 Automatic feeder drive-end (1. perforated, plpe and auger end, 2. electric motor and drive, 3. electronic control)

Photo.10 Fish feeding from automatic feeder

Photo.11 Automatic feeder in operation (notice the concentration of fish)

six plastic containers (50 l). The numericaly major type of fish are left on the table and then scooped through the end-gate in to the elevator. The other types are sorted in to the plastic containers. The plastic containers have to be emptied by hand in to the tanks on the embankment. As you will see later on the elevators have two outlets, so that we can send up two different types of fish in to two different tanks. If the embankment is very steep or far away, we put elevators in to the fish-hole, i. e. we can transport four different types of fish in to the different tanks.

Mechanical Sorter

This is a large and complicated machine, which is situated permanently at the fish-pond centre. It contains the following units : Tank, Elevator, Sorter. All the moving parts are driven by hydraulic motors. All operating selectors are situated up on the sorting platform.

The tank is of 45 m^3 capacity. Parallel to the tank is a high embankment from which the trucks or trailer-tanks empty the fish in to the tank. Inside the tank is a reduction gate which gradually moves towards the elevator, thereby driving the fish in to the elevator. However, in order not to stop the hauling operation from the pond, fish can be dropped in to the tank behind the gate. When the gate gets to the elevator and all the fish in front of it have been lifted, the gate lifts up, travels to the oposite end, goes down and starts reduction operation all over.

The elevator consists of an endless belt, on which 60 cm wide, perforated stainless steel cups are fastened. The cups scoop up the fish at the deepest part of the tank. The whole length of the elevator is covered by plastic netting, to prevent the fish from jumping out of the cups. The speed of the elevator can be adjusted from the sorting platform through the hydraulic system. The elevator lifts the fish to the sorting platform, the bottom of which is aproximately 4 m above ground.

From the elevator the fish slide through two revolving drums. The drums consist of slats, the space between them can be adjusted. Here, the two small sizes of fish are automatically extracted and slide through a shoot down in to a tank, on truck or trailer. The rest of the fish slide on to a sorting table, where with a flick of a finger they are send to the respective shoot, from where again, they slide in to a tank.

From there the tanks distribute the fish to the different ponds, according to the "Master Plan". The marketable carps go to the store-pond. All other marketable fish slide to the packing station, which is just a few meters away. Here, they are weight, packed, covered with shaved ice and put in to a cold storage room, till marketing.

Loading :

The elevator consists of a frame, built on to an axle with two wheels. In the elevated position it can be pulled by tractor or Jeep.

On top of the frame are two rails ($1\frac{1}{4}$" pises) on which travells the trolley. There are two forms

Photo.12 Semi-automatic secter (1. tank, 2. reducing gate, 3. elevator, 4. 5. sorting drums, 6. sorting table, 7. shoots-under which tanks are standing, 8. operating controll)

of containers on the trolley :

(a.) a round drum, 20% of which is cut off as an opening. The drum is hung up in the trolley frame above its centre, so that the opening is always at the top. When the trolley travels up the rails and arrives almost at the top, there is an other couple of rails, besides and higher then the pipe rails, on to which the drum mounts, and by traveling on, graduall turns the opening of the drum downwards, thereby spilling the fish in to the funnel.

(b.) a square box is hung up in the trolley frame. The bottom is held on by springs. As the trolley travels up the rails and gets almost to the top, the bottom pushes against two stationary blocks, thereby opening the bottom and the fish spill out in to the funnel.

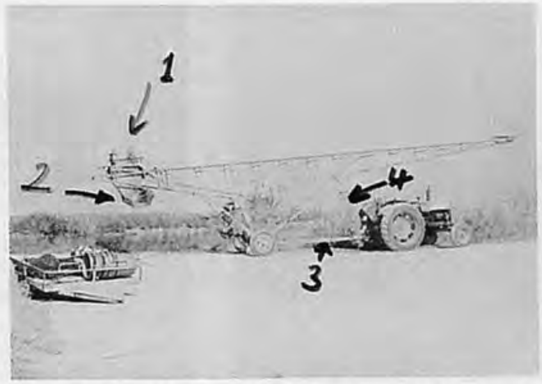

Photo.13 Elevator in transport position (1. trolley, 2. shoot or slide, 3. drawbar, 4. Stay. By folding up the stay, the end of the elevator is lowered in to the pond)

Photo.14 Top end of elevator (1. trolley, 2. pipe rails, 3. elevated rails-on which drum revolves)


Photo.15 Loading the truck (4.5 tons of carp to the market. The trolley holding 250kg going up)


Photo.16 Loading the trolley

Both forms of trolleys can hold up to 250 kg of fish. Below the funnel are two outlets, of which one is always closed by a flap. The flap is controlled from the bottom of the elevator, in the pond, through a rod. By moving the flap, the crew in the pond can decide in to which tank to dispatch the fish.

The hydraulic system is driven by a 7 H. P. air-cooled engine, mounted on the axle. The engine drives an oil pump. From the pump the oil flows to the selector, which is mounted aproximately at the middle of the elevator rails. From there the oil flows to the hydraulic motor, mounted at the top of the elevator, which drives a steel-cable winch, which haules up or lowers the trolley. The control of the selector is at the bottom of the elevator, in the pond.

we have lately fitted quick-connection couplings to the hydraulic piping system, in case engine or pump break down, we can connect the hydraulic system of a tractor to the elevator.

Tanks

All the tanks are constructed on the same principle, although they differ in size.

They have a small housing on the front top, in the centre of which an air-blower is situated. On both of its sides a 5 HP air-cooled petrol engine is fitted. The air-blower is driven by one engine through a V-belt. In case that engine breaks down, the V-belt is moved to the other engine.

On the bottom of the tank are four perforated $\frac{1}{2}''$ pipes, held down by clips. They can be folded up in couples, on to each side, to empty the tank. The air is pumped through these pipes into the water.

Photo.17 Standard air supply to tank (1. air blower, 2. air cooled petrol engines, 3. V-belt)

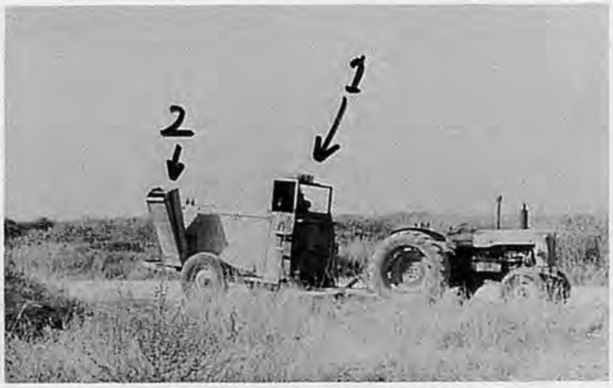

Photo.18 Trator-drawn tank (1. air blower and engine housing, 2. colapsible slide above outlet door)

