

Abstracts of Main Papers

Trouble Detector at Tomato Counter

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40 (1), pp. 91~98 (1978)

When tomato flow is disturbed at a tomato packing center, it causes damages on tomatoes and machine troubles. Also, it makes troubles on the management at the center when tomato counter does not work normally.

Therefore, in order to dissolve these troubles, a trouble detector at tomato counter, using integrated circuit (IC) or micro-computer, was designed and examined.

As the sensor, two micro-switches A, B with distance H were installed as shown at Fig. 1, and four pulses (A, B, frequency divided pulse C and delay pulse D) were selected to detect the abnormal pulse combination (Fig. 4).

Truth table of the four pulses is shown at Table 2, and normal logical equation was shown as $N = \bar{B}\bar{C} (\bar{A} + AD) + \bar{A}CD$

Logical equation of tomato flow stagnation was simplified as $Z = C\bar{D}$.

Judging of any trouble in detail is possible, but it is reasonable from the point of cost performance to display the information of the three states that are normal (N), tomato flow abnormal (Z) and other abnormal (S).

Logical circuit of tomato flow abnormal signal Z using IC was designed as shown in Fig. 5, and was examined to be successful.

Next, the trouble detector using microcomputer (SDK-80) was tested. Program lists for stagnation detector and for switch trouble detector are shown in Table 3 and 4.

The memory of these programs for about one hundred detecting cases will need approximately 1100 bytes.

The cost performance of this detector is better than a detector using IC since as the scale of plant becomes larger.

Farm Machinery Utilization Planning

Toshio KONAKA · Shotaro YUZAWA and Iwao KUROISHI

Report of Special Research Project on Tropical Agricultural Resources 3, pp. 41~52 (1984)

In order to plan and design a farm mechanization system, a farm machinery data base, farm operation data base and farm machinery utilization planning program were set up on a personal computer NEC-PC9800. Maximum areas covered by a farm machinery set or optimal machinery set for a given area were analyzed by simulation using this program. Cost

analysis of farm machinery utilization planning is shown in tables so that we may compare and select the optimal machinery sets and laborers for a certain cultivation system. Energetic analysis was also performed.

On the Thermal Conductivity of Rice Husk

Yoshiyasu AIHARA

Research on Effective Use of Energy in Agriculture

SPEY 11, pp. 209~211 (1983)

The primary objective of this study was to determine the thermal conductivity (λ : W/mK) of rice husk to test proposals for using them as the thermal insulator in agricultural buildings. Findings of the study were:

- 1) Rice husk piled on a flat plate or filled in a space by hand had a fairly constant value of bulk density which did not affect the thermal conductivity of rice husk, assuming the rice husk to be dried naturally, and their temperature to be constant.
- 2) There was no significant difference in thermal conductivity of rice husk due to the variety, or lapse of time since producing.
- 3) The thermal conductivity of rice husk was a linear function of the logarithmic moisture content (W: % d. b) expressed by the equation $\lambda = 0.322 \times 10^2 + 0.0251 \ln W$ for a bulk density range of 98 to 145 kg/m³ and a temperature range of 293 to 313 K.
- 4) The thermal conductivity of rice husk was a linear function of temperature (T: K) expressed by the equation $\lambda = -7.19 \times 10^2 + 4.37 \times 10^4 T$ for a moisture content range of 8.5 to 9.2% d. b. and a bulk density range of 98-110 kg/m³.
- 5) From the results above, rice husk may be cheaply used as the thermal insulating material in farm buildings.

