THE MECHANICS OF CUTTTING PLANT RESIDUES ON A RIGID AND SOIL SURFACE

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DISSERTATION ABSTRACT

THE MECHANICS OF CUTTING PLANT RESIDUES

ON A RIGID AND SOIL SURFACE

Engin Cakir

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The mechanics of cutting four common plant residues (corn, cotton, soybean, and wheat) on a rigid and soil surface were investigated. Plant residue was cut with a flat and an angled knife positioned perpendicular to the residue fiber. Residue with different cross-sectional areas and moisture contents was cut in different sections along the stalk and in different locations between the internodes. Cutting forces, cutting stresses, cutting energy, and specific cutting energy were examined. Also, the effect of applying tensile force to the residue ends was examined during cutting corn, cotton and soybean residue on a rigid and soil surface.

An Instron Testing Machine model 4201 was used to cut the residue on a rigid surface. The rigid surface was comprised of two plates secured on the Instron with a 6 mm

gap to allow the knife edge to pass through. Residue was also cut on a Norfolk Sandy Loam soil with 5% moisture content. The soil was compacted with a roller to two levels of compaction: fairly compacted with two roller passes and most compacted with five roller passes.

The cutting stress and specific cutting energy of all residues were independent of the cross-sectional area of the residue within a section between nodes. However, cutting stress and specific cutting energy requirements decreased significantly from bottom to the top of the residue. Generally, tensile force had no effect on cutting stress and specific cutting energy for both the flat and the angled knife with two exceptions: the cutting stress was higher on nodes for corn and soybean residues, and tensile force decreased the required cutting stress and specific cutting energy for corn residue.

Dimensional analysis was used to develop an empirical function for cutting the plant residue on a rigid and soil surface. Two dimensionless ratios were found to be constants for a given residue and knife for cutting on a rigid surface. Two dimensionless ratios were found to be influential when cutting residue on a soil surface from which an empirical equation was developed for all four residues for each of the knives.

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I. INTRODUCTION

Crop residues are the portions of a crop that are left in the field after harvest. Management of the residue, such as leaves, stems, branches, and roots is one of the cultural practices that affects crop production via nutrient availability and cycling. Residues are not only a nutrient source but also provide erosion prevention and moisture retention.

In the past decade or so agricultural scientists have studied how crop residues affect the yield and the environment of plants. Mannering and Richey (1975) studied the influence of various tillage systems on soil and crop residue properties that affect both water infiltration and evaporation. They found that management systems that place crop residue on the soil surface greatly increased water infiltration. Tillage systems that leave significant amounts of the surface covered by residue are also effective in moisture conservation because of reduced evaporation losses.

Widespread removal of crop residues increases wind and water erosion on cultivated land in the U.S. Because erosion on much of the nation's cultivated area already exceeds tolerance limits, any increase would be particularly serious. Removal of residues could also increase mineral fertilizer use (Larson, 1975).

Although surface residue is beneficial, some problems have been encountered such as a toxic effect on seedlings when the residue contacts the seedlings, and some mechanical difficulties occur in operating the planter and seeding equipment on soil covered heavily by residues. Jones et al. (1969) investigated the effect of cotton crop residue length on planter performance. Although they found no statistical differences among the 3-, 6-, and 9-inch residue lengths, they found 9-inch residue lengths caused more interference with planting depth than the 3- and 6-inch lengths.

With increasing application of the no-till planting methods, residue management becomes more vital. Erosion prevention is also playing an important role for sustainable farming. One practice aimed at preventing erosion due to wind and water is to leave the residue on the soil surface. However, some problems occur such as cutting the residue, anchoring and/or incorporating the residue within the soil surface. To easily incorporate the residue within the soil and to prevent long residue interference with planting, residue should be cut in small sizes. Although some researchers have focused on cutting corn residue on a soil surface with a disk coulter (Choi and Erbach, 1986; Kushwaha et al., 1986a) none have developed the mechanics of cutting common residues on a rigid or soil surface.

Objectives

The overall goal was to develop an understanding of the mechanics of cutting corn, cotton, soybean, and wheat residues on a rigid surface and soil surface with both flat and angled knives. Specific objectives were:

1. To determine the cutting force, shear stress, cutting energy, and specific cutting energy of corn, cotton, soybean, and wheat residues on a rigid and soil surface with flat and angled knives.
2. To investigate the role of the residue properties and soil strength on residue shearing with flat and angled knives.
3. To apply the dimensional analysis theorem to residue cutting on a rigid and soil surface.
4. To develop a functional relationship between major residue properties, soil properties, and geometric parameters using dimensional analysis and statistical techniques to predict cutting force requirements of residue on a rigid and soil surface.

II. REVIEW OF LITERATURE

Crop Residue Management

According to Skidmore and Siddoway (1978), crop residue is essential to reduce wind erosion. According to their findings potential average annual soil loss as influenced by flat, small-grain residue decreases with increasing residue left on the soil surface. Especially on erodible soil, crop residue left on the soil surface reduces the erosion potential.

Proper use of crop residues is the most powerful tool available for reducing runoff, erosion, and transport of sediment to streams. Conservation tillage with 3,360 kg/ha of residue on the surface reduces soil loss throughout southern Minnesota and Iowa to one-half that of conventional tillage without residues (Larson et al., 1978). Residues from the nine leading crops in all states contain about 4 million metric tons of N, 0.5 million metric tons of P, and 4 million metric tons of K (about 40%, 10%, and 80% of N, P, and K, respectively of current fertilizer applications to all crops). Therefore, any system that removes crop residues requires the return of the nutrients associated with the residue if crop production levels are to be maintained (Larson et al., 1978).

Hayes and Kimberlin (1978) investigated soil erosion by water using the universal soil loss equation. They concluded that crop residues should not be removed from sloping land where soil erosion by water is a significant hazard.

Van Doren and Allmaras (1978) discuss the usefulness of crop residues on the soil surface in reducing soil erosion, improving infiltration so that water storage is enhanced, and reducing the soil temperature differences, yet they also concluded that there were some difficulties in residue management, such as:

1) Carbonaceous residues tied up much of the nitrogen added by leguminous crops in the early years of the research.
2) Insect problems were often more severe, especially corn borer, before the development of stronger-stalked varieties.
3) Seedbeds were often so rough that planting equipment was unable to operate correctly in clods, or sod clumps. Consequently, low plant density reduced yields where residues were left on the surface.
4) Cultivation for weed control (corn only) was difficult, and often corn was covered and destroyed by clods or sod clumps dragged over the row.

Effectiveness of residues from six crops for reducing soil erosion by wind in a semi-arid region, the Southern High Plains, was investigated by Bilbro and Fryrear (1985) using the wind erosion equation and 38 years of crop residue data. The crops and their respective potential annual soil losses from wind erosion (when C = 70, I = 193 t/ha, L = 914 m, and K = 0.7) were found to be as follows: kafir, 12 t/ha; forage sorghum (cut 80 cm high), 15 t/ha; winter wheat, 39 t/ha; grain sorghum, 43 t/ha; corn, 77 t/ha; and cotton, 83 t/ha.

Crop residues play an essential role in the cycling of nutrients through agricultural ecosystems. Changes in the size of the residue sink affect nutrient cycling and subsequent nutrient availability. Crop residues are an important factor in controlling the rate at which nutrients become available for plant growth (Power and Legg, 1978).

Even though evidence is still indirect, phytotoxicity seems to be a problem with surface residue management systems, especially with winter wheat grown in cereal residues. Several possibilities exist for residue management. One is uniform straw spreading and another is managing crop residues away from seed rows (Elliot et al., 1978).

Raimbault et al. (1991) conducted a study in 1983 and 1984 on a Maryhill (Typic Hapludalf) loam soil to determine the effect of spring tillage systems and timing of rye chemical kill on a subsequent corn crop. Studies in Ontario have shown that corn (*Zea mays* L.) yields are reduced when corn is seeded immediately after rye (*Secale cereale* L.) harvest or chemical kill of winter rye. Moving the residue out of the row with disc furrowers resulted in corn yields that were significantly higher than those in no-till treatments with ripple coulters.

Griffin et al. (1981) studied wheat-straw residue treatments in a no-till systems. In field trials in SW Louisiana, wheat (cv. Coker 68-15) was cut to (a) 6-in or (b) 12-in stubble height with subsequent spreading of straw or to 6-in with (c) removal, (d) burning or (e) incorporation of straw before sowing soybean (cv. Terra Vig 708) directly on 22 May. By late June, stubble treatment had little effect on establishment or plant height. Ground cover by weeds was only 9% in (e) the lowest, and for the other treatments it was next lowest (38%) in (a).

The decay of straw as it took place in the field was assessed by measuring loss of dry matter in 5 experiments conducted during four winters. Barley straw decayed more rapidly than wheat straw and chopping increased the decay rate (Grossbard, 1979).

In field trials at five sites in the United Kingdom in 1975-1977 average wheat yields were 5.01, 5.11, and 4.95 t/ha after ploughing, reduced cultivation and direct drilling, respectively, after burning. The presence of stubble reduced yields compared with burning and yields were further reduced by chopping the straw in situ (Oliphant, 1982).

Cutting Plant Residue

Plant tissues may be classified as protective tissues, conductive tissues, and ground tissues. The protective tissues include epidermis and periderm tissues which are the primary and secondary protective covering of the body (Figure 1). The ground or supporting tissues are the parenchyma, collenchyma and sclerenchyma tissues which provide strength and mechanical support for the plant body (Mohsenin, 1986).

Figure 2 shows the most frequent forms of cutting. The first, Figure 2(a), shows a process involving counter-moving blades, where both sets of blades participate in cutting (like scissors). The second, Figure 2(b), illustrates cutting by means of a stationary and a moving blade, where the material is supported by the stationary blade (common in forage choppers). The third, Figure 2(c), shows the cutting of thin layers (e.g., beet cutting), where the stress distribution around the cutting edge is significantly distorted by the free surface found close to the cutting plane. Figure 2(d) presents the recently widespread method of free cutting, where one end of a relatively long stalk is fixed and counter-support is ensured by the moment of inertia of the stalk (e.g. rotary mowers). In this case the velocity of the cutting edge must be high (20-40 m/s) (Sitkei, 1986).

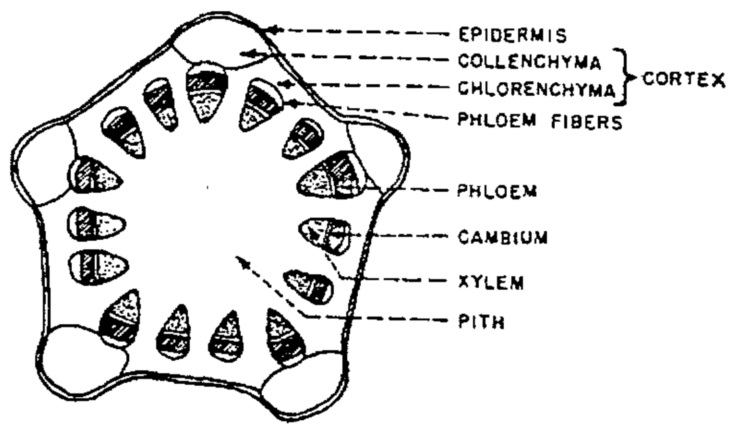

Figure 1. Schematic diagram of a young alfalfa stem (Mohsenin, 1986).

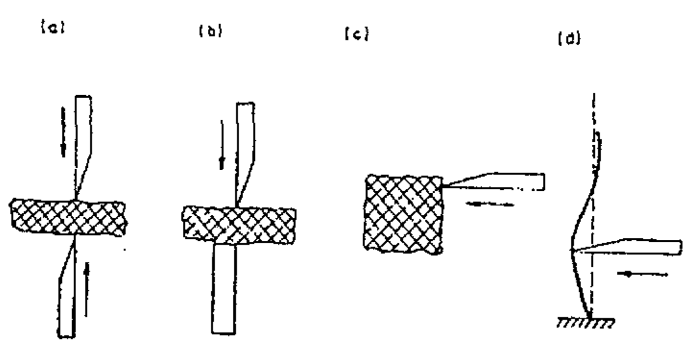

Figure 2. Various forms of cutting (Sitkei, 1986).

Cutting knives are generally sharpened on one side, with a sharpening angle β and edge thickness δ. The penetration of a knife into a material causes deformation of the matter and various forces are acting on the surface of the knife, as illustrated schematically in Figure 3 (Sitkei, 1986).

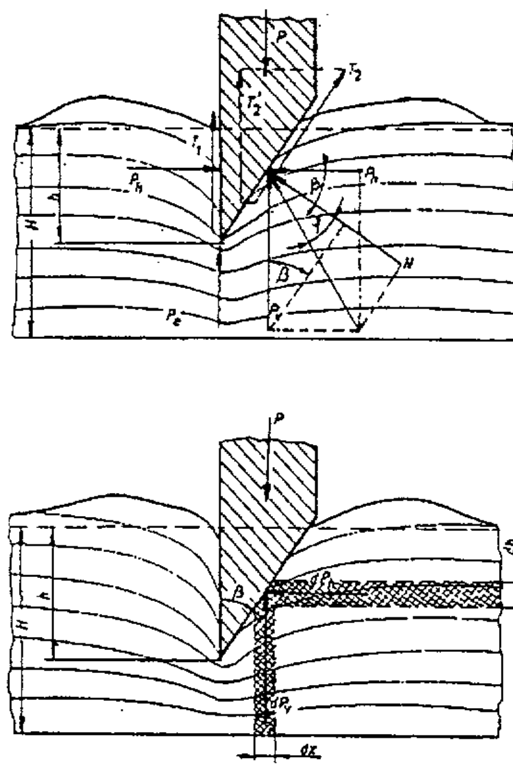

Figure 3. Force relations for a knife penetrating into material (Sitkei, 1986).