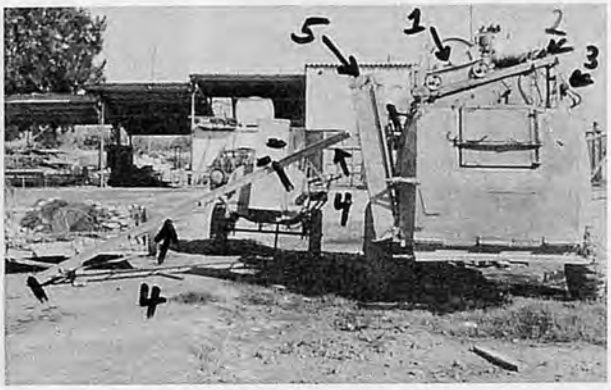

Photo.19 Tractor-drawn thinning tank (1. trolley, 2. hydraulic motor, 3. selector, 4. rail sections, 5. colapsible slide above outlet door)

Photo.20 Truck tanks below top of elevator

A door is situated at the rear bottom end of the tanks, mounted on trucks and at the rear side of the trailer tanks. The door has a rubber gasket, a couple of hinches on the top and is water tightened through a U-profile and two ex-centres from the outside of the tank. A 2″ pipe with a handle is situated on top of the tank, with a steel cable connected to the door. By turning the pipe, the door is opened against the water pressure.

The trucks go down a special slope in to each pond, to empty the fish. The tractor-trailer-tanks cannot go down that slope, as the load is too heavy. They, therefore, have a 5m long colapsible slide outside the sidedoor, so that they can spill the fish from the embankment.

There is one special trailer-tank for thinning a certain amount of fish from the pond. An elevator is constructed on the tank, the rails of which are in light sections and can be connected up to 12m from the tank. It has a light, drum-type, trolley which holds aproximately 120kg. It is driven through the hydraulic system of the tractor. The selector, to operate the trolley is fixed on the outside of the tank and operated from the pond through two nylon strings.

Aeration

The stationary units are driven by electric motors and usually supply air to two ponds. The air is driven through a 4″ steel pipe through the embankment, to each pond. From there the air is distributed through $1\frac{1}{2}$″ PVC pipes, the ends of which, are ankered to the ground, 1m below the water surface.

The mobile units are build on an axle with two wheels and can be towed by tractor or Jeep. They are driven by a 15HP air-cooled diesel engine. The air pumping units are reconditioned air blowers from 6 cylinder GMC diesel engines. Each air blower has four quick-connection outlets. A flexible (cloth type) fire fighting pipe (2″) can be connected to each outlet, the end of which is weighed down in the pond 1 m below the water surface. When not in use, the pipes are rolled up on a reel, above the unit.

Electric Boat

As I have mentioned before, all the ponds are connected to water channels, therefore covering a comparatively large area. Quite a large amount of fish grow in these water channels. Those, which escape as fingerlings (in small numbers) through the concrete locks from the ponds and others, which we do not breed (cat fish). We catch these fish, whenever we can spare two or three people of the crew.

We have taken a large, flat bottom, fibre-glass boat and mounted in it an electric generator, driven by an air-cooled 4 cylinder petrol engine. The generating set takes up about two thirds of the space in the boat. The generator output is 320V.

At least two people work in the boat. One pushes the boat with the help of a wooden pole and the other catches the fish as following : The negative pole of the generator output is hung in to the water, with the help of a

Photo.21 The electric boat on its trailer (1. fiberglass boat, 2. generator)

copper plate ; the wire, up to the plate, is well isolated. The positive pole is connected through a well isolated wooden handle to a round hand-net. The hand-net is put in to the water about two to three meters from the negative pole. The fish are drawn to the hand-net, like iron to a magnet, get a light electric shock and can be scooped up with the hand net.

If the going is good (and it usually is) 200kg of all sorts of fish can be scooped up within a couple of hours. We throw the small ones in to the ponds for further breeding and the large ones are marketed.

Hand Net

I have been talking about hand-nets without describing them. All the transfer of fish from the large catching nets to mobile sorting table or elevator is done by hand-net.

It has a 1.5m long round wooden handle on to which is fitted a round $\frac{1}{2}''$ 60cm diameter steel ring. A net is notted on to the steel ring which can hold from 10 to 12kg of fish.

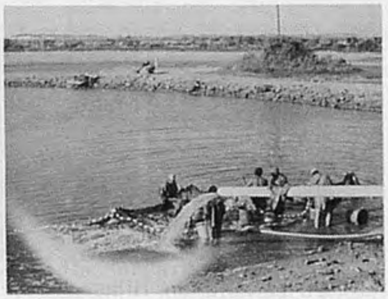

Photo.22 The closed net, before the elevator is put in to pond

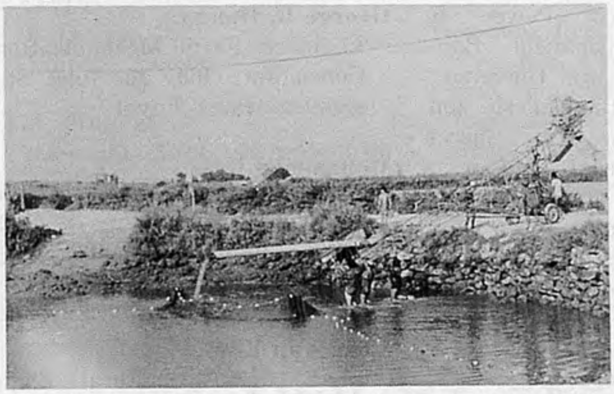

Photo.23 The net is closed. Lowering the elevator into the pond.

Photo.24 Closing the net in the storage pond

Conclusion

I am sure you will agree with me, that it is impossible to give full details of all the equipment in one article. If any of the readers are interested in any special equipment, I would only be too pleased to supply full technical details. ■■

Co-Operating Editors

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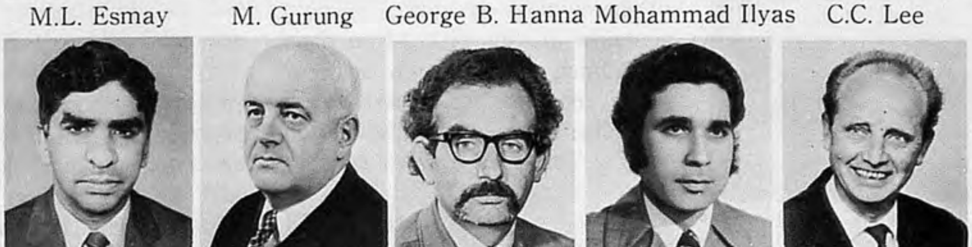

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G. Pellizzi

Tien-song Peng

Jun Sakai

B.K. Shrestha

Siswadi Soepardjo

R.P. Venturina

A.M. Michael
Professor, Water Technology Center, Indian Agr. Research Institute, New Delhi 110012, India

Adrian Moens
Head Professor, Dept. of Agr. Engineering, Agricultural University, Dr S.L. Mansholtlaan 12, Wageningen, Netherlands

T.B. Muckle
UNDP
P. O. Box 3021
Nairobi, Kenya

A.A. Mughal
Assistant Professor, Agricultural Engineering in the Faculty of Agricultural Engineering, Sind Agriculture College, Tandojam, Sind, Pakistan

T. Touggaard Pedersen
Professor, Agricultural Engineering at the Royal Veterinary—and Agricultural University, Copenhagen, Denmark.