Studies on the Thermal Radiation Environment within Livestock Barns (VII)

—Experimental Evaluation of Factorial Effects for Thermal Radiant Environment in Gable Roofed Open-type Livestock Barns—

Masayoshi MINOWA · Tomoharu YAMAGUCHI · Yoshiyasu AIHARA

The Journal of The Society of Agricultural Structures, Japan, **15** (2) pp. 1~16 (1985)

In order to verify the results of a numerical analysis of the effects of different dimensional factors on radiant heat coming downward on to an infinitesimal horizontal surface in a gable roofed open-type barn, the authors compared the calculated radiant heat rate with the measured one in existent barns. The radiant heat rate on the surface of swine was also measured to evaluate the results of the analysis concerning the radiant heat load of a real swine. Some conclusions are as follows:

- 1) Though the calculated values of the radiant heat rate were larger than the measured ones, the calculating procedure seemed to be adequate for practical use in the design of thermal radiant environment in barns.
- 2) It was suggested that the equations obtained from the results of the analysis could be applied practically to the design of the radiant environment in barns to easily predict the radiant heat rate.
- 3) From the measurement of the radiant heat rate on the surface of a swine, the factorial effect based on the radiant heat rate on an infinitesimal horizontal surface tended to estimate the effect based on the radiant heat load of a real swine higher.

Work Studies of Rotary Milking Parlour

Denzo SAHARA

The Journal of The Society of Agricultural Structures, Japan, **9** (1), pp. 19~26 (1978)

Time and travel studies on milking routine were conducted in two farms (A and B) with 12-stall herringbone rotary milking parlour and a farm (C) with 8-stall tandem one. Heart rate and energy expenditure of milking operators were measured in another farm (D) with 12-stall herringbone type. Results were summarized as follows.

1. The time for milking routine 103.6, 140.6 and 195.6 sec./cow in A, B and C, respectively. The time for washing udder ranged 38.4~75.5 sec./cow, and that for replacing and removing that cup was 41.0~64.4.
2. The distance for milking routine was 27.0, 17.6 and 31.0 m/cow in A, B and C, respectively.
3. The number of cows milked per man-hour was 34.7, 25.6 and 18.4 in A, B and C, respectively.
4. The values of relative metabolic rate (R. M. R.) measured in D were 2.42 for washing udder and 2.36 for putting cups on.
5. It is suggested that the low efficiencies observed in this study were mainly ascribed to the inefficiencies of washing udder and putting cup on and off.

Research and Development on the Automatic Sacking Device for Combine Harvester (Part 4) —Details of Unit of Automatic Sacking Device—

Masato SUZUKI · Haruo EZAKI · Sasakazu IMAZONO · Takao SUGIYAMA · Masao MANAKA

JSAM, **42** (2), pp. 243~249 (1980)

The functions and the mechanism employed for the automatic sacking device were discussed in detail. Basically, the sacking mechanism consists of the following functions; hanging, dividing and releasing of the bag, weighing of the grain sacked and grain tank to store

the grain during the replacement of the bag.

In designing the device, many possible functions were adapted to each mechanism so as to make it compact and simple. In case of bag divider, which is one of the important mechanisms, functions of hanging, dividing and releasing of the bag were combined using a pair of auger. These mechanisms are engaged for three operations during one revolution of the screw auger. The level of the grain in the tank was measured by level switch and then the grain was discharged through a rotation of shutter. The capacity of grain sacked was determined by counting the number of rotation of the shutter. Thus, the functions of weighing, storing and discharging were included in the grain tank and then the chute, to guide the grain discharged from the tank to the bag and to open the grain bag, was also attached to the grain tank.

Studies on the Dividing Properties of Rice Seedling Mat

Haruo EZAKI · Masami UENO · Shotaro YUZAWA · Akira YODA · Michikazu ICHIKAWA

JSAM, **42** (2), pp. 221~226 (1981)

In the present National Test for Agricultural Machinery, only one estimation to the mechanical strength of rice seedling mats for Japanese-type rice transplanter is done by the measurement of dividing resistance to five or six rice seedlings. We reviewed that this test was the most suitable method to represent the dividing properties of rice seedling mats.