The normal force acting on the inclined face of the knife is the sum of the horizontal and vertical force components:

$$N = P_v \sin\beta + P_h \cos\beta \tag{1}$$

while the tangential force arising on it is

$$T_2=\mu N=N\tan\phi \tag{2}$$

where $\mu=\tan\phi$ is the friction coefficient.

On vertical side of the knife, the tangential force is

$$T_1=\mu P_h \tag{4}$$

The vertical component of the tangential force T_2 is

$$T'_2=T_2\cos\beta=\mu[(1/2)P_v\sin 2\beta+P_h\cos^2\beta] \tag{5}$$

At the instant of cutting, a force

$$P_\varepsilon=F\sigma_B=\delta l\sigma_B \tag{6}$$

appears on the knife edge, where F is the cross-sectional area of the material, δ is the thickness of the edge, σ_B the yield strength of the material under the edge, and l is the cutting edge length. Equilibrium of the vertical forces may be expressed by the equation

$$P=P_\varepsilon+P_v+T_1+T'_2 \tag{7}$$

The forces P_v and P_h may be determined as follows. Assuming the Hooke's law is applicable to the material

$$\epsilon=h_x/H=\sigma/E \tag{8}$$

the elemental force acting on the surface of width d_x and of unit length is

$$dP_v=\epsilon Ed_x=\epsilon E\tan\beta dh \tag{9}$$

Substitution of the preceding expression for ϵ yields

$$P_v=(E/H)\tan\beta\int_0^h h_x dh=(E/2H)h^2\tan\beta \tag{10}$$

The horizontal force increment is

$$dP_h=\upsilon\varepsilon E dh \tag{11}$$

where the υ is Poisson's ratio. Then P_h can be derived as

$$P_h=(\upsilon E/H)\int_0^h h_x dh=(\upsilon E/2H)h^2 \tag{11}$$

and thus the vertical force can be written in the form

$$P=\delta\sigma_B+(E/2H)h^2[\tan\beta+\mu\sin^2\beta+\upsilon(\mu+\cos^2\beta)] \tag{12}$$

The edge thickness of the knife is generally δ = 50-150 μm. The stress σ_B for maize stalks is 250-500 N/cm^2. Thus a force of 25-50 N falls on every cm length of cutting edge (Sitkei, 1986).

Two stages may be distinguished in the cutting process: the first stage involves preliminary compaction of the material until a pressure is reached at which the material under the edge yields, while the second stage concerns the motion of the edge in the material which is cutting. These two stages may be observed clearly from static cutting diagrams. Figure 4 shows the static cutting diagram for a bundle of maize stalks. The material is compressed up to a height h until the cutting resistance is overcome, and the energy required is given by the area A_c under the curve. The energy requirements of effective cutting are given by area A_v (Sitkei, 1986).

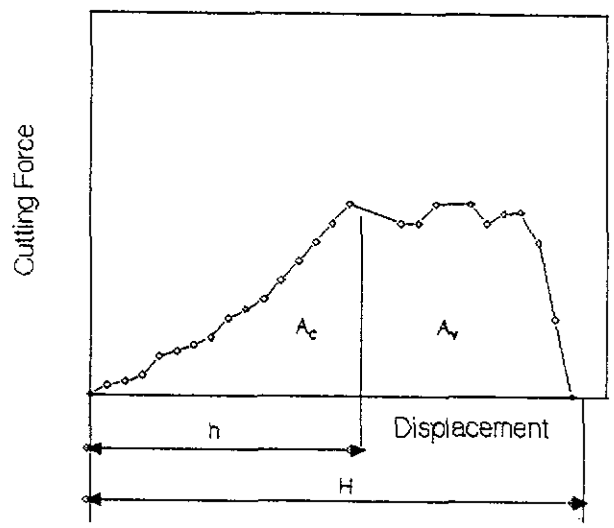

Figure 4. Static cutting diagram
(Sitkei, 1986).

The total work is thus

$$A = A_c + A_v \tag{13}$$

While the proportion of useful cutting work is

$$\eta_v = \frac{A_v}{(A_c + A_v)} \tag{14}$$

The specific energy requirements of cutting may be obtained by dividing the total work by the cross-sectional area of cutting.

$$A_f = \frac{A}{F} \tag{15}$$

The thickness of the cutting edge influences the cutting resistance in various ways. The cutting force is practically constant for thickness up to 70-80 μm but for greater thickness it increases significantly (Figure 5). Consequently, it is not advisable to use knife edges that are too thin, since they represent no improvement in terms of energy consumption while they wear rapidly and deform easily.

The angle of sharpening (bevel angle) is one of the most important parameters, not only in terms of energy consumption but also concerning the life of the knife. According to measurements, the energy requirements increase rapidly for angles above 30°, and in practice the angle is chosen between 20 and 30° (Figure 6). The use of angles less than 20° is not advised, since the edge will then be deformed easily and thereby the life of the knife reduced (Sitkei, 1986).

Kushwaha et al., (1986a) studied three types of 460 mm diameter power driven-disc coulters to evaluate their crop residue cutting ability in the soil bin. Rotational speeds that gave peripheral speeds up to twice the travel speed were used in the tests. They measured power consumption, draft and vertical forces with no residue and with straw density ranging from 1000-5000 kg/ha. Their observation and analysis of data indicated that straw cutting performance of the plain coulter was nearly 100%. With the notched and serrated coulters, the quantity of straw cut increased with

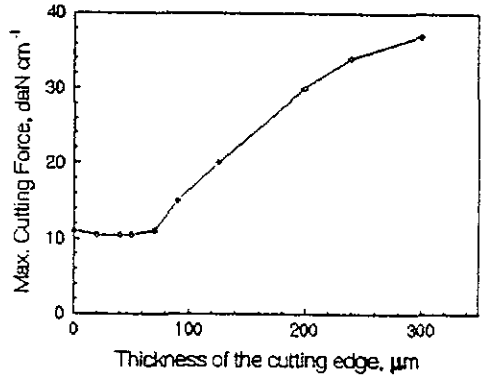

Figure 5. Effect of cutting edge thickness on cutting force (Sitkei, 1986).

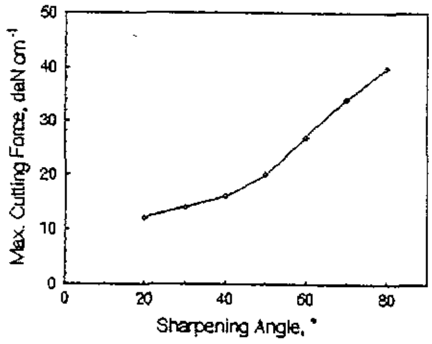

Figure 6. Effect of sharpening angle on maximum cutting force (Sitkei, 1986).

an increase in the rotational speed and decreased with an increase in straw density.

Choi, C.H. and Erbach, D.C., (1986) tested free rolling coulters (smooth, ripple, fluted and notched) in a laboratory soil bin, and they discovered that the coulter type had no significant effect on draft force or the percentage of maize stalk sheared. Draft force on the coulter was influenced by operation depth, coulter size, and soil condition. The percentage of stalks sheared was greatly affected by sharpness of the coulter, moisture content of corn stalks, and soil strength.

The basic problem associated with no-till and minimum tillage sowing is the seed placement under the crop residues. Kushwaha et al. (1986b) evaluated three common size plain disc coulters in a soil bin for their crop residue cutting ability as influenced by soil resistance and straw density. They measured the draft and vertical forces on coulters for tests with and without straw cover. They found that a 460 mm diameter coulter was able to cut nearly 100% of the straw under various conditions, while a 360 mm and a 600 mm diameter coulter were not as effective.

Ability to cultivate large areas of land in a limited period of time, i.e. high system capacity, is a vital requirement for straw incorporation machinery preparing heavy land for winter cereals. Fine chop length of both straw and cereal stubble (between 25 and 50 mm) will ease incorporation difficulties and aid high output of cultivation equipment (Patterson, 1984).

Janusz et al. (1978) studied the static cutting resistance and energy of stalks of winter wheat and rye with a resistance measuring apparatus on an Instron Testing Machine, type 1112, with a recording and integrating system. The measuring system consisted of a special table with a knife (the shape of blade was analogous to that of blades in a shearing system of forage harvesters) placed vertically (with the cutting edge perpendicular to the axis of stalk fixed on the table). The counter-cutting knife was fitted to a tensiometer head to measure loading. The speed of the static shearing was 20 mm/min. Their investigation included eight varieties of winter wheat and three varieties of rye harvested in the period of full maturity. The measurements were taken at every 2 cm of the stalk cut 30 cm in length. They found that the cutting resistance for winter wheat varied from 24.43 to 54.54 N, and significant differences were found in the majority of the varieties and stalk sections compared. The cutting resistance of rye varied from 44.73 to 67.20 N. The distribution of the force was found to be different at sections. From the propagation nodium to the top of the plant, cutting force decreased very rapidly, reaching a minimum at the height of 30 cm. Mean values of the energy used during the cutting of a single stalk were 34.21-74.36 MJ for winter wheat, and 61.30-101.99 MJ for rye.

Vaishnav et al. (1982) measured the shear strength of wheat straw at different moisture content and shearing velocity by using a shear box with a 90° straight edge blade and a 30° bevel edge blade. The shear box had two rectangular metal pieces sitting one above the other and the bottom was movable whereas the top was stationary. The bottom was driven to and fro by a screw fixed to the rear end of the box. They found that shear strength increased rapidly with moisture content up to approximately 15% moisture content, then remained nearly constant for higher moisture contents. The magnitude of the shear strength with the 30° blade was lower than that of the 90° blade. They also found that shear velocity did not have any effect on the shear strength of straw.

The force required and amount of work done to sever a stem that had been tensed by bending were reduced by almost 50% by comparison with an untensed stem. The cut was made from the stretched side of the stem (Sakharov et al., 1984).

A common hypothesis is that material failure is created by the shear stress exceeding a critical value. Shear stress in a fiber (fiber wall) may be created by a combination of tensile stress in the fiber direction and compression stress perpendicular to the fiber. The tensile stress is created by fiber bending and stretching and is normally not sufficient to create fiber failure. The compressive stress is created by the pressure under the knife edge (Persson, 1987).

III. MATERIALS AND PROCEDURE

Cutting Plant Residue on a Rigid Surface

Residue Preparation

Corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), soybean [*Glycine max* (L.) Merr], and wheat (*Triticum aestivum* L.) residue were collected by cutting close to the soil surface just before harvest. The harvesting time, location and material characteristics are shown in Table 1. Each residue stalk was cleaned of branches and fruit so that only a stalk was left. Residue were then stored in a well ventilated room to allow natural drying.

Before being used in tests, internodes of each residue sample were numbered, and the effective diameter and cross sectional area for each cutting location were calculated from the measured circumference. Each section of the residue was defined as the location between the two internodes. Section numbers were given in the ascending order from the bottom to the top of the residue (Figure 7).

An Instron Testing Machine model 4201 was used to cut the residue on a rigid surface. The rigid surface was comprised of two plates secured on the Instron with a 6 mm gap to allow the knife edge to pass through.

Table 1. Residue characteristics for cutting on a rigid surface.

Residue	Variety	Row Spacing mm	Planting Date	Harvesting Date
Corn*	Pioneer-3165	762	6/11/1992	10/1/1992
Cotton**	DPL-90	1016	5/16/1992	9/5/1992
Soybean*	Hutcheson	762	5/1/1992	10/1/1992
Wheat*	Coker-9835	178	11/19/1992	5/27/1993

* Plants were grown at the Alabama Agricultural Experiment Station E.V. Smith Research Center.

** Cotton was grown in the experimental fields at Auburn University.

Cutting Apparatus

A PC equipped with a data acquisition card and appropriate software was connected to the Instron displacement and force transducers. Displacement, force, and time were acquired and recorded every 0.5 second. The cutting speed was 0.85 mm/s.

Knives

Flat and angled knives were used for cutting the residue (Figures 8 & 9). The flat knife had a thickness of 12 mm. The angled knife had a thickness of 3 mm which

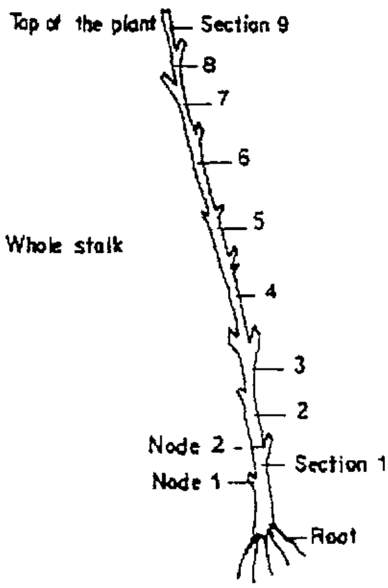

Figure 7. Schematic of sections of the residue.

represents a disk-coulter with 460 mm diameter working at a depth of 50.8 mm. The bevel angle for both knives was 30° to achieve the best cut with the least effort (Sitkei, 1986). To indicate the degree of sharpness of the knife, a sharpness index was used. Sharpness index was calculated as (Choi, 1984)

$$SI=1/(5*T_i*T_s) \tag{16}$$

where

SI = sharpness index

T_i = ideal thickness at point 1 mm from cutting edge

T_s = actual thickness at point 1 mm from cutting edge

By using the geometry of the knife, the ideal thickness can

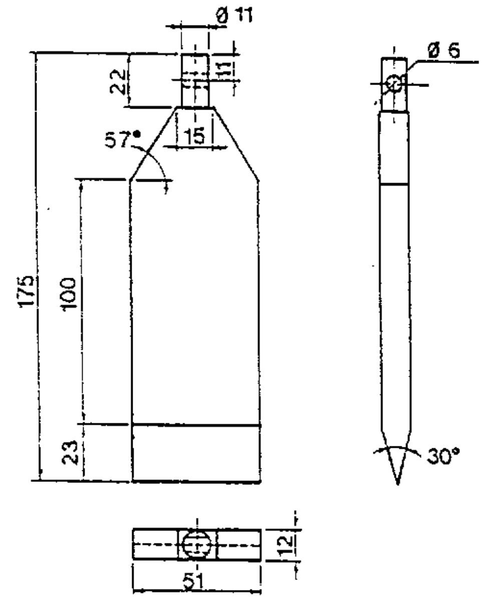

Figure 8. Dimensions of the flat knife (mm).