Giuseppe Pellizzi
Professor, Universita Degli Studi, Facolta Di Agraria, Instituto Di Meccanica Agraria, Via G Celoria 2-20133 Milano Italy

Tien-song Peng
Specialist, Plant Industry Division Joint Commission on Rural Reconstruction 37, Nanhai Road, Taipei, Taiwan

Jun Sakai
Associate Professor, Department of Agricultural Machinery, Faculty of Agriculture, Mie University, Kamihama-cho, Tsu City, 514 Japan

Bala Krishna Shrestha
Assistant Agr. Engineer, 4/141, Pulchowk Behind the Fire Brigade Latipur, Nepal

Siswadhi Soepardjo
Chairman, Agricultural Engineering Dept., Bogor Agricultural University, Japan Gunung Gede, Bogor, Indonesia

Ricard P. Venturina
Assistant Scientist for Agricultural Research, National Science Development Board, P.O. Box 3596, Rizal, Manila, Philippines

New Co-Operating Editors

John Kilgour

Appointment :
Lecturer in Engineering Drawing and Design

Academic Qualifications :
1959 BSc (Agric) Reading
1961 MSc (Agric. Eng) Dunelm

Professional Qualifications :
1961 Student Member IMechE
1962 GIAgrE
1968 AIMechE
1969 MIAgrE

Career :
1961–63 Tractor Design Department, Ford Motor Co. Ltd.,
1963–65 Assistant Lecturer NCAE
1969–74 Senior Lecturer, NCAE
1975– Lecturer, Cranfield Institute of Technology

Teaching Duties :
Engineering Materials
Design Drawing
Mechanics of the tractor and implement
Engineering materials and proceses
Strength of materials and drawing
Engineering Drawing

Personal Research :
Rice Harvester design. Sponsored by Howard Rotavator Co. Ltd. The SNAIL System–a low cost primary cultivation system for developing countries. Sponsored by the Ministry of Overseas Development.
The Spider System, an improved mechanization system for developing countries.

External Appointments :
Member of Membership Panel IAgrE.
Representative on Engineers Registration Board Technical Engineering Board.
Member of Joint Qualifications Committee for ERB.
Assessor NDAgrE.

Consultancies :
Design of Anhydrous Ammonia Applicator Frame, for Calor (Agricultural) Ltd.,
Design of Goflow meter frame and drive, for Calor (Agricultural) Ltd.,
Design of Interlock System for bale handling sledge.
Design of meter for Anhydrous Ammonia Application. For Calor (Agricultural) Ltd.,
Design of drainage demonstration box for Drainage Service of Ministry of Agriculture, Fisheries & Food.

NEWS

Seminar on Mechanization of Individual Farms in Tropics (28th Feb.—12th March 1977)

by **A.H. Abdoun**
Deputy Director
Department of Agric Engineering
Ministry of Agriculture, Food & N.R.,
Khartoum, D.R. of Sudan

On arrival to Charles De Gaulle airport of Paris, it was rather hard for me to find my way due to language disabilities. But later, it became quite easier particularly on attending the conference meetings. Three major events had been reported during that time, namely

1. the Conference
2. a visit to CNEEMA and CEEMAT
3. seeing the Exhibition.

Conference

It has been taken as two separate events :

Seminar

held in the Olivier de Serres Building. It was dealing with four major topics, which were vivid and valid for all participants. These were

a) Mechanization and Agro-socio-economics
b) Maintenance and Logistics
c) Mechanization Environment
d) Training.

Technical day

held in the conference buildings of the Exhibition. In those meetings many specialized subjects were introduced and they were thoroughly discussed, regarding their importance and practical application in the concerned tropical countries. Topics such as : Mechanization of sugar cane, bannana and cotton, crop residues and seed treatment etc., with reference to the individual farmers had attained high attention by most of the participants.

The attendance for both events was great, and it was accordingly considered as very successful. It was fairly evident that representation of the french speaking countries was outstanding, which is quite obvious.

Initiation of vital points about the production problems and seeking solutions to them was given most care and big projection by scientists as well as manufarers of agricultural equipment. The theme on technology in the developing countries led to hot discussions in the seminar. It had been stated that to a certain extent intermediate technology has to be linked in accordance to the requirements and the understanding of the individual countries in due respect. On the hand it was clearly expressed that intermediate technology can rarely be specified to the Sudan as a whole, because land is available in ample and stretch. Labour could in the last years create some difficulties, as it is going towards scarcity in the peak times of production.

Another mode of action that shot good enthusiastic debate during the conference was the subject of transfer of technology. Some developing countries could support the opinion that it is a transfer of technique rather than technology, which is offered to them.

In conclusion the point was stressed on the fact that the conference had served its purpose quite satisfactorily, in addition to openning the door for more countries to actually contribute in most of the items of the conference. Emphasis was set on the necessity of developing local research abilities, establishing training and testing centres to confirm the suitability of machines to the local environmental conditions. Nonetheless, it was appreciated quite well to go into the effect of machine application on the socio-economical aspect of life for the individual farmer at large.

Visit to CEEMAT & CNEEMA

The CEEMAT

The 'Centre D' Etude et D' Experimentation Du Mechanisme Agricole Tropical is an intitution, which had been started in 1962 in the Ministry of Cooperation. It is located in the town of Antony, near Paris. Actually it is under the domain of CNEEMA, where it is taking the advantage of utilizing building and equipment as well as benefiting from the valuable technical assistance of the engineers of CNEEMA. The duties of the centre are identified as clearly in dealing with the problems of mechanization, promotion of research and study activities in tropical countries, mostly confined to french speaking land. The centre could act on the following principals as well :

1. Documantation, information and training
2. Economic and development activity
3. Research.

The CNEEMA

The Centre National D' Etude et D' Experimentation Du Mechanisme Agricole is directed by the Ministry of Agriculture. It is resonsible mainly for technical and documentation activities. Testing of tractors is carried out in the centre, and these are spe-

Fig.1 Mobile Laboratory-testing a tractor

cific tests done as demand necessitates. A new approach for testing was the construction of mobile laboratoried (Fig.1), which were expected to help the farmers by testing their tractors in the field.

The visit to both centres was extremely useful. Certain points were cleared, particularly on the work of Power. The relationship between the two centres is very soft and one feels that there is great colaboration.