- 1) At first, the dividing test based on the method by pulling five or six seedlings apart from their own mat was done (cf. Fig. 1). The experimental results showed that through the test of thirty times the measurements was not able to provide an accurate dividing resistance of a mat, because the confidence interval was so large for the confidence coefficient 95% (cf. Table 3)
- 2) After the dividing test by use of many methods and devices were examined one method was chosen for this study, which a mat can be divided into two parts in the parallel plane to short edges of a mat by the use of an experimental instrument shown in Fig. 4. In spite of a few measurements for the mat, the confidence interval for the dividing resistance with confidence coefficient 95% became smaller than that of above-mentioned test (cf. Table 3 and 5). It can be found that this test is able to estimate more accurately the dividing resistance. The improvement of dividing test method presented in Fig. 4 would be recommended.
- 3) The four characteristic values to represent the dividing curves (load-displacement relationship: cf. Fig. 5), namely the dividing resistance, the dividing secant modulus the initial secant modulus and the half-value width, are available to estimate the dividing properties of rice seedling mats.
- 4) The kinds of bed soil, the days for raising of seedling and the planting rate were regarded as parameters of factor on the dividing properties. Moreover, the weight of roots and the water content of mat seemed to be complex factors. The following trends can be observed

generally to these factors. The heavier the weight of roots is, the larger the dividing resistance occurs. Mats became softened with the increase of their water content. The kinds of bed soil also affect the dividing properties, so the kinds of bed soil should be considered to make strong mats.

Factor Analysis on the Relationship of Bearing Pressure and Sinkage Behaviours Using Model Track of Combine

Haruo EZAKI · Atsushi SAWAMURA · Masami UENO · Shotaro YUZAWA
JSAM, **43** (4), pp. 533~540 (1982)

To clarify the relation between the sinkage of combine harvester and soil moisture content, shape and pressure of ground contact surface, test was conducted using 1/5 scale models of track of combine harvester.

The outline of experimental results are as follows.

- 1) Nine models shown in Fig. 2 were used. Factors which influenced upon the sinkage are the width and contact area of track and soil moisture content when the ground contact pressure is under 0.2 kgf/cm^2 (19.6 kPa). The influence of tread length is not significant in this test.
- 2) When the ground contact pressure is lower than 0.2 kgf/cm^2 (19.6 kPa), the sinkage of smaller track is less than that of larger one under the same ground contact pressure. This means that the sinkage of the track depend on the weight of combine. When the tracks have the same contact area, the sinkage of the track having narrower width is less than that of wider one. This means that shorter track is easier to sink than longer one.
- 3) Soil moisture content is the main factor which affects to the sinkage of track. Even if the ground contact pressure is lower than 0.2 kgf/cm^2 (19.6 kPa), the sinkage of track increases rapidly as the soil moisture content increases. The sinkage is remarkable when the soil moisture is near the liquid limit. The sinkage is more when the soil is kneaded in the same moisture content. These results indicate that the soil moisture content and the soil structure are the important factors for the sinkage of track. Under high soil moisture content, the influence of the shape of track is not recognized.
- 4) The effect of the tread length of tracks is not clear.
- 5) Assuming that sinkage behaviours of combine harvester exhibit a similar tendency to the model experiments we have done, it can be said that the elements for designing combine harvester are: the weight of combine should be as light as possible, the length of track should be long enough within the limit of giving no serious effect on turning operation and the tread of tracks should be arranged so that they do not run on the same trace. However, it must be born in mind that the sinkage behaviour is more heavily affected by the soil moisture content than the shape of track.

Research on the Compressive Forming Characteristics of Rice Husk (No. 2)

Haruo EZAKI · Takaaki SATAKE

JSAM, **45** (1), pp. 123~128 (1983)

In order to clear the behavior of compression stress and strain characteristic of rice husk, the stress relaxation test and the creep test were experimented using the plunger and cylinder type compression device. Some results are summarized as follows.