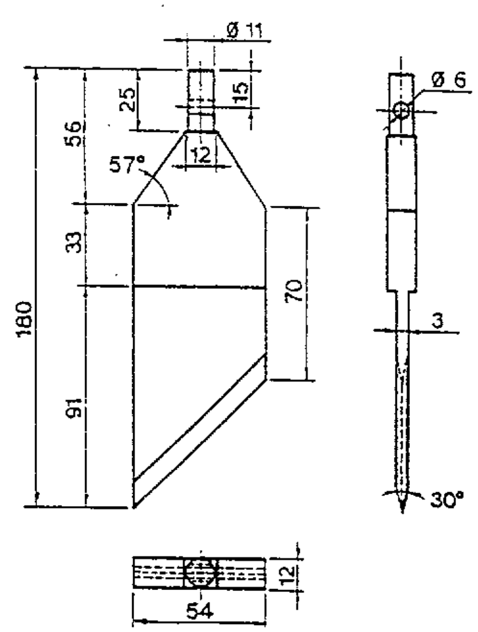

Figure 9. Dimensions of the angled knife (mm).

be expressed as:

$$T_i = 2*\tan(\frac{\Theta}{2}) \tag{17}$$

When the angle is small, $\theta/2 \approx \sin(\theta/2)$, this becomes

$$T_i \approx \frac{\Theta}{\cos(\frac{\Theta}{2})} \tag{18}$$

From that the sharpness index of the knife can be calculated as:

$$SI = Cos(\Theta/2)/5*\Theta*T_s \tag{19}$$

where

θ = bevel angle of the knife (30°)

Sharpness indices were 0.5876 for both knives. The characteristics for knives are given in Table 2.

Cutting Procedure

Cuts were made with the knife positioned perpendicularly to the fiber of the residue (Figure 10). Corn, cotton, and soybean residue were cut without being secured to the plate. The wheat residue had to be held at both ends because of its soft texture.

Six main factors were investigated:

1- Cross-sectional area of the residue,

2- Cutting location along the residue,

Table 2. Knife characteristics.

Knife	Thickness mm	Material	Bevel Angle	Sharpness Index	Blade Angle
Flat	13	5160 Steel	30°	0.5876	90°
Angled	3	5160 Steel	30°	0.5876	45°

3- Sections along the residue,

4- Moisture content of the residue,

5- Type of the knife,

6- Tensile force on the residue

Three sizes of residue, from each crop, were selected to examine the cross sectional area effect. The cross sectional areas of each single residue are shown in Table 3.

The cutting locations along the residue were mid-way between the nodes, adjacent to the node, and on the node. Cutting locations were designated as 1/2 for between the nodes and 1/4 for next to node (Figure 11).

The strength levels of the residue were adjusted by using three levels of moisture content. Residue was placed

Table 3. The cross-sectional areas of the residue.

Residue	Cross-sectional Area (cm^2)		
	Small	Medium	Large
Corn	1.36	1.79	2.37
Cotton	0.32	0.54	0.72
Soybean	0.23	0.42	0.54
Wheat	0.0103	0.02	0.038

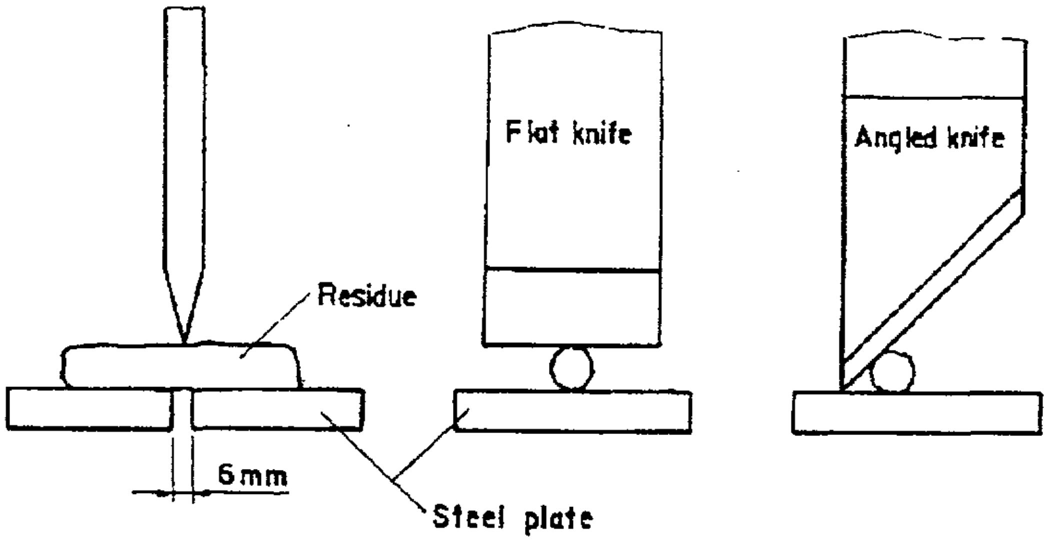

Figure 10. Schematic of cutting plant residue on a rigid surface.

in a tank filled with water for 24 hours. Then the residue was dried in an oven set to 103 °C until the desired moisture content was reached. After removal from the oven,

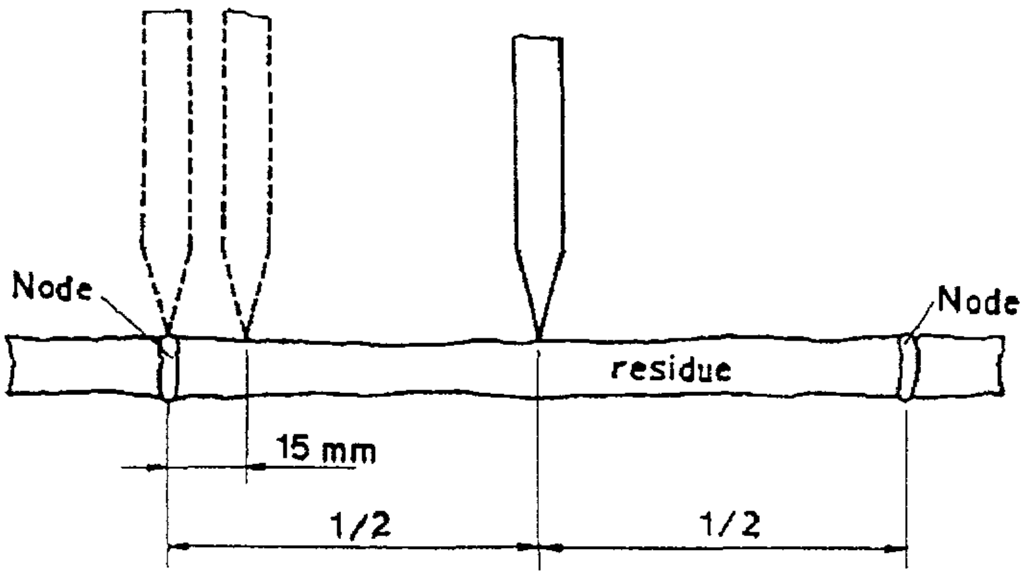

Figure 11. Schematic of cutting location of the residue.

the residue was kept in double sealed plastic bags for 24 hours to reach the equilibrium moisture content before cutting. Moisture contents of residue were reported on a dry basis.

Three different levels of applied tensile force: 0 N, 89 N, and 178 N were axially applied to residue stems to examine the tensile force effect on cutting the residue with the knives. Residue was placed in a frame which had a spring scale that measured tensile force at one end and was fixed at the other end. A threaded rod was attached to the scale to adjust the desired level of tensile force.

The maximum cutting force was defined as the cutting force needed to cut the residue. The maximum cutting force occurred mostly at the end of the cutting. The cutting stress was calculated by dividing the maximum force by the initial cross sectional area of the residue. Cutting energy was calculated as

$$Energy=\int_a^b F(x)dx \tag{20}$$

where

F(x) = cutting force

dx = knife displacement

a = initial displacement at zero cutting force

b = final displacement

The integral was approximated by using the Trapezoidal Rule (Burden and Faires, 1989):

$$\int_a^b F(x)dx=\frac{(b-a)}{2}[F(a)+F(b)]-\frac{(b-a)^3}{12}F''(\zeta) \tag{21}$$

where

$F''(\zeta)$ = 2nd derivative of F(x) at ζ (any point between a and b)

The total cutting energy was divided by the initial cross sectional area of the residue to estimate the specific cutting energy.

A completely randomized experimental block design with five replications was used to collect the data (see Appendix

A). The order of the tests and selection of the residue and knives were randomized.

Cutting Plant Residue on a Soil Surface

Residue Preparation

Residues were prepared the same way as they were prepared for cutting on a rigid surface. Corn, cotton, soybean, and wheat residues were used for cutting on the soil surface. Only wheat residues were held at both ends to evaluate accurate timing for predicting the cutting point (since very low force was required to cut the wheat residue, it was hard to tell the cutting point without securing the ends). Three wheat straws were fastened together at their ends across the ends of a U-shaped wood fixture so that the residue cutting force can be distinguished visually from the soil cutting. Residue characteristics are shown in Table 4. From the preliminary tests, it was found that short residue, less than 6 cm long, affects cutting on soil (in most cases, the knife drags the short residue into the soil). To prevent the short residue effect, each residue was cut at least 15 cm long.

Soil Preparation

Residues were cut on the inside Norfolk Sandy Loam Soil (Typic Paleudults) soil bin at the USDA National Soil Dynamics Laboratory. The soil was 71.6% sand, 17.4% silt, and 11.0% clay. Soil was wetted to a desirable moisture content (7%) and was tilled with rotary tiller and smoothed with a scraper. To establish different soil strengths, Norfolk Sandy Loam soil was compacted with an increasing number of roller passes. Two roller passes and 5 roller passes were found to produce two significant levels of compaction as determined by soil cone penetrometer readings (Table 5.). Then the soil was covered with a plastic cover to get equilibrium moisture in the soil. After 3 days, soil was uncovered to dry 2 days and covered again to keep the desired moisture (5%) until the test. Soil characteristics are given in Table 5. The penetration resistance of the soil was measured with a 323 mm^2 base area cone penetrometer (ASAE, 1994).

Cutting Apparatus

The penetrometer car at the USDA National Soil Dynamics Laboratory was used to cut the residue on a soil surface. The penetrometer car equipped with a PC, data acquisition card and software, is capable of measuring the force and the displacement. With a hydrostatic transmission, the penetrometer car can move along rails of the soil bin. The penetrometer car can also move laterally with the help of an electric motor. The same knives used for cutting on the rigid surface, flat and angled, were attached to penetrometer rod. Time, force, and displacement measurements

Table 4. Residue characteristics for cutting on the soil.

Residue	Variety	Row Spacing mm	Planting Date	Harvesting Date
Corn*	Dekalb-689	762	4/20/1993	8/16/1993
Cotton**	DPL-90	1016	6/27/1993	10/8/1993
Soybean*	Braxton	762	5/31/1993	10/27/1993
Wheat*	Coker-9835	178	11/19/1992	5/27/1993

* Plants were grown at the E.V. Smith Research Center, Alabama Agricultural Experiment Station.

** Cotton was grown in the experimental fields near campus at Auburn University.

Table 5. Soil characteristics.

Soil Type	# of Roller Passes	Moisture Content % d.b.	Bulk Density at 0-10 cm depth g/cm^3	Average Cone Index at cone base N/cm^2
Norfolk Sandy Loam	1	4.8	1.3	5
Norfolk Sandy Loam	2	4.9	1.4	10
Norfolk Sandy Loam	4	4.8	1.5	50
Norfolk Sandy Loam	5	5	1.55	60

were taken every 0.3 second and saved in an ASCII file on the PC. Cutting speed was chosen as 1.5 mm/s which was assumed to be static cutting. Cutting speed was selected faster than the cutting speed of the cutting on a rigid surface in order to obtain a clear decrease in cutting force when the residue was cut.

Cutting Procedure

Residues were cut with the knife positioned perpendicularly to the fiber of the residue (Figure 12). Before cutting, each residue was laid on the projected cutting line which was marked with a rope tied between the soil bin rails. The cutting was performed without disturbing the soil from one residue cutting position to the other along the same line. Each cut was watched very carefully to the severance point. At the end of the cut, data acquisition was terminated to avoid excessive data and to know approximately where the cut was made. Sometimes it was hard to tell where the cut occurred due to the residue cutting force being very small compared to soil cutting force at the cutting location. To prevent residue sliding along the soil surface when cutting with the angled knife, residues were supported at their ends by two nails driven in the soil far from the cutting location.