Exhibition

The fair was impressive (Fig.2), especially for any one who had been away from it for not less than 15 years. A large number of agricultural machinery was shown in the big and capacious halls of the exhibition. Gigantic equipments were accomodated in the halls, which indicates the trend towards applying high-power machinery in agriculture, though some of them could be far away related to the normal agricultural operations.

New innovations and modifications for many of the machinery

Fig.2 General View of Exhibition

could be detected very easily in the CNEEMA technical halls. Claas sugar combine was a good example for a noticeable development in this line, Fig.3.

To comply with the mode of action in relation to the conference, one could observe that there were large numbers of small implements, which had been expected to be of great interest for the small farmers. Following the trend of the application of intermediate technology simple designs of the machines had been shown. An example for easy assembled prime-drivers was the invention of small tractor, which could be installed by vill-

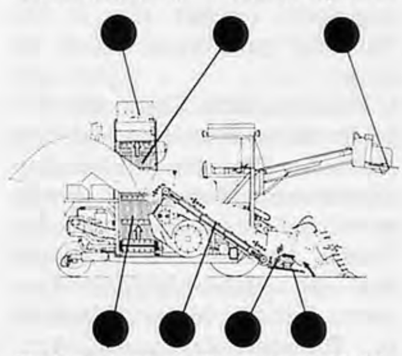

Fig.3 A sketch of Class Combine Model Libertadora 1400 (A : Topping mechanism, B : Cutting mechanism, C : Chopping cylinder, D : Conveyor, E : Part of conveyor exposed to blower, F : Conveyor-leading axial blower, G : Axial blower)

Fig.4 A Simple, Locally made Prime-Mover which is installed by village artisans

age artisan, Fig.4. The components of this tractor can locally be collected and assembled in a simple village workshop, but the engine and gearbox are to be imported assembled. Such a proto-type machine of a low cost might induce beneficial application in certain but not all african countries, where land utilization is invariably distinctive.

However, a more interesting aspect to promote agricultural production was the application of artificial irrigation systems, (Fig.5). The advantage of the drip irrigation as has been projected in the slide, is to create micro-climate to the surroundings of the plants and at the same time to use water in much less economical ways. This can only be used in many of the tropical countries once the capital investment, which is comparatively very high for normal peasant, could be secured.

In the end it could be stated that many interesting implements had been shown, though they were not of great use to most of the developing countries. This was clear in the departments for high and sophisticated items in the exhibition. Yet from our side we could benefit greatly from that as to live the time of global


Fig.5 Drip-Irrigation

achievements in such lines. ■■

1st Expo Africa'78

March 7-10, 1978, Lagos-Nigeria

Available Services Include :

1. Complete Booth

A standard 6′×8′ display stand with aluminium side and back rails, draped in colourful fabric. Table, cover and 2 chairs included.

2. Deluxe Room Accommodations

7 nights stay at one of the leading hotels Lagos specially reserved for participants at Expo Africa '78.

3. Special Interpreter/Assistant Service

Interpreters and Assistants will be available (on request at a minimal charge) during the entire 4-day Expo for any participant who requires assistance with presentations or negotiations. Note : Official language is English.

4. Full Page Advertisement in the Official Catalogue-Trade Index

One full page advertisement (black & white) in the Africa Trade Index and Official Catalogue.

A copy of the index is also included. Size 8″×10″-(Newsweek Format.)

5. Complete VIP List Printout Plus 50 VIP Passes

VIP Computer list of companies, government agencies, families and important buyers in this area of Africa plus 50 VIP Passes to the Expo will be available prior to the Exposition so that businessmen from Africa can be contacted and confirmed appointments set-up before your arrival.

6. Special Low Cost Flights

All exhibitors/participants will be able to make arrangements on special group flights from London and the U. S. A. to Lagos.

To Qualify :

Organizations desiring to introduce, sell and strengthen their company's product line in the following categories, Which include :

Food Products, Chemicals/Allied Products, Petroleum and Coal Related Products, Electrical-/Electronic Machinery, Equipment and Supplies, Wood and Timber Products, Furniture and Fixtures, Rubber/Plastic Products, Primary Metals, Machinery, Transport Equipment, Agricultural Equipment, Construction and All Energy Related Products, etc.

For further information please contact :

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110 St. Martin's Lane London WC2N 4HB, England.
Telephone : 01-836-8211
Telex : 27651 Inforpat London
USA & Canada Expo Headquarters :
Patents International Affiliates Ltd.
99 Park Avenue, NYC.
Telephone : (212) 755-3500
Telex : 424814 PIA UI ■■

55th DLG-Exhibition International Agricultural Show

28.4—4.5. 1978, Frankfurt/Main-West Germany

300 000 agricultural specialists, visitors from Europe and overseas can inform themselves about the latest developments in animal husbandry, agricultural production and about fertilizers, plant protection and seeds. What does the international agricultural equipment industry offer, the tractor industry, the building industry, which combination of equipment is recommended, and lastly what profit is to be expected? 1 200 exhibitors and organizations will give you these answers!

The DLG exhibition organization is known for its operational efficiency.

Complete services, hosting of international guests, interpreting and information service will assure you the right contact and orientation.

Make certain of your accommodation through the room service of the Fair and Exhibition organization (Messe-und Ausstellungs-GmbH), Post Box 970 126, D 6000 Frankfurt am Main.

Our DLG travel service will offer you the most interesting professional excursions. You will learn, see and enjoy a great deal, not to mention experiencing both historical and modern Frankfurt. ■■

The IX International Congress of Agricultural Engineering July 8-13 1979, East Lansing, Michigan-U.S.A.

July 8-13 1979, East Lansing, Michigan-U.S.A.

Sponsored CIGR (Commission Internationale de Ge'nie Rural)
An International Agricultural Engineering Organization with administrative headquarters in Paris.
An International CIGR Congress is held at five-year intervals.
First CIGR Congress to be held in U. S. A.
CIGR membership is drawn from 31 countries.

Program

Three concurrent technical sessions during each of five one half day sessions, plus mid-week IX International Congress sponsored teahnical tours to Michigan farms and agricultural industries.

Hosts

Michigan State University and American Society of Agricultural Engineers (ASAE).

Participation

Leading world authorities present technical papers related to :
Soil and Water Sciences
Agricultural Structures and Equipment
Agricultural Machinery
Electricity distribution in rural areas and its agricultural applications in the general context of energy
Scientific Organization of Agricultural Work

Related Educational Benefits

Annual ASAE Summer Meeting June 24-27, 1979, with CSAE, Winnipeg, Canada. Nearly 400 technical papers presented in three-day meeting.

Scehduled pre and post CIGR Congress Technical Tours of agriculture, agricultural institutions and related industries. ■■

Spring National Conference

Engineering for Food Production in Developing Countries—Are Small Tractors Appropriate?

21 March 1978, National College of Agricultural Engineering, Silsoe, Bedford., U. K.

Objective :

To discuss the economic and technical requirements of small tractors, to see how far these are met by present designs and to propose a policy for their future development.