1) The relaxation modulus of rice husk had a linearity and the following equation was obtained in relation between the relaxation modulus and the time,

$$G(t) = a \cdot \log t + b$$

where, $G(t)$ is the relaxation modulus, t is the time and a , b are constant values.

2) The larger the initial stress, the larger the value of relaxation spectrum and the shorter the relaxation time.

3) The creep compliance of rice husk had a linearity and the following equation was obtained in relation between the creep compliance and the time,

$$J(t) = c \cdot \log t + d$$

where, $J(t)$ is the creep compliance, t is the time and c , d are constant values.

4) The smaller the initial compression stress, the larger the ratio of the increase of the compression stress and the value of retardation spectrum.

5) The creep strain and the residual strain had a tendency to increase with the increase of the number of repeated creep tests.

6) The result of the stress relaxation test and the result of the creep test were compared using the approximate equation. From this comparison, it may be concluded that these two results could convert together.

Analytical on the Origin of the Metal Abrasive Wear by Rough Rice

Haruo EZAKI · Iwao KUROISHI · Shotaro YUZAWA

JSAM, **45** (2), pp. 215~222 (1983)

We have been working on the metal wearing by flowing paddy from the viewpoint of the physical characteristic of paddy.

We have been got many research reports concerning the metal wearing at the rice handling devices of agricultural machinery, but any reports have not cleared factors involved in wearing.

Some factors of abrasive wearing of metal by paddy are cleared in this study.

1. The longer the distance of friction between metal and paddy, the larger the abrasion, namely, the longer the friction time, the more the wearing.
2. The rougher the surface of paddy, the larger the action of wearing.
3. The larger the contact pressure between paddy and metal, the larger the action of wearing.

4. The metal wearing (W) by paddy may be indicated by the following formula.

$$W = aL^\alpha f^\beta (\gamma)^R$$

where L is the friction distance, f is the contact pressure, R is the surface roughness of paddy and a , α , β and γ is the coefficient.

Fundamental Studies on Running Resistance of Head-feeding Combines (I)

—Influence of Profile and Dimension of Running Track Using Models—

Haruo EZAKI · Atushi SAWAMURA

JSAM, **46** (2), pp. 173~181 (1984)

This running resistance measuring test using combine models was conducted for the purpose of improving the combine's trafficability on wet paddy field. These models were simplified to the tracks with 1/3 of two rows head-feeding type combine. The influence of track width, nominal track contact length and angle of approach on the running resistance for various soil conditions were observed.

Transmission Characteristics of Compression Force on Rice Husk

Haruo EZAKI · Takaaki SATAKE

JSAM, **46** (1), pp. 615~620 (1984)

When rice husk is compressed by a plunger, the plunger pressure applied to the upper surface of the rice husk can not be transmitted to the bottom of the cylinder sufficiently, although some part of it is transmitted to the bottom.

In order to clear the transmission of plunger pressure to the rice husk filled in the cylinder, the vertical transformation of rice husk in a transparent cylinder was firstly observed. Then the vertical bottom and cylinder side pressures were measured, and the theoretical aspects of the amount of pressure on different parts of the rice husk in the cylinder was discussed.

On the Development of A Two-Phase Methane Fermentation System (I)

—Characteristics of Loading of Organic Matter on Swine Waste as the Substrate for Methane Fermentation—

Takaaki MAEKAWA · Shingo YAMAZAWA · Seiji YOSHIKAWA ·

Taira HANAOKA

The Journal of The Society of Agricultural Structures, Japan, **15** (1), pp. 7~21 (1984)

Based on a possibility of the phase separation of methane fermentation connected the two fermenters in series which had different hydraulic retention times, the experiment of the two-phase methane fermentation was performed with the substrate of the mixture of swine feces, and swine feces and urine. As the results, it became possible to charge higher loadings of organic matter than that of the former conventional methane fermentation, and digested gas production rate was maintained high as the digested gas yield was increased by 20-30%. It was found that the loading of organic matter (Lvs) of 7.5kg-vs/m³/d was the optimum for the purpose of recovering the energy, and the Lvs of 5.0kg-vs/m³/d was optimum operation condition in case of considering for the quality of digested liquid, such as the ratio of volatile solid removal, volatile acid removal, and NH₄⁺. In addition, each methane gas production rate is 1.596, 1.447 Nm³-CH₄/m³/d, respectively.