In order to distinguish the residue cutting from soil cutting and to examine the soil effect, soil was cut with the same knife at the location next to the previous residue

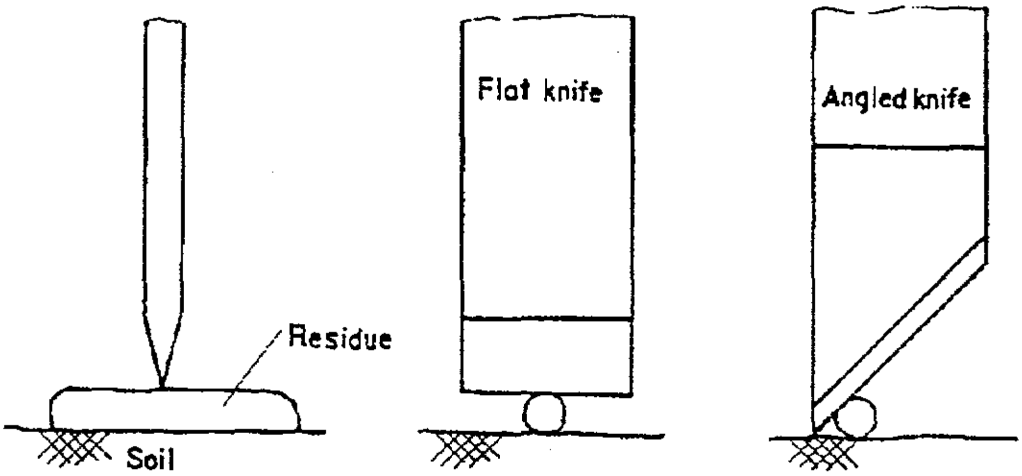

Figure 12. Schematics of cutting plant residue on a soil surface.

cutting location without cutting the residue after each group of three residue were cut (Figure 13 & 14).

Six factors were investigated:

1- Cross-sectional area of the residue,

2- Sections along the residue,

3- Moisture content of the residue,

4- Type of the knife (flat or angled),

5- Holding effect on the residue, and

6- Soil strength.

To avoid the cutting location effect between the internodes residues were cut at mid-way between the

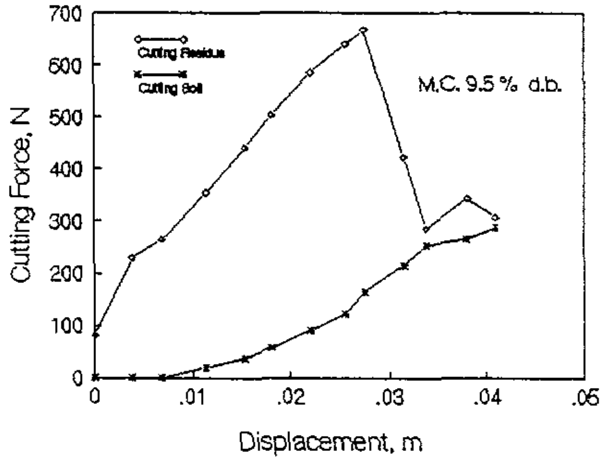

Figure 13. Cutting the cotton residue along with the soil and cutting the soil without residue with the flat knife

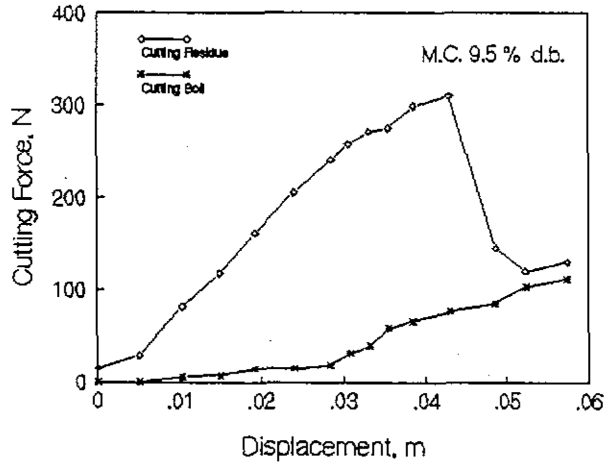

Figure 14. Cutting cotton residue along with the soil and cutting the soil without residue with the angled knife

internodes. Since it was found from the cutting residue on a rigid surface that section of the residue was significant, residues were selected from similar sections for each factor examination except sections of the residue effect for cutting on the soil. The effect of residue sections, from bottom to the top of the residue, was examined on the soil compacted with 4 roller passes (very compacted).

For each residue type, three sizes were selected to examine the cross-sectional area effect. The cross-sectional areas of each single residue are shown in Table 6.

Table 6. The cross-sectional areas of the residue for cutting on a soil surface.

Residue	Cross-sectional Area (cm^2)		
	Small	Medium	Large
Corn	1.22	2.64	3.44
Cotton	0.35	0.54	0.77
Soybean	0.26	0.35	0.54
Wheat*	0.07	0.087	0.11

* Total cross-sectional area of 3 wheat straw stalks.

By using the information gathered from cutting on the rigid surface, residue strength was adjusted by varying moisture content (M.C.) between air dry residue (approximately 10% M.C.) and residue with 25% M.C. since above 25% M.C. has little effect on residue strength. The holding effect was examined on corn, cotton, and soybean residues. Each residue sample was tied at the ends with a wire and placed in a rectangular steel frame to examine the holding effect on residue cutting on the soil. Residue was tied tight enough to hold the residue; no tensile force was applied. Residues were cut on the soil compacted with 1 roller pass on which no residue was cut without holding at the ends.

Two soil strengths were used: fairly compacted soil which was made with two roller passes and the most compacted soil was made with five roller passes. In these two levels, cutting was possible for most of the residue samples; loose soil or less compacted soil didn't provide enough support to cut the residue. More than 5 roller passes didn't significantly increase soil strength.

Cutting force, knife displacement and time were measured from the experiment. From the data, cutting stress, total cutting energy, and specific cutting energy were calculated as described earlier.

For statistical analysis of the data from cutting residue on a soil surface, four main experiments with split-split plot design were combined. Knife type was split in the whole plot of soil compaction level and moisture content of the residue. And residue type was split in the knife type. The order of cutting different size, selection of the residue and knife type were randomized to collect the data (see Appendix B). For each soil compaction level and moisture content of the residue, the soil bin was divided into four blocks (replications).

The main objectives for cutting plant residue on the soil were not only to examine the factors similar to those that were investigated on cutting on the rigid surface, but to obtain data to develop an empirical function for cutting. Expected pi terms were formulated using dimensional analysis and the Buckingham's Pi Theorem (Murphy, 1950; and Young, 1992). So, levels of variables were selected to provide the widest range of values for the pi terms.

To obtain residue strength information used in the dimensional analysis, each residue sample was numbered before cutting on the soil. After cutting on the soil, each residue sample was kept in the same condition (wet or dry) and was cut on the rigid surface.

IV. RESULTS AND DISCUSSION

Cutting Plant Residues on a Rigid Surface

Cutting Stress Pattern

Figure 15 shows the general cutting stress pattern for all types of wet residue. However, this pattern differs for cotton, soybean, and wheat residues with 8-10% moisture content. Figure 16 shows an example of cutting stress curves for dry residues of cotton, soybean, and wheat. This difference was typical for all the tests and both knives.

Due to the stiffened structure of the cortex which contains tough tissues of collenchyma and sclerenchyma (Mohsenin, 1986), both knives first compressed the corn residue to a peak stress (Figure 15). Then the cutting stress remained nearly constant due to compression of the pith for an increased displacement until the point of severance was approached, and finally the stress increased rapidly to severance. This was the case for all wet residue. For air dried cotton, soybean, and wheat residue, the cutting action of both knives was a combination of compression and cutting almost from the beginning due to a much stiffer cortex, and the stress increased in a rather linear fashion to the point of severing (Figure 16).

Corn residue's vascular bundles scattered throughout the pith are stiff and the pith is soft (Prince et al., 1968). The cortex layer (outermost of stalk) of dry cotton and soybean is thicker than the cortex of the corn residue. The cells in the pith are loosely arranged and have little effect on the stem strength for cotton and soybean residues; whereas, corn residue's pith is much thicker than the cortex which affects the stem strength. Compression becomes necessary to cut the corn residue in dry or wet conditions due to its soft pith. Similarly, for wet cotton, soybean and wheat, the cortex layer is less stiff and requires more compaction before cutting.

Effect of cross sectional area

Figures 17-20 show the effect of knife type and cross-sectional area on cutting stresses and specific energy. There was no consistent trend for the cutting stress or specific cutting energy with regard to area. The cutting force and cutting energy increased as the residue area increased, while the cutting stress and specific cutting energy remained relatively constant.

General trends for the effect of area on cutting stress and specific cutting energy of the residue were different for both knives. The flat knife cut the residue with higher stress but required less energy than the angled knife due to that angled knife's sliding effect. This was true with some exceptions. Cutting stress was approximately the same for

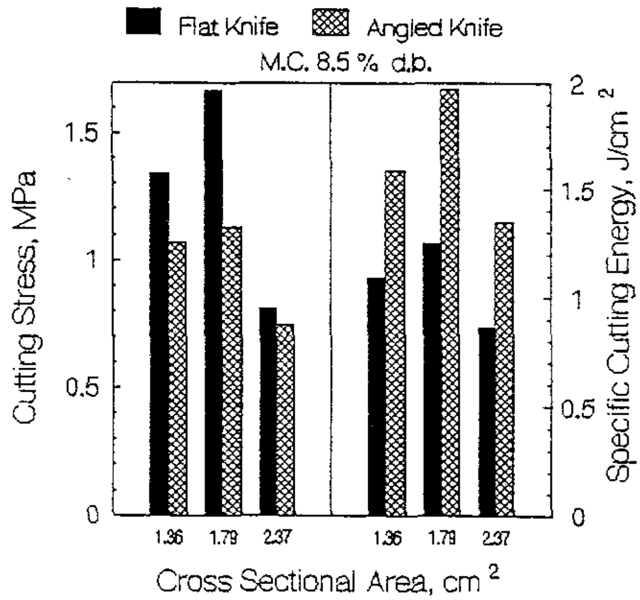

Figure 17. Cross-sectional area effect of corn residue for cutting on a rigid surface.

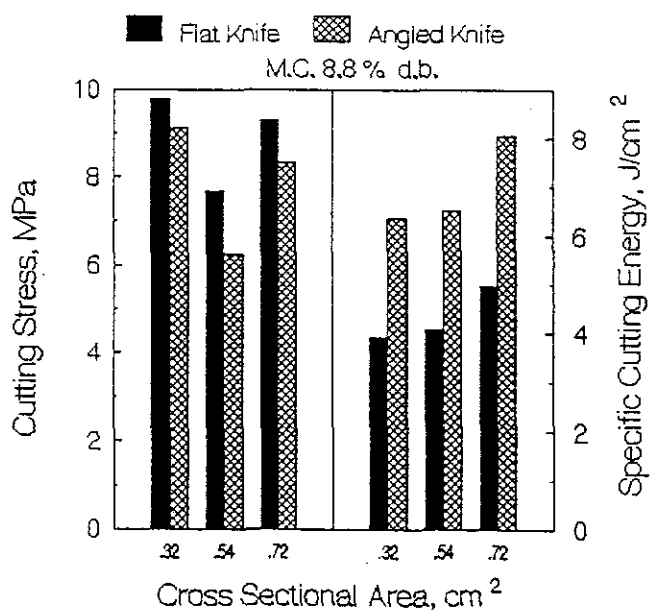

Figure 18. Cross-sectional area effect of cotton residue for cutting on a rigid surface.

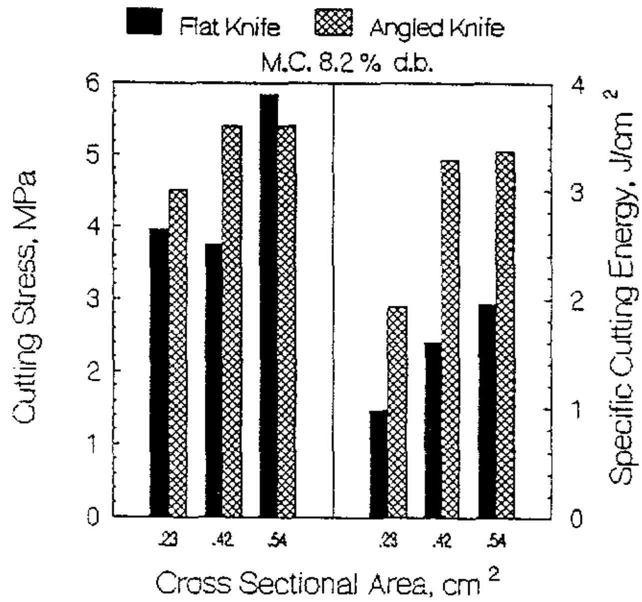

Figure 19. Cross-sectional area effect of soybean residue for cutting on a rigid surface.

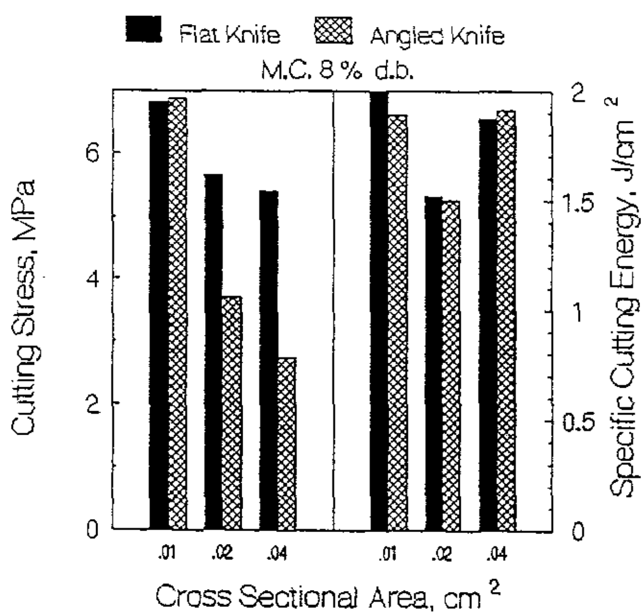

Figure 20. Cross-sectional area effect of wheat residue for cutting on a rigid surface.

both knives for the smallest area of the wheat residue and stress was found significantly less (95% confidence interval) for the angled knife for the larger areas (Figure 20). No significant differences were found between the knives in the cutting stress for soybean residue (Figure 19) and for specific cutting energy for wheat residue (Figure 20) for all cross sectional areas (see Appendix C).