SESSION 1 Economic and Design Theory of Small Tractors

Chairman, Professor B. A. May, Head, National College of Agricultural Engineering, Silsoe, Bedford.

SESSION 2 Existing Designs

Chairman, C. Uzureau, Acting Director of Centre D'Etudes et D'Experimentation du Machinisme Agricole Tropical (CEEMAT).

SESSION 3 Disussion Forum on How the Present Problems may be Overcome

Chairman, Dr. von Hülst, Chief of Agricultural Engineering Services, Food and Agriculture Organization, Rome.

Convener :

John Kilgour,
National College of Agricultural Engineering.

Registration forms and further details can be obtained from :

Mrs. Edwina J. Holden,
Conference Secretary,
The Institution of Agricultural Engineers,
West End Road,
Silsoe, Bedford. MK45 4DU.
Telephone : silsoe (0525) 61096. ■■

NEW PRODUCTS

Tractor

Kubota L12201-G…(1) It assures the highly efficient work in muddy paddy fields and safety because of 9-24 high rag crop tyres. (2) The road clearance is 350 mm, which makes any work smooth with rag crop tyres. (3) A silent engine of little vibration (22hp 3 cylinder diesel engine). So, it especially suits heavy works such as muddy paddy operation. (4) A steel rotary cover pressed with springs levels ground very evenly. (5) 16 forward and 4 backward gears. Also special low speed (creep speed) is possible. These features means multiple uses of this tractor. You can adjust speed to the any operation. (6) You only need to step into a pedal slightly because a wet disk brake of high performance is adopted. The maintenace is easy. (7) You can maintain the working position in which you begin works. In addition, a slight change of the position is possible because of the automatic position control system, which makes working efficiency higher than ever.

(Specifications)

Dimentions : L 2,510 × W 195 × H 1,325 (up to the handle), Weight : 770kg (body only), W. B. : 1,552mm, Road clearance : 350-mm, Engine : vertical water cooled 4 cycle diesel 3 cylinder 1,115 cc 22ps/2,800rpm cell starter, Clutch : diaphragm, Speed change gear : forward-16 backward-4, Brake : wet disk brake, wheel : front 4.00-15 rear 5/9-24 high rag tyre, Hydraulic system : position control three point linkage=JIS (1), Rotary cutting width : side drive-1,410mm full cut-1500

(Kubota Ltd. : 22-2, Funadecho Naniwaku, Osaka Japan)

Tractor

Satoh Beaver … Meet the rugged and lively Beaver by Satoh. Its 15 hp Diesel engine lets you handle heavy chores as well as light. You get full farm features : PTO, live hydraulics, six forward and two reverse speds, Category 0.3-point hitch, sealed brakes ; warning lamps for oil pressure, charge indication and temperature ; full lighting, choice of tire tread, horizontal muffler plus a host of other features. And you can also add many custom-designed implements and attachments.

〔Specifications〕

Dimensions : 1,875 × 690 × 1,105mm (L×W×H), Weight : 470kg, Ground clearance : 245-mm, Engine type : 2-cylinder. water-cooled 4-cycle diesel, Engine Out put : 15hp/2,700rpm, Speed : Forward 6/reverse 2.

(Satoh Agricultural Machine Mfg. Co., Ltd. : Hibiya Kokusai Bldg., 2-3, 2-chome, Uchisaiwai-cho, Chiyoda-ku,

Disc Harrow

Sasaki Off-set Series of Disc Harrows … These harrows is made up of three widths of disc harrow, "SD-1614" being 1.4m wide, "SD-1616" being 1.57m wide and the SD-1816 being 1.6m wide.

* The soil can be moved when using the disc harrow as it inclines to forward or backward. With this action, the uneven surface is flattend.
* Since the disc blades are made high quality stuff, they are tough enough to break stubborn soil, also chop stalks successfully and clean.
* The gang angle can be adjustable simply by tightening bolts.

(Sasaki Noki Co., Ltd. : 259-1, satonosawa, Towada, Aomori, Japan)

Toolbar Carrier

John Deere 569…John Deere has introduced a versatile new toolbar carrier which can be used with 5,08 or 6,35 cm toolbars and mounted on any tractor equipped with Category 1, 2, or 3 3-point hitch. Toolbar-based cultivators, planters, rod weeders, or combination tools can be assembled by using the new John Deere 569 Toolbar Carrier and selections from a wide variety of optional toolbar equipment.

The 569 has a 3-position hitch bracket that provides accurate positioning for both planters and tillage standards. Hitch components transfer loads to the toolbar for optimum strength and durability. A special mast is available to adapt the 569 Toolbar Carrier for use with hi-crop tractors.

(Deere & Company : John Deere Road, Moline, Illinois 61265, U. S. A)

Sprayer

Hustler RLS···The Hustler Rice Levee Sprayer is the Field/Proven method for effiectively controlling weeds on rice levees.

The RLS puts the chemical only where it's needed-eliminating wasted chemicals and dollars-and you control the volume and strength required for your particular weed problem.

The unique adjustable wheel width feature and optional 20-ft. boom svstem gives the RLS the capability of additional spraying jobs, such as spot-spraying in row crops.

The four-wheel-drive RLS is a real one-man operation that does the work of several men in just a fraction of the time. And the RLS is economical to operate. That means fuel cost savings.

Plenty of ground clearance and ease of operation, whether your field is under flood or dry. Spray more acres per day and be assured of weed elimination.

〔Specifications〕
Engine : 16hp. 4-cycle air-cooled, Dry Weight : 1700 lbs, Overall Width : Maximum 106", Ground Clearance : 36" frame clearance, Application Speed : Approximately 4 m. p. h. Maximum Speed : 10 m. p. h.

(Hustler Corporation : P. O. Box 1283 Jonesboro, Arkansas 72401, U. S. A.)

Irrigation sprinkler

Self-propelled "Traveler" sprinkler···Ferrex International, Inc., Export Managers for Cloud -Burst Manufacturing Company, Inc., announce the launching of a giant new self-propelled "Traveler" irrigation sprinkler, designed to provide adjustable water coverage with a minimum of human labor and supervision.

Mounted on a solid steet, equipped with four pneumatic tires, the "Traveler" features a large, part-circle sprinkler gun with a rain capacity (depending on nozzle selected) of up to 2,000 liters per minute (535 GPM) that can be applied within an easily adjustable arc from 35 to 340 degrees.

The cart is self-propelled along a straight line, by winching in its guiding steel cable towards an anchor point at end of the field. Its sprinkling run of 400 meters (1,320 feet) covers a width of about 100m (330 feet), i. e. an area of 40,000 square meters of automatic field coverage per run.

(Ferrex International, Inc. : 253 Broadway, New York, N. Y. 10007, U. S. A)

Combine Harvester

Kubota NX3000...(1) Automatic speed control system which regulates working speed automatically. (2) Speed is controled by hydraulic drive system of no gear variable-speed control.