Methane Gas Production from Swine Waste with Two-Phase Methane Fermentor Shingo YAMAZAWA

Proceedings of the Intl. Sympo. on Biogas, Microalgae and Livestock Waste
(1980)

It was an advantage in mesophilic fermentation that solar energy could be utilized as the heat source for methane gas fermentor to produce digested gas from livestock wastes in Japan. The technical aspects of establishing high-rare fermentation were investigated with a view to decreasing the heat loading on the fermentor. A series of two-phase fermentation experiments were conducted to get high rate fermentation, and performance characteristics were determined using swine feces as a substrate. The two-phase fermentation system consisted of two separate fermentors in series, one for acid fermentation and the other for methane fermentation. The working volume of the acid forming vessel and that of the methane fermentor used in this study were 0.35 m³ and 1.0 m³, respectively. This study clearly shows that the two-phase mesophilic fermentation system can substantially increase the gas yield and the rate of gas production is more stable than the conventional fermentation process. The gas production in this study was 0.42 to 0.60 Nm³/kg-VS, and the gas from the methane-fermentor was composed of about 63% methane and 37% carbon dioxide under the operational conditions of 4% total solid concentration in the fermentor, a retention time of 6.75 days to 27 days (i. e., a minimum of 1.19 kg-VS/m³·day and a maximum of 4.74 kg-VS/m³·day of organic matter loading) and 35, 90 minutes/day total agitating time at the rate of 0.15m³/min·m³

Development of a New Methane Gas Fermentation System

Takaaki MAEKAWA

Energy Developments in Japan, 5, (1983)

For the stabilization of digested gas fermentation and to increase the gas yield, a new anaerobic fermenter which is a two-phase methane fermentation system was developed and the performance characteristics tested.

The two-phase methane fermentation system consisted of two separate fermenters in series, one for acid fermentation and the other for methene fermentation. In the case of mesophilic fermentation, the two-phase system increased digested gas yield and rate of gas production.

The energy balance between produced digested gas and heating energy of a conventional fermentation system in the winter season was estimated to be negative in the northern area in Japan, but that of the two-phase fermentation system was calculated to be positive in the same season and area. The usable digested gas for farming and domestic use was estimated to be more than 40% of the produced digested gas volume in the case of swine wastes as the substrate for the two-phase methane fermenter.

Dissemination of the Methane Fermentation System and Associated Problem in Japan
Takaaki MAEKAWA
Alternative Sources of Energy for Agriculture FFTC, **28**, pp. 163~174 (1985)

In Japan, LPG costs 0.08 US \$ per 1000 kcal and oil costs 0.042 US\$. The production cost of methane gas is found to fluctuate with the kinds of livestock, seasons, and locations. The production cost of methane gas by using swine feces is lowest (almost as low as that of LPG) when swine feces are used. As for cattle wastes, the treatment by fermentation is not profitable in cold area because the balance of energy will have a deficit.

It can be disputed if a sense of economy should be brought into agriculture in Japan, but a trial calculation is needed so as to make engineering choices. Administrative aids such as subsidies from the Ministry of Agriculture, Forestry, and Fisheries, and local governments must be induced to reduce the production cost of 1000 kcal methane gas, which is comparatively more expensive than oil. In order to plan local industry activation, it is necessary to estimate local energy resources on the local government level, and to establish appropriate, fundamental plans. For this purpose, the estimation computer program developed by the author and his co-researchers must serve both the administrations and farmers.