Effect of cutting location

Figures 21-24 show the effect of knife type and cutting location relative to nodes on cutting stresses and specific cutting energy. Corn, soybean, and wheat residues acted the same: cutting stress and specific cutting energy is not significantly different except on the node. On the nodes, both cutting stress and specific cutting energy were higher. For cutting cotton residue, cutting location did not have any effect even cutting on the nodes.

Cutting stress for the flat knife was higher than for the angled knife except for soybean residue at the 1/2 and 1/4 locations (Figure 23). Specific cutting energy for the angled knife tended to be greater than that for the flat knife with the exception of the soybean residue at the node location (Figure 23) and wheat residue at the 1/4 location (Figure 24, Appendix C).

Effect of section

Figures 25-28 show the effect of knife type and section

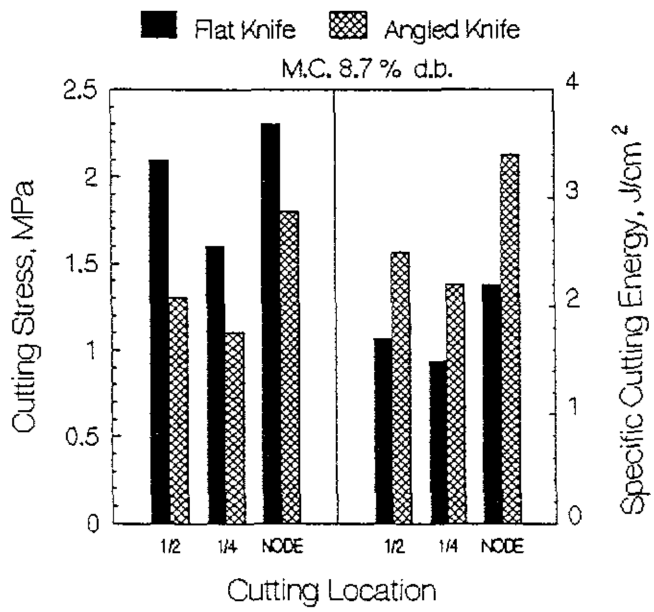

Figure 21. Cutting location effect of corn residue for cutting on a rigid surface.

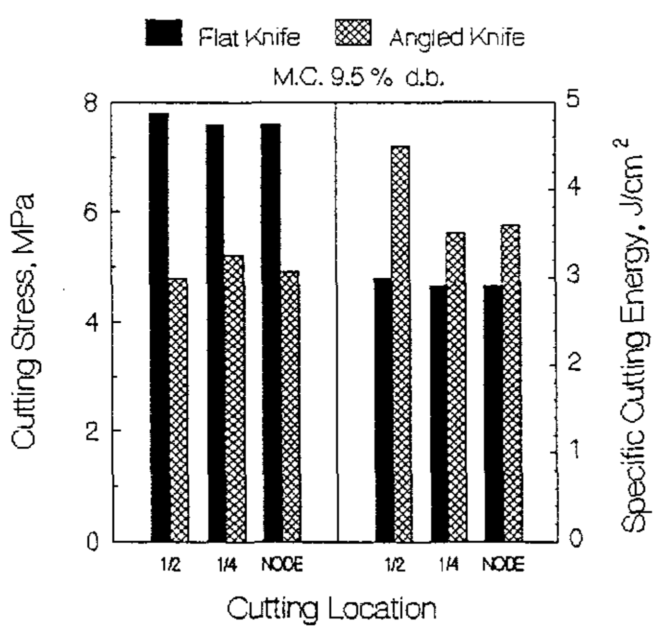

Figure 22. Cutting location effect of cotton residue for cutting on a rigid surface.

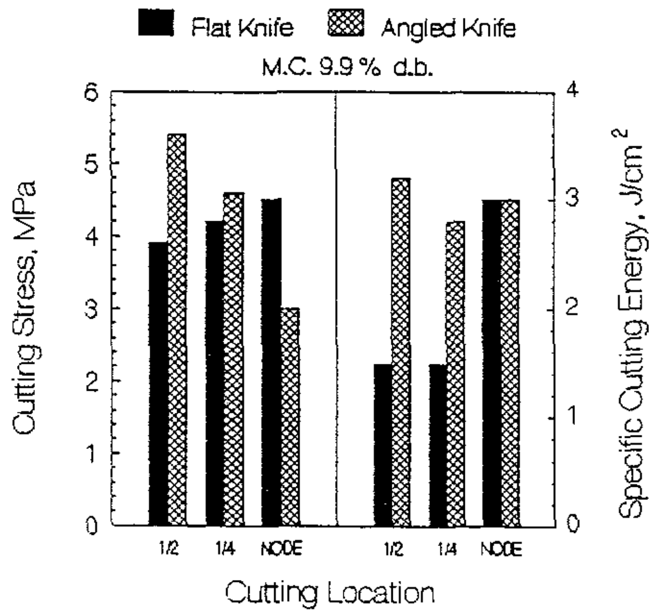

Figure 23. Cutting location effect of soybean residue for cutting on a rigid surface.

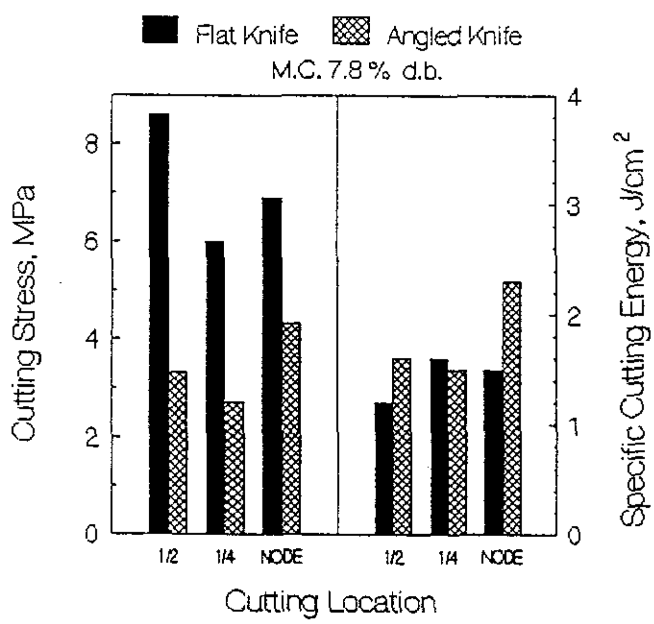

Figure 24. Cutting location effect of wheat residue for cutting on a rigid surface.

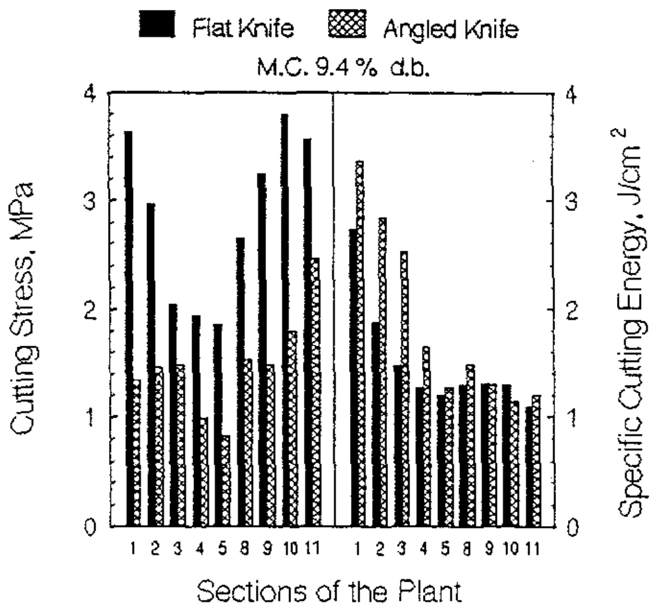

Figure 25. Section effect of corn residue for cutting on a rigid surface.

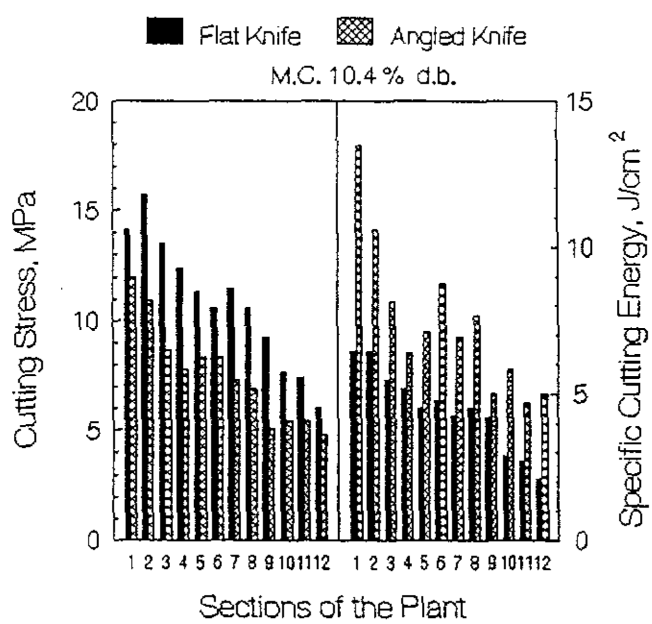

Figure 26. Section effect of cotton residue for cutting on a rigid surface.

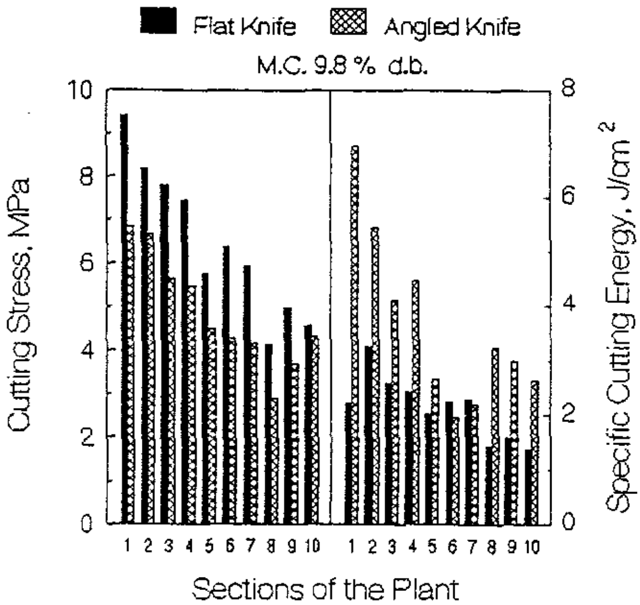

Figure 27. Section effect of soybean residue for cutting on a rigid surface.

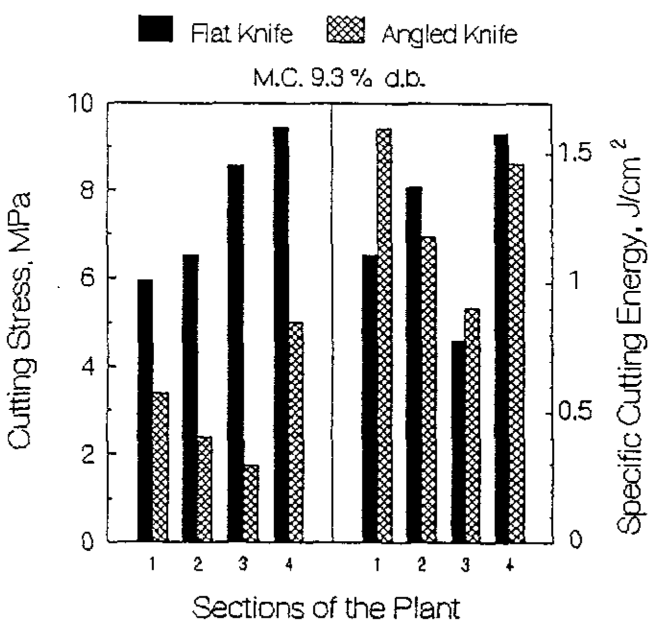

Figure 28. Section effect of wheat residue for cutting on a rigid surface.

of the stalk on cutting stresses and specific cutting energy. The trend for cotton and soybean residue tended to be decreasing cutting stress and specific cutting energy as the section being cut moved up from the base of the stalk, while corn and wheat residue tended to have minimums and maximums. Cutting stress for the flat knife was always higher than that for the angled knife; but specific cutting energy was generally higher for the angled knife than the flat knife. There was more cutting displacement for the angled knife compared to the flat knife (see Appendix C).

Effect of moisture content of the residue

Moisture content (M.C.), which is one of the main factors that changes the strength level of the residue, had a significant effect between 10% and 20%, but not between 20% and 40%. Figures 29-32 show the effect of knife type and moisture content on cutting stresses and specific cutting energy. Moisture content significantly affected cutting residue on a rigid surface with the flat and angled knife. It is important to note that residue was not cut with the flat knife for the corn, cotton, and soybean residue at higher moistures (Figures 29-31), while the wheat residue was severed at all moisture for both knife types due to holding effect. This emphasizes the importance of considering residue strength and knife type.

The specific cutting energy requirement was the lowest for the lowest residue moisture content with the exception

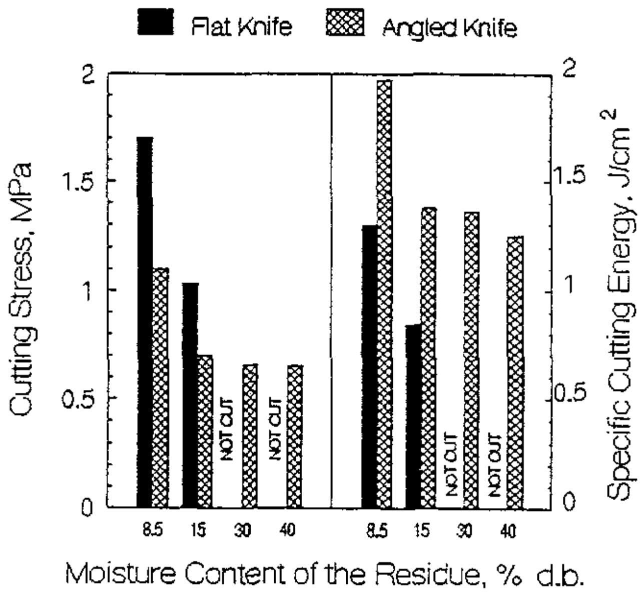

Figure 29. Moisture content effect of corn residue for cutting on a rigid surface.