(3) Cutting heigh is controled with a lever, without gear. You can set the reaping device quickly to the exact place you want. (4) Threshing device is double cylinder system. (5) Grading device is three gear shaking method which does not cause no clugging. So, you can make neat unhusked rice without loss. (6) A leak of unhusked rice is automaticaly changeable. When the two bags outside the deck get full, rice is poured into the third bag and the safety lamp notifys the driver at the same time. (7) A dropper cutter as a straw disposer is built into the body. You can cut straw into short or long as you like with a lever.

〔Specifications〕
Dimentions : L 4,220 x W 1,650 H 1,950mm, Weight : 1,950kg, Working Efficiency : 0.25–0.45h/10 a, Reaping device : tine chain · cutting width–1,400mm · attachment elevator-hydraulic position control, Reaping range : crop length=55–120cm · crop angle= up to 85°, Threshing : threshing cylinder (420mm diameter · 880-mm width) grading-grain sieve · chaff sieve · chaff blowing grading, Engine : vertical water cooled 3 cylinder diesel · 1299cc · maximum 28ps/2,800rpm (cell starter), Gear : no gear change, Dropper cutter : round cutter · cutting · bundling · straightening works (Kubota, Ltd.: 22-2, Funade-cho, Naniwa-ku, Osaka, Japan)

Combine Harvester

Yanmar TC440 ... (1) You can observe and control every

work from reaping to ejecting straw after cutting, while you are driving in the seat. (2) Straw is cut into small pieces with cylinder cutter and then ejected backward. (3) you can easily start a work any where and reap entirely in the field. (4) A double wheel wide crawler is adopted. The surface of contact with ground is large and straw never gets entangled. This combine especially suits the heavy work in the muddy paddy field. (5) Efficient work of threshing and grading. It manages to thresh every rice even in a bad condition with a shaking absorbing device. (6) All levers are concentrated on a driver's seat and with only one lever, you can exchange bags for unhusked rice or do other works. (7) with 8.2hp electronical engine attached balancer of little vibration and noise, you can easily start to move it with an easy starter.

〔Specifications〕

Dimentions : L 2,390 x W 1,625 x H 1,450mm, Weight : 425kg (including cutter), Engine output : 8.2ps/2.000rpm, Reaping row : 2 rows, Cutting width : 600mm, Crawler width : 200mm (special one for muddy paddy field–250mm), Gear : 3 forward & 1 backward, Threshing cylinder : 365mm (diameter) x 313 (width), Grading method : air shaking absorption, Straw handling : cylinder cutter • disk cutter, Field efficiency : 4 -6 a/h,

(Yanmar Agricultural Equipmment Co., Ltd. : 62, Chayamachi, Kita-ku, Osaka, Japan)

Forage Wagon

John Deere 716. ... The wagon ($19.2m^3$) provide the capacity to increase efficiency with bigger but fewer loads.

Unloading, either into feed bunks or a blower by means of conventional front unloading or into pit silos through an optional rear unloading system, is controlled with a variable-speed belt drive. The operator can control floor conveyor sped infinitely from 0,75 to 3,32 meters per minute, to dump in a hurry or to match unloading speed to the intake capacity of a forage blower receiving the material.

All-steel sides and undercarriage, John Deere wagon gear with floating bolsters, and heavy-duty pintle chain (the strongest such chain used on any forage wagon) provide an unusual degree of in-the-field dependability for long hours of hard work.

Spiral beaters, for even feeding, reduce the probability of large clumps of material falling into the cross-conveyor. A belt clutch assures positive transfer of power to the drive system.

A safety trip bar, which disengages all moving parts immediately when pressure is applied to it, protects the operator while unloading into a forage blower.

(Deere & Company : John Deere Road, Moline, Illinois 61265, USA)

Moisture Meter

The Motomco Model 919 ... Designed specifically to meet the requirements of the grain trade. Moisture Meter is used for inspection of grain, rice and beans under the official standards of the U. S. A.

The electronic measuring circuits are the ultimate in simplicity and are so designed that battery or line voltage, aging of components and variable climatic conditions do not affect their accuracy.

Wet or dry, warm or cold, even newly blended–at country elevator or reseach lab you can be sure with the 919 meter.

(Grain Equipment Corporation : 14 Lawton Street, New Rochelle, New York, U. S. A.) ■■

Farm Machinery Directory
—Orange Book—

The publication comprises of following different sections with a brief write-up covering—(i) Importance of the epuipment to agricultural development, (ii) growth of the industry, (iii) statistical data and (iv) information on research/development, quality control, training, export performance etc. An alphabetical list of manufacturers and product listing are also given.

—Agricultural Tractors
—Power Tillers
—Earthmoving and Construction equipment
—Irrigation Pumps
—Plant Protection Equipment
—Dairy & Poultry Equipment
—Engines
—Animal Operated Implements
—Power Operated Implements
—Handtools and Implements
—Processing Equipment
—Hydrology & Sedimentation Instruments
—Standardization & Ouality Control
—Consultancy Services

The Driectory consists of about 226 pages. The printing has been done on the best available text paper and the cover is of hard-bound with P. V. C. cloth.

Publishers : Indian Society of Agricultural Engineers, National Agro House, 2, Tansen Marg, (Bangali Market) New Delhi-110001, India

Price : Rs. 40.00, US $10 (Postage & packing extra)

Agricultural Education in Europe

The first section of this book is the collected reports on the 11 European countries visited. A certain variability in approach and emphasis will be evident in these reports arising out of the group authorship which went into their writing and editing. It was felt that to remove this variability would have been to lose an essential ingredient of their usefulness.

The second section of this book is the proceedings of that Symposium ; it contains a keynote lecture by J P Hudson, an account of the conclusions reached by the three working groups during discussions on pre-arranged topics and an afterword from Sir Emrys Jones. The Appendices to these proceedings give the organizational details of the symposium.

Size : 21.0×29.5cm Page : 135 pages

Edited by The British Council, 10 Spring Gardens, London SWIA2BN.

Distributed through Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Slough SL23BN

Culture of Sugarcane for Sugar Production in the Mississippi Delta

Agriculture Handbook No.418

This handbook summarizes information on sugarcane production in the United States based on extensive research findings and grower experience. It is intended to give essential information for growers, producers, processors, extension personnel, and others interested in the production of this crop.

The main contents of This publication is as follows :

- Growing conditions
- Soil lypes
- Description of the sugarcane plant
- Cultural practices
- Varieties
- Variety improvement
- Weed control
- Sugarcane diseases
- Insects
- Harvesting
- Manufacture of sugar
- Literature cited

Size : 15×23cm Page : 42pages

Published by Agricultural Research Service, U. S. Department of Agriculture, Hyattsville, Maryland 20782, U. S. A.

Applying Pesticides

Management · Application · Safety

Written in simple language, easy to understand and well-illustrated in full color. Elementary enough for the secondary school student and complete enough for the private pesticide applicator. It is adaptable to both secondary level and college level of instruction.