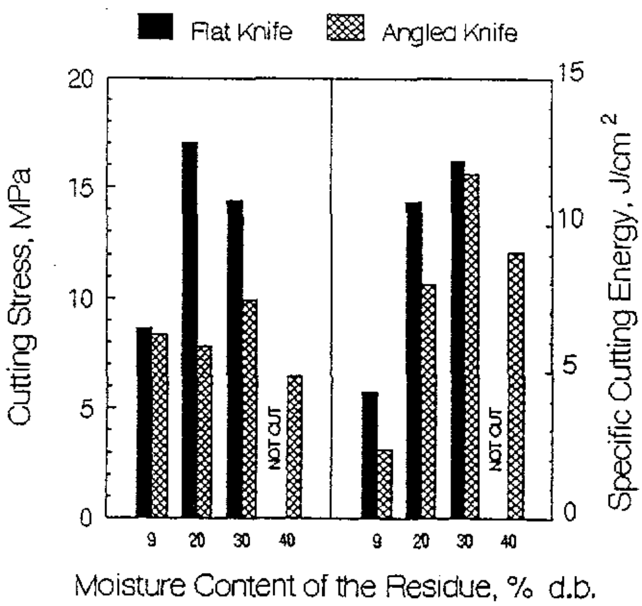

Figure 30. Moisture content effect of cotton residue for cutting on a rigid surface.

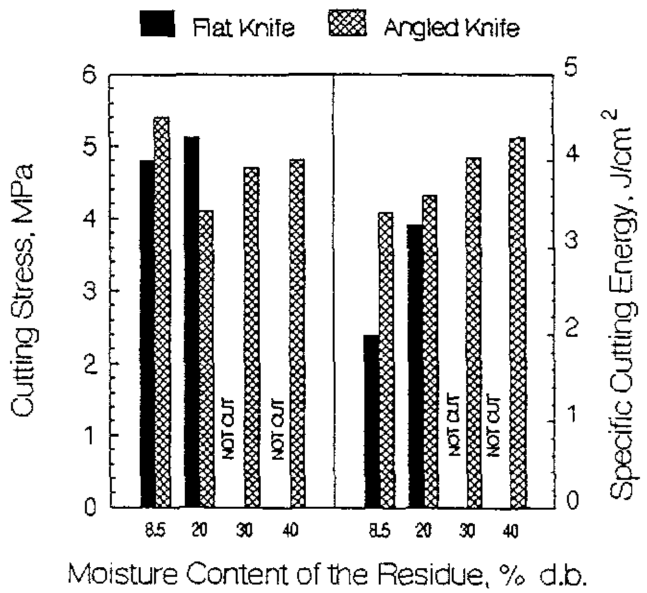

Figure 31. Moisture content effect of soybean residue for cutting on a rigid surface.

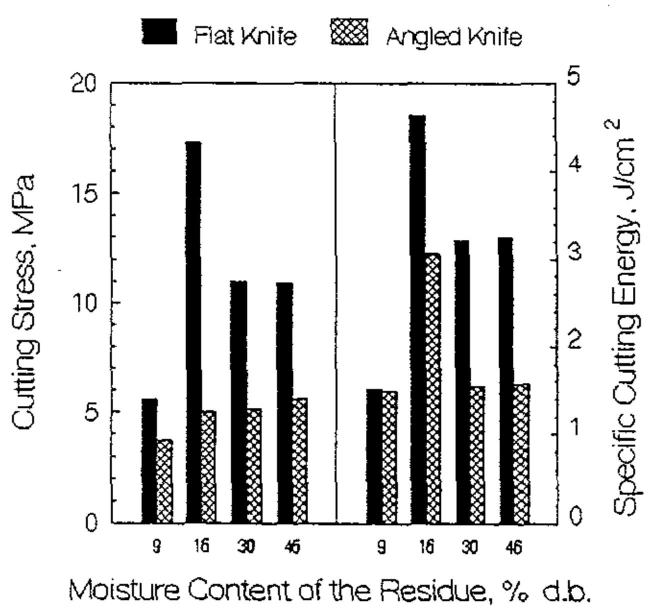

Figure 32. Moisture content effect of wheat residue for cutting on a rigid surface.

of corn residue (Figure 29) (see Appendix C).

Effect of tensile force

Figures 33-35 show the effect of knife type and tensile force on cutting stresses and specific cutting energy for corn, cotton and soybean residues. Tensile force had a significant effect only on the corn residue for cutting with flat knife. The cutting stress and the specific cutting energy requirement increased considerably for cutting corn residue with flat knife as tensile force increased, while the effect on cotton and soybean residue was found not statistically significant (95% level). The specific cutting energy of the soybean residue for the angled knife decreased considerably as tensile force increased. Tensile force effect on the wet residues for all moisture contents was found not significant for both knives (see Appendix C).

Generally, cotton requires more cutting stress and specific cutting energy than the other residues due to its stiff structure. Approximately 5 MPa cutting stress and 2.5 J/cm^2 specific cutting energy were sufficient to cut the soybean and wheat residue, whereas cotton requires twice as much. Considering all four residues, corn residue required the least amount of cutting stress and specific cutting energy which were an average of 1 MPa and 1.5 J/cm^2, respectively. In terms of force requirements, wheat took the least force; 5 to 10 N. The average force to cut the wet or dry residues either with the flat or angled knife for small

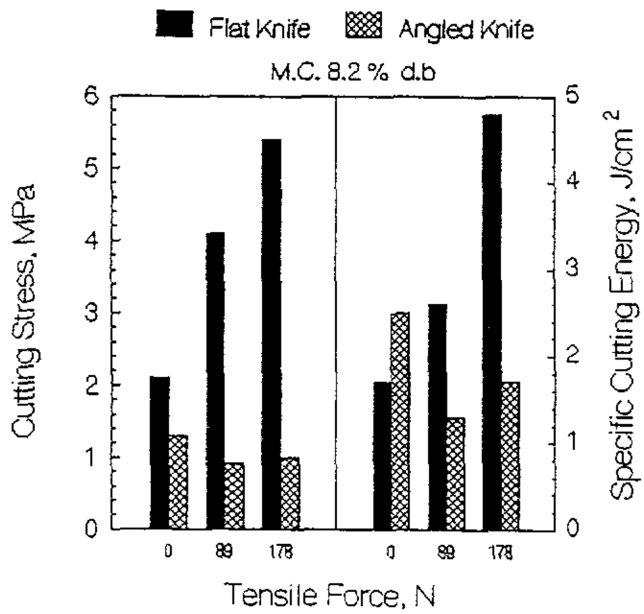

Figure 33. Tensile force effect on corn residue for cutting on a rigid surface.

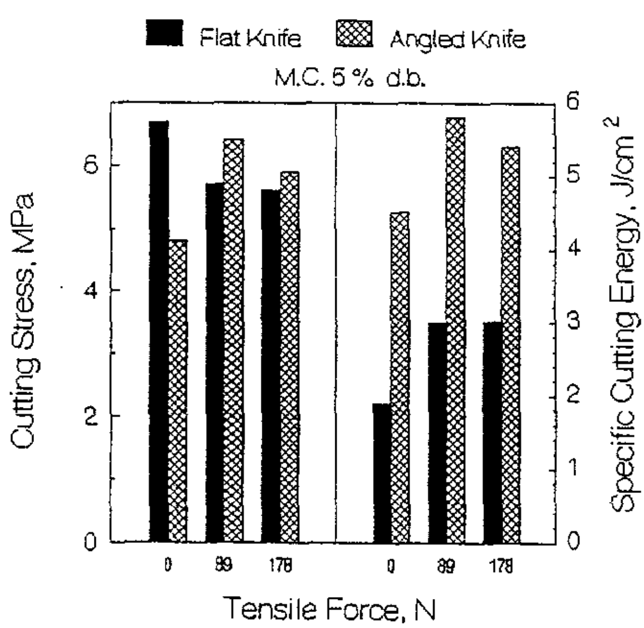

Figure 34. Tensile force effect on cotton residue for cutting on a rigid surface.

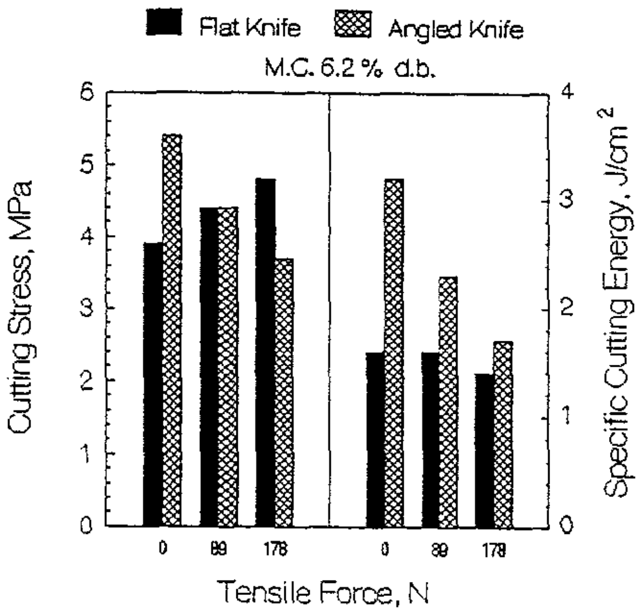

Figure 35. Tensile force effect on soybean residue for cutting on a rigid surface.

and large stem sizes were 145-300 N for corn; 300 to 600 N for cotton; 100 to 400 N for soybean; and 5 to 24 N for wheat residue.

Cutting Plant Residues on a Soil Surface

Cutting Stress Pattern

Cutting the residue on a soil surface differs from cutting on a rigid surface. Cutting stress patterns for both knives increased somewhat linearly from the beginning of the cut to the severance of the stalk for all residues wet or dry except for corn residue. Corn residue's cutting behavior on a soil surface was like the corn cutting on the rigid surface: first the cutting stress increased somewhat linearly and then the stress remained constant due to compression while displacement increased. At the end of this compression, cutting stress increased rapidly until severance (Figure 15). However, corn residue taken from the last sections of the plant (top of the plant) behaved the same as the other residue since the cortex is thin in these last sections.

Effect of cross-sectional area of the residue

Similar to cutting on a rigid surface, cutting stress and specific cutting energy were found to be independent of the cross-sectional area of the residue. Cutting force and total cutting energy increased as residue cross-sectional area increased, while stress and specific cutting energy remained unchanged. Figures 36-39 show the effect of cross-sectional area along with the knife type effect for the soil compacted with 2 roller passes. Although there were some differences regarding the means on both knives, statistically no significant differences were found for cutting stress and specific cutting energy with changing area of the residue except for cotton residue; stress was statistically significant for cutting the smallest area of the cotton residue with the flat knife (see Appendix D).

Like cutting on a rigid surface, the flat knife cut the residue with higher stress but less specific cutting energy for all areas than the angled knife with some

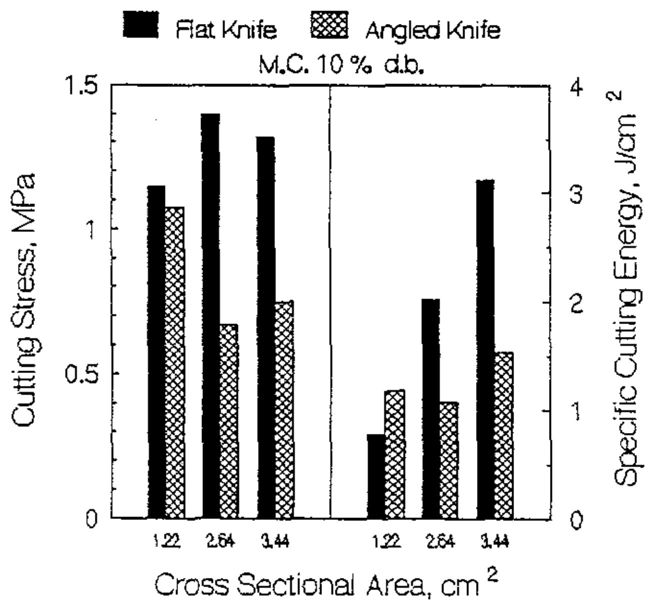

Figure 36. Cross-sectional area effect of corn residue for cutting on a soil surface.

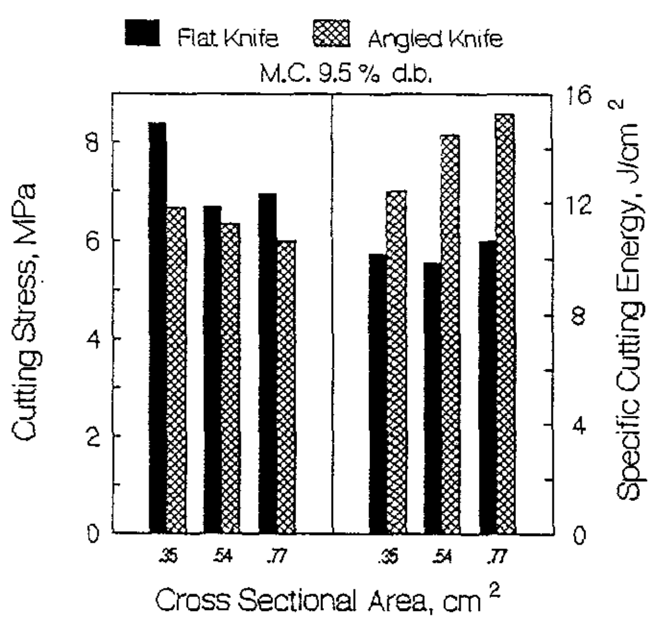

Figure 37. Cross-sectional area effect of cotton residue for cutting on a soil surface.