Although this series will prepare a person for meeting the requirements of the private applicator, it is intended to do more than that. The objectives of the package are threefold : to provide for the training of an effective, an efficient and a safe applicator.

Included in the package are the following types of media :

—Manual,
—Audiovisual,
—Teacher Guide
—Student Workbook.

The **manual** is a 96-page, $8\frac{1}{2}'' \times 11''$ book. It contains 193 4-color illustrations. Wherever applicable, the SI (metric) system is used along with the U. S. customary system.

The **audiovisual** consists of 337 35mm slides paralleling the manual. The slides and narrative are divided into six sections. There are six cassette tapes.

The **Teacher Guide** is a 40-page series of questions and answers, problems and laboratory exercises based on the information in the manual. In addition, there are 18 transparency masters composed of 67 illustrations with matching exercises for identification.

The **Student Workbook** is similar to the Teacher Guide, except no answers are given.

Price is as flows (except postage & handling fee) : Applying Pesticides-$4.95, Audiovisuals-$195.00, Teacher Guides-$2.00 and Student Workbooks $2.00.

Published by American Association for Vocational Instructional Materials (AAVIM), Engineering Center Athens, Georgia 30602, USA.

Hand Pump Maintenance

(An Oxfam Document)

Many governments, with the assistance of official agencies and voluntary organizations, have tackled the water supply problems of rural communities by drilling tubewells and boreholes. Unfortunately, a vast number of these tubewells are useless in practice because thousands of the hand pumps have broken down. Why should this be so? This manual suggests that one of the major reasons for the breakdown is that the community or the village have not been adequately involved in the project in the first place, and have not accepted the social responsibility for the task of maintaining the pump.

This volume puts forward various strategies which, if followed, might overcome the social problems. It also examines and evaluates different types of pump, and puts forward a schedule of recommended work that should be undertaken by the community or the villager responsible for the pump.

The book is a valuable contribution which should be read by all involved in development work, and particularly by those concerned with rural water supplies.

Compiled by Arnold Pacey.

14.8×20.8cm 38page. Price : £1.25net, £1.44 surface and U. K. postpaid £1.69 airmail

If you wish to receive a review copy of the above title, please contact Jane Landymore, Intermediate Technology Publications ltd., 9 King Street, London, WC2E 8HN, Telephone 01-836 9434.

Annual Report of the Farming Systems Research Program

(June 1976–May 1977)

This is an informal report written to provide interested colleagues in a more detailed account than that which will be given in the ICRISAT annual report.

In this informal report many preliminary observations are recorded which need to be further tested before the information would be released for general distribution.

The main contents of this report are as followings.

- Research in Sub-Program
  - Agroclimatology
  - Hydrology
  - Soil Physics
  - Soil Fertility and Chemistry
  - Farm Power and Equipment
  - Land and Water Management
  - Agronomy and Weed Science
  - Cropping Systems
- Watershed-Based Resource Utilization Research
  - Watershed Operations and Development
  - Water Balance Studies
  - Crop Production and Economic Data
  - Implications and Future Plans
- Cooperative Research

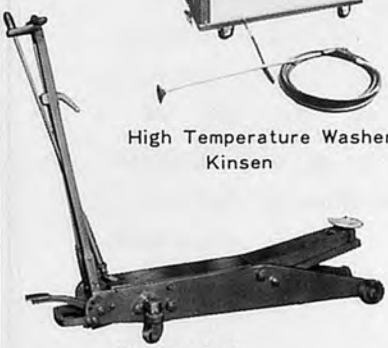
Published by International Crops Research Institute for the Semi-Arid Tropics, 1-11-256, Begumpet, Hyderabad-500 016 (A.P.) India. ■■

BACK NUMBERS

(Vol. 8 No. 1~4, 1977)

HASEBE is widely known as a manufacturing and a distributing company of cars, farm machinery, fixing tools and testing machines in the automotive and agricultural industry of Japan. Please give us information to establish a distributing network in your country and also inform us necessary machine tools, testing machine, whatever you need.

High Temperature Washer
Kinsen



Garage Jack

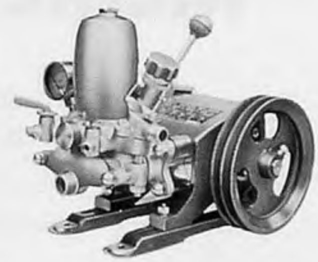
Silicon Quick Charger
Dengen High Rate

HASEBE CO., LTD.

HEAD OFFICE: 1-4-1 ATAGO MINATO-KU. TOKYO JAPAN

TOKAI, ALL-ROUND MAKER OF PREVENTIVE AND EXTERMINATING MACHINES

Di aphram
Man-Power Sprayer
Model HD-I



Power Sprayer
Model AP-25

We are a manufactuer with 30 years' rich experience and new technique, for all types of sprayer from small one to large.

Products:

Man-Power Sprayer	Model 10	Power SSprayer	Model 11
Speed Sprayer	Model 17	Mist Brower	Model 4
Pump	Model 9	Grass Mower	Model 5

TOKAI INDUSTRIAL CO., LTD.

Head Office and Factory: Midorien, Ogaki City, Gifu Prefecture
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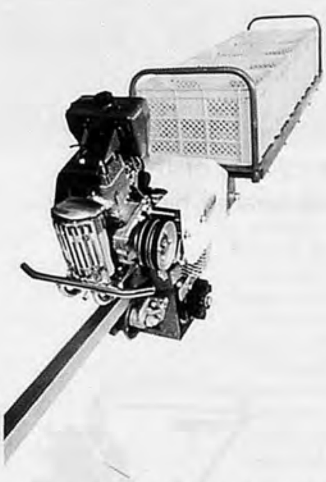
The Most Safety, Economical & Durable



▪ SEIKO-MONORAIL MR-7

We get highest appraisal in the world as a pioneer of MONORAIL. Not to mention, we get a large share in the market. Recently MONORAIL has been developed to use on a slope for a tractor. It gained high popularity and is using in every part of agriculture. Applying the technique, we have also developed Vegetable Harvesting Carrior. It is booming among Japanese vegetable farmers as not only a harvesting but also selecting and packing machine.

▪ SEIKO VEGETABLE HARVESTING CARRIOR, MIDORI

KYODO SEIKO CO., LTD.

2059, Miyoshi, Okayama City, Okayama Pref., 700 TEL 0862-77-9505

NewsLetter

INTERNATIONAL FARM MECHANIZATION RESEARCH SERVICE
c/o SHINNORIN-SHA 2−7 KANDA NISHIKI-CHO CHIYODA-KU,
TOKYO, JAPAN., TEL. 03−291−5718, 3674

Dear friends

International Farm Mechanization Research Service was established in 1968 with the pourpose of promoting efective communications and researches on agricultural mechanization especially in developing countries.