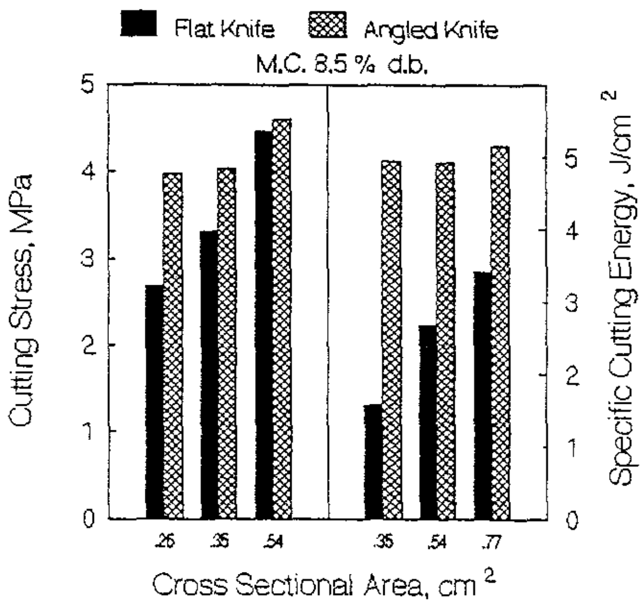

Figure 38. Cross-sectional area effect of soybean residue for cutting on a soil surface.

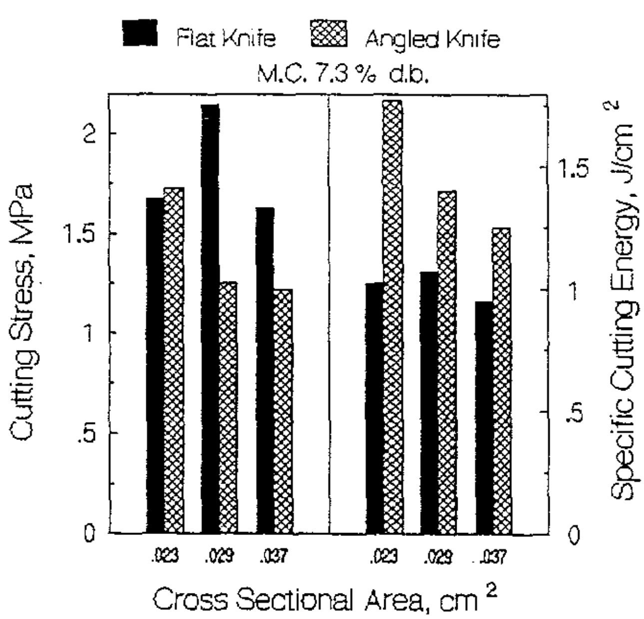

Figure 39. Cross-sectional area effect of wheat residue for cutting on a soil surface.

exceptions. Specific cutting energy of corn was higher for the flat knife with large cross-sectional areas. Cutting stress was found higher for the angled knife with small cross-sectional areas of soybean residue.

Effect of moisture content of the residue

Figures 40-43 show the effect of knife type and moisture content on cutting stresses and specific cutting energy for cutting the residue on a soil surface (compacted with 2 roller passes). Except for corn residue, cutting force, stress, total cutting energy and specific cutting energy increased with increasing moisture content for cutting with the flat knife. Moisture content not significant for cutting the residue with the angled knife. Similarly, cutting stress and specific cutting energy were not significantly influenced by moisture content for cutting corn residue with either the flat or angled knife (Figure 40). Only the cutting force was found to be significantly higher for cutting wet corn residue (see Appendix D).

Effect of section

Section effect was found significant for all residues except for wheat residue. The cutting stress of the residue from the base of the plant to the top of the plant changes when cutting corn and soybean residue on a soil surface. Specific cutting energy of corn and cotton residues decreased from the first section to the last section of the stalk while cutting stress remains unchanged for both knives

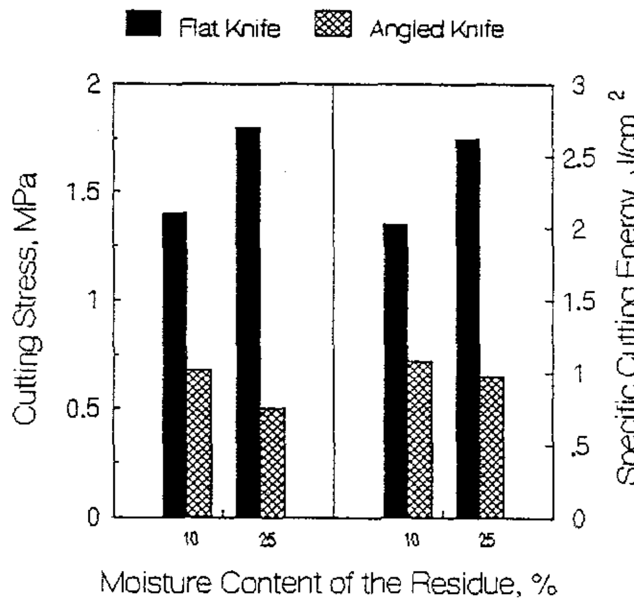

Figure 40. Moisture content effect of corn residue for cutting on a soil surface.

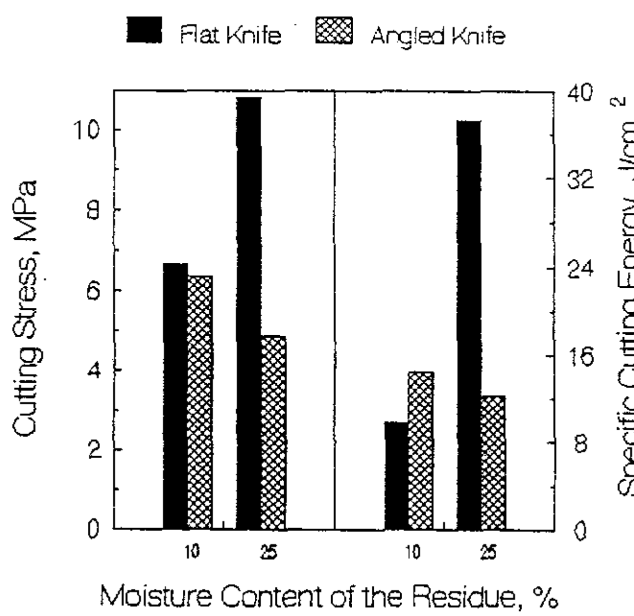

Figure 41. Moisture content effect of cotton residue for cutting on a soil surface.

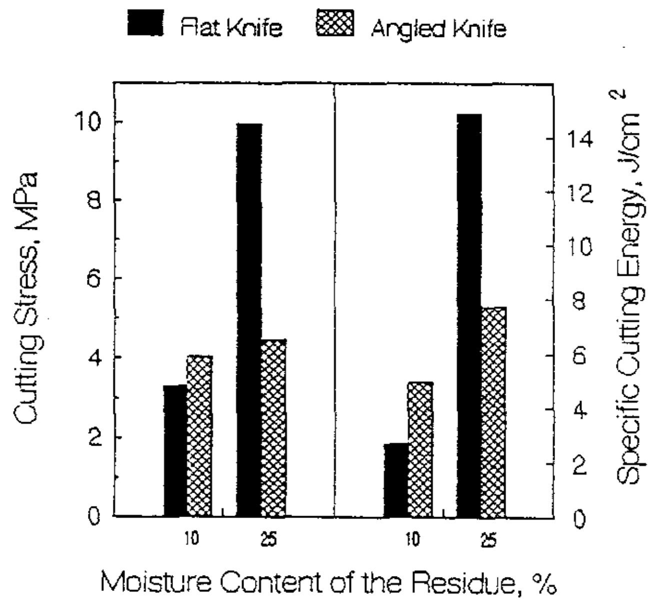

Figure 42. Moisture content effect of soybean residue for cutting on a soil surface.

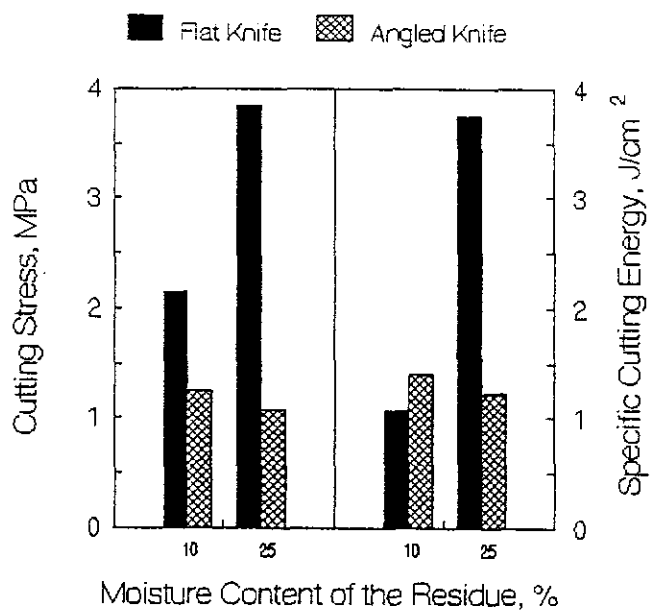

Figure 43. Moisture content effect of wheat residue for cutting on a soil surface.

(Figures 44 and 45). For soybean residue, cutting stress first increased and then decreased from first section to the last section of the plant while the specific cutting energy remained same (Figure 46, Appendix D).

Holding and moisture content effect

Holding the wet or dry residue ends did not affect cutting on the soil surface. It should be noted that holding was required to cut both wet or dry residue on the soft soil surface. Residue could not be cut with either the flat or angled knife without holding the residue ends. But the holding effect was not statistically significant compared to cutting on a hard soil surface (see Appendix D).

Soil strength effect

For cutting wet residue, soil strength plays an important role. More cutting force and total cutting energy were needed to cut the wet residue on more compacted soil. Although the net residue cutting force did not change, total cutting force (force to cut the residue plus force to cut the soil) increased with increasing soil strength (see Appendix B).

Adequate soil strength was found to be essential to cut the dry or wet residue with both the flat and angled knives. Very soft soil did not give enough support to cut the residue. On the other hand, very hard soil did not change the way of cutting but increased the necessary total force

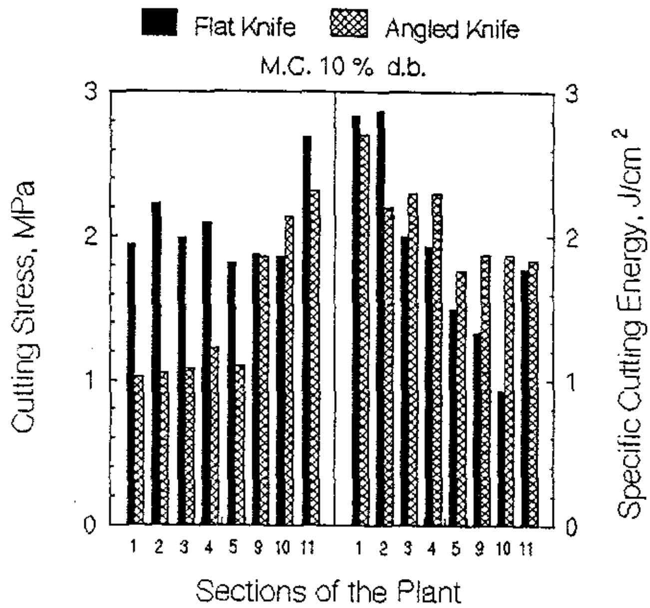

Figure 44. Section effect of corn residue for cutting on a soil surface

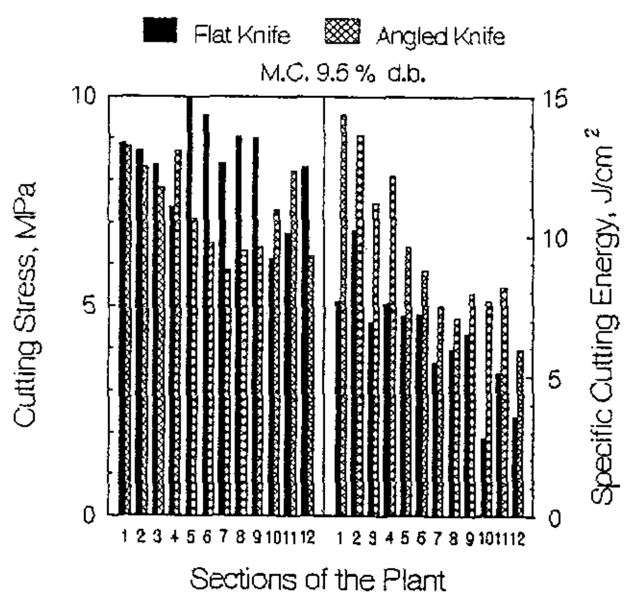

Figure 45. Section effect of cotton residue for cutting on a soil surface.

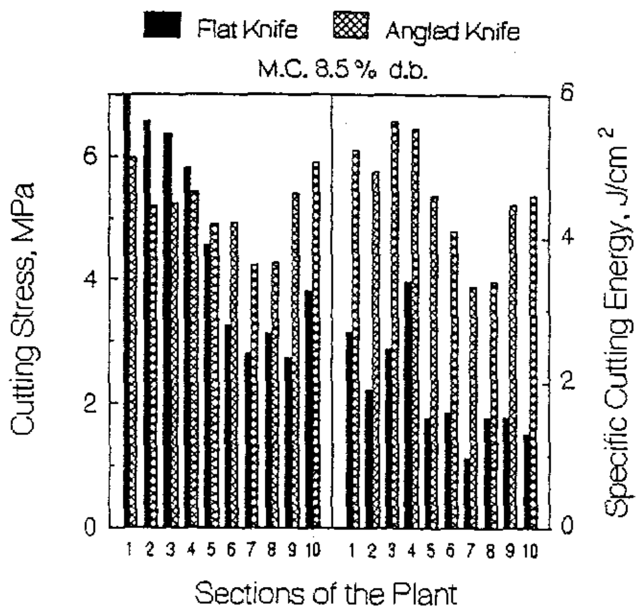

Figure 46. Section effect of soybean residue for cutting on a soil surface.

to cut the residue due to the effect of cutting the soil.