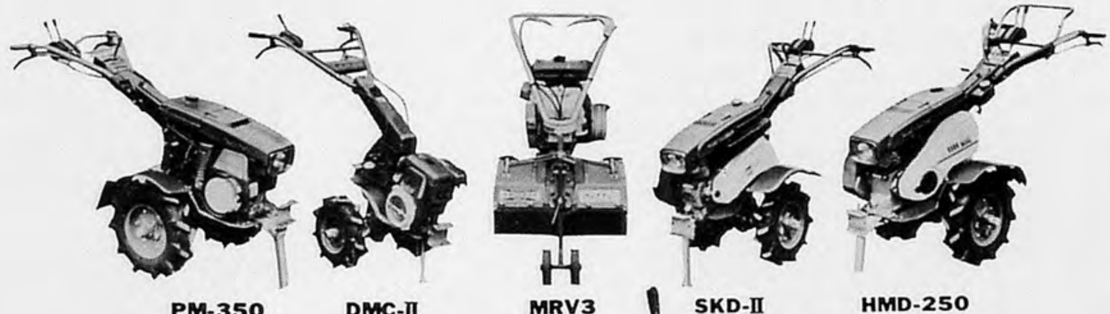
We will gladly welcome everybody to join us who want to promote free and vital communications on agricultural mechanization over many barriers like sectionalism.

Our body is really independent one supported by every member's free and active mind to make better world.

Whenever you need more informations, pleas write me!

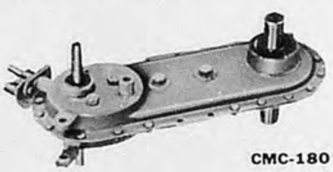
Yours Sincerely
Yoshikuni Kishida
Head of Directors

CULTURE ALL OVER THE WORLD

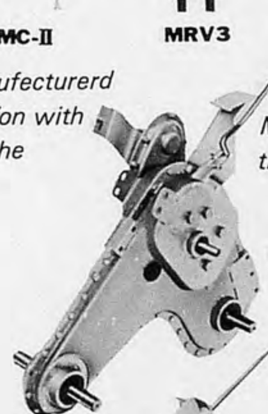


PM-350 DMC-II MRV3 SKD-II HMD-250

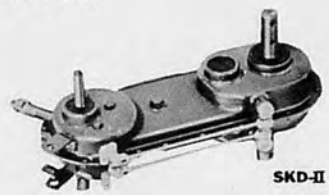
We are provided other Japanese manufacturerd with the transmission only.
We believe you can find the satisfaction with MAMETORA AGRICULTURAL MACHINERY.
We have not only the tiller but also the transmission under oder.



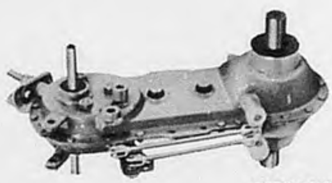
CMC-180



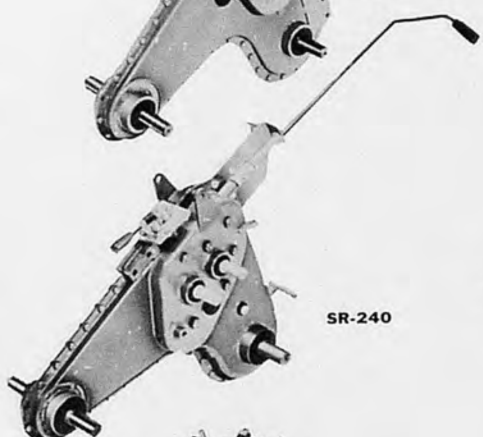
MRV3



SKD-II

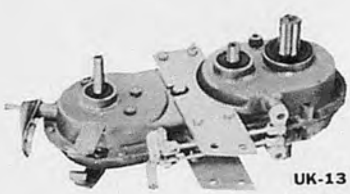


DMC-180

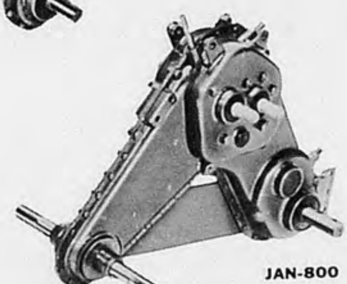


SR-240

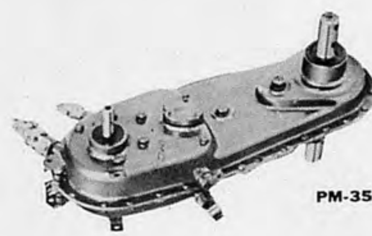
HMD-250



UK-13



JAN-800



PM-350

Model		MC-80	MCF-130K	CMC-180	DMC-180	DMC-II	SKD-18	SKD-II	SKD-III	HMD-250	PM-350	UK-13	MH-750	MT-40
Applications (PS)		1·8~2·5	2·0~3·5	3·0~4·5	3·0~4·5	3·0~4·5	3·0~4·5	4·5~6·0	4·5~6·0	5·0~7·0	6·0~8·0	3·0~4·5	3·0~4·5	3·0~4·5
Shifiting Stages		F1	F1, R1	F2, R1	F2, R1	F3, R1	F2, R1	F2, R1	F3, R1	F4, R2	F6, R2	F2, R1	F1, R2	F1, R2
Sidecluch		—	—	—	—	○	○	○	○	○	○	○	○	○ with Lock
Gear Ratios		F_1=1:21·71	F_1=1:18·16	F_1=1:25·41	F_1=1:25·41	F_1=1:41·31	F_1=1:21·21	F_1=1:31·06	F_1=1:66·07	F_1=1:70·03	F_1=1:53·97	F_1=1:32·13	F_1=1:25·54	F_1=1:37·62
			R_1=1:27·24	F_2=1:15·38	F_2=1:15·38	F_2=1:19·40	F_2=1:10·28	F_2=1:11·34	F_2=1:18·96	F_2=1:38·73	F_2=1:37·41	F_2=1:16·92	R_2=1:29·37	R_1=1:32·83
				R_1=1:35·58	R_1=1:35·58	F_3=1: 9·35	R_1=1:21·33	F_1=1:44·52	F_3=1:11·43	F_3=1:15·81	F_3=1:18·50	R_1=1:32·77	R_1=1:20·22	R_2=1:10·69
						R_1=1:49·91			R_1=1:81·09	F_4=1: 8·74	F_4=1:19·42			
										R_1 1:105·04	F_5=1:13·47			
										R_2 1:23·71	F_6=1: 6·66			
										:	R_1=1:66·67			
											R_2=1:24·0			
Dimensions	A	170	170	170	170	202	192	192	224	234	243·5	192	192	192
	B	434	434	434	435·5	532	492	492	545	578·5	603 3	467	467	467
	C	289·5	289·5	289·5	289·5	344·7	336·75	336·75	336·75	319·7	402·5	409·9	287	287
	D	15	15	15	15	16	16	17	19	19	19	16	16	16
	E	31	31	31	31	31	31	31	31	34·5	34·5	31	31	31