V. DIMENSIONAL ANALYSIS

It is possible that some functional relationship between the variables could be found to develop empirical equations for cutting residue on a soil surface with respect to cutting residue on a rigid surface. The pertinent variables for cutting on both surfaces were considered. Variables that represented indices of the residue properties and the soil strength for both knife types were considered. Dimensional analysis and the Buckingham Pi Theorem (Murphy, 1950; and Young, 1992) were used to formulate the expected pi terms for cutting on a soil surface with respect to a rigid surface.

Cutting on a Rigid Surface

The chosen pertinent variables and their basic dimensions for cutting residue on a rigid surface with a given knife, assuming a piecewise linear stress-strain relationship, were:

$$E_i=f(S_p,D,\sigma_1,m_1,\sigma_2,m_2,\sigma_3,m_3\ldots,\sigma_k,m_k,\nu_1,\nu_2,\nu_3,\ldots,\nu_k) \tag{22}$$

where

E_i= specific cutting energy on a rigid surface; FL^{-1}

S_p= peak cutting stress required; FL^{-2}

D= diameter of the residue; L

σ_j= piece-wise stress point on "stress-strain" curve; j=1,...,k; FL^{-2}

m_j= slope of piece-wise linear segment along "stress-strain" curve; j=1,...,k; FL^{-2}

υ_j= Poisson ratio "like" variables; ratio of lateral strains to longitudinal strains at piece-wise linear "stress points",σ_j; j=1,...,k; F^oL^o

where F and L are the basic dimensions of force and length, respectively.

Using the Buckingham Pi theorem, pi terms were formed as follows:

$$\pi_{1R}=\frac{E_i}{S_p\ D}=\phi\left(\frac{\sigma_1}{\sigma_2},\frac{\sigma_1}{m_1},\frac{\sigma_2}{m_2},\frac{\sigma_3}{m_3},\ldots,\frac{\sigma_k}{m_k},\frac{m_2}{m_1},\frac{m_3}{m_1},\ldots,\frac{m_k}{m_1},\nu_1,\nu_2,\nu_3,\ldots,\nu_k\right) \quad (23)$$

Since the pi terms in the parenthesis are totally defined by stress-strain behavior of the residue, π_{1R}, $E_i/S_p\ D$, becomes constant for a given knife and residue.

Statistical descriptions of the π_{1R} values for cutting corn, cotton, and soybean residues with the flat and angled knives are given in Tables 7 and 8. For three residues, π_{1R} values were 0.59 and 1.14 for cutting with the flat and angled knives, respectively. The linear correlation between the E_i and S_p D was 0.96 for cutting with the flat knife and 0.91 for cutting with the angled knife.

Table 7. Statistical descriptions of $\pi_{1R}=E_i/S_p D$ for cutting corn, cotton, and soybean residue with the flat and angled knives on a rigid surface.

	CORN, COTTON, AND SOYBEAN RESIDUE	
	FLAT KNIFE	ANGLED KNIFE
Mean	0.59	1.14
Std. Deviation	0.09	0.25
Minimum	0.38	0.39
Maximum	0.78	1.69
No. of Observations	51	82

Table 8. Statistical descriptions of $\pi_{1R}=E_i/S_p D$ for cutting wheat residue with the flat and angled knives on a rigid surface.

	WHEAT RESIDUE	
	FLAT KNIFE	ANGLED KNIFE
Mean	2.00	2.55
Std. Deviation	0.56	0.83
Minimum	1.16	0.98
Maximum	3.66	4.47
No. of Observations	29	29

π_{1R} values were found quite different on wheat residue. The means were 2.00 and 2.55 for cutting with the flat and angled knives, respectively. The standard deviations were higher for wheat than the other residues. The linear correlation between the E_i and S_p D was 0.85 for cutting with flat knife and 0.55 for cutting with the angled knife.

Another pi term, the ratio of the vertical displacement of the knife until severance of the residue, δ, to the diameter of the residue, D, called π_{2R}, appears to be constant for a given residue and knife type.

$$\pi_{1R} = \frac{\delta}{D} = Constant \tag{24}$$

Statistical descriptions of the π_{2R} values for cutting corn, cotton, and soybean residues with the flat knife are given in Table 9. The average value of π_{2R} for all three residues ranged between 0.94 and 1.17 with a standard deviation of 0.07 and 0.32, respectively. The π_{2R} values for the angled knife were different than the flat knife. π_{2R} was between 1.73 and 1.91 with a standard deviation of 0.63 at maximum for three residue types (Table 10).

The consolidated π_{2R} values for cutting corn, cotton, and soybean residues with the flat and angled knives are given in Table 11. The mean of π_{2R} values was 1.04 for the flat knife and 1.81 for the angled knife.

Table 9. Statistical descriptions of $\pi_{2R}=\delta/D$ for cutting corn, cotton, and soybean residue with the flat knife on a rigid surface.

	FLAT KNIFE		
	CORN	COTTON	SOYBEAN
Mean	1.01	1.17	0.94
Std. Deviation	0.07	0.30	0.32
Minimum	0.86	0.87	0.44
Maximum	1.2	2.36	2.16
No. of Observations	44	49	45

Table 10. Statistical descriptions of $\pi_{2R}=\delta/D$ for cutting corn, cotton, and soybean residue with the angled knife on a rigid surface.

	ANGLED KNIFE		
	CORN	COTTON	SOYBEAN
Mean	1.74	1.91	1.73
Std. Deviation	0.28	0.47	0.63
Minimum	0.72	0.78	0.78
Maximum	2.46	2.67	4.96
No. of Observations	54	55	55

Table 11. Statistical descriptions of $\pi_{2R}=\delta/D$ for cutting corn, cotton, and soybean residue with the flat and angled knives on a rigid surface.

	FLAT KNIFE	ANGLED KNIFE
Mean	1.04	1.81
Std. Deviation	0.27	0.45
Minimum	0.44	0.72
Maximum	2.36	4.96
No. of Observations	138	162

π_{2R} values for wheat residue were different than the rest of the residues. The means were 2.88 for the flat knife and 3.48 for the angled knife (Table 12) with higher standard deviations than those for the corn, cotton, and soybean residues. Confidence intervals of samples assuming normal distributions can be written as (Miller et al., 1990)

$$\bar{X}+t_{\alpha/2}\cdot\frac{s}{\sqrt{n}}<\mu<\bar{X}-t_{\alpha/2}\cdot\frac{s}{\sqrt{n}} \tag{25}$$

Using equation (23), 95% confidence intervals were calculated and given in Table 13. π_{2R} values for cutting corn, cotton, and soybean residue were approximately 1.0 for cutting with the flat knife, and 1.8 for cutting with the angled knife. For cutting wheat residue, π_{2R} values were

Table 12. Statistical descriptions of $\pi_{2R}=\delta/D$ for cutting wheat residue with the flat and angled knives on a rigid surface.

	FLAT KNIFE	ANGLED KNIFE
Mean	2.88	3.48
Std. Deviation	1.31	0.94
Minimum	1.02	0.94
Maximum	5.32	6.12
No. of Observations	32	31

approximately 2.9 and 3.5 for cutting with the flat and angled knives, respectively.

Cutting on a Soil Surface

The chosen pertinent variables and their basic dimensions for cutting residue on a soil surface with respect to cutting on a rigid surface with a given knife were:

$$F_t=f(E_i,D,CI_{avg}) \tag{26}$$

where

F_t= total cutting force; F

E_i= specific cutting energy (Energy/Area) on a rigid surface; FL^{-1}

Table 13. Calculated confidence intervals of $\pi_{2R}=\delta/D$ for cutting residue on a rigid surface.

Cutting Knife, Residue	Confidence Interval (95 %)
Flat Knife, Corn	$0.99 < \mu < 1.03$
Flat Knife, Cotton	$1.09 < \mu < 1.26$
Flat Knife, Soybean	$0.85 < \mu < 1.03$
Angled Knife, Corn	$1.66 < \mu < 1.81$
Angled Knife, Cotton	$1.78 < \mu < 2.03$
Angled Knife, Soybean	$1.56 < \mu < 1.90$
Flat Knife, All (except wheat)	$1.00 < \mu < 1.09$
Angled Knife, All (except wheat)	$1.74 < \mu < 1.89$
Flat Knife, Wheat	$2.42 < \mu < 3.33$
Angled Knife, Wheat	$3.15 < \mu < 3.81$

$D=$ diameter of the residue; L

$CI_{avg}=$ average cone index to depth of $\delta+D$ (depth of the residue diameter + vertical travel distance of the knife during cutting); FL^{-2}

where F and L are the basic dimensions of force and length, respectively.

Using the Buckingham Pi theorem, two pi terms were formed:

$$\pi_{1S}=\frac{F_t}{CI_{avg}\ D^2} \tag{27}$$

$$\pi_{2S}=\frac{CI_{avg}\ D}{E_i} \tag{28}$$

The average cone index used in the pi terms was calculated from the average of the cone index of the three measured cone resistance versus depth data taken from each compaction level of the soil. Figures 47 and 48 show these cone index data for two compacted levels of the Norfolk Sandy Loam soil. To calculate the average cone index, the area under the average cone index curve was divided by the depth in soil at which the residue was cut as follows:

$$CI_{avg}=\frac{\int_0^d CI\ dx}{d} \tag{29}$$

Figures 49 and 50 show the relationship of the two pi terms. In figures 51 and 52, δ was added to the D (diameter) to examine the δ+D effect on the pi terms by taking the average cone index for a δ+D depth into the soil. Although it did not affect the results for residues other than wheat, D itself was sufficient enough in the π_{2S} term to include wheat residue along with the other residues. Figures 53 and 54 show the log-log relationship between the two pi terms.

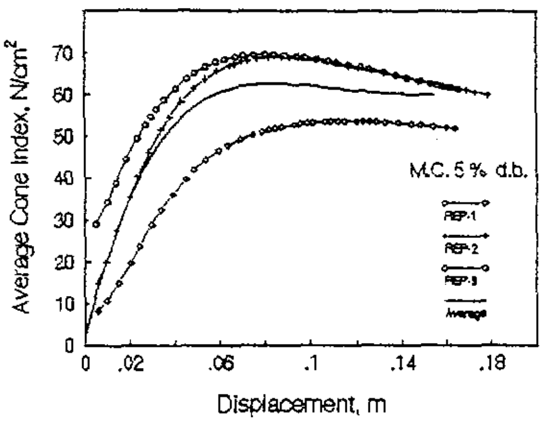

Figure 47. Cone resistance readings of Norfolk Sandy Loam soil with two roller passes.

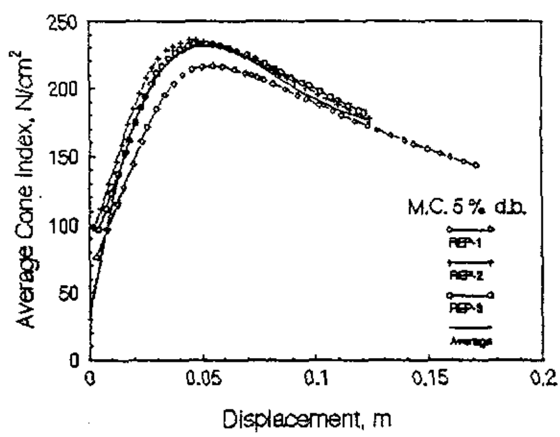

Figure 48. Cone resistance readings of Norfolk Sandy Loam soil with five roller passes.

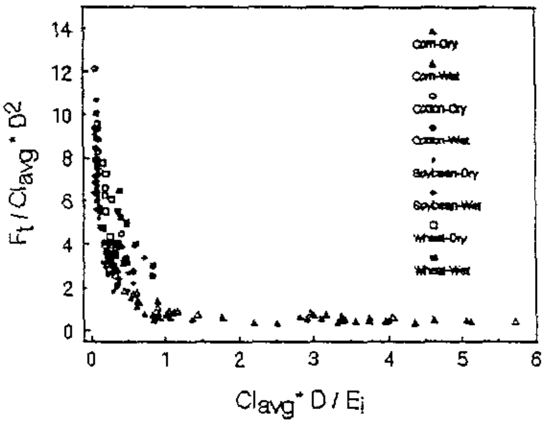

Figure 49. π_{1S} versus π_{2S} for cutting corn, cotton, soybean, and wheat residue on a soil surface with the angled knife.

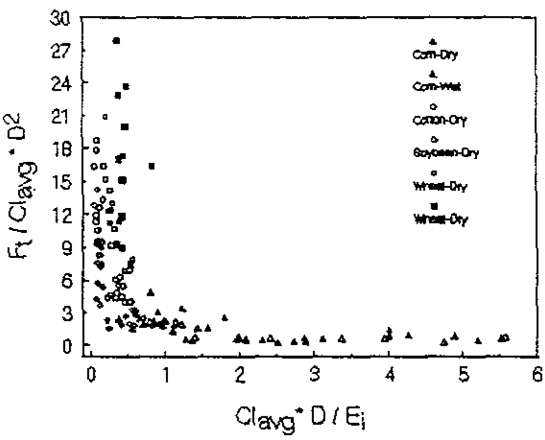

Figure 50. π_{1S} versus π_{2S} for cutting corn, cotton, soybean, and wheat residue on soil surface with the flat knife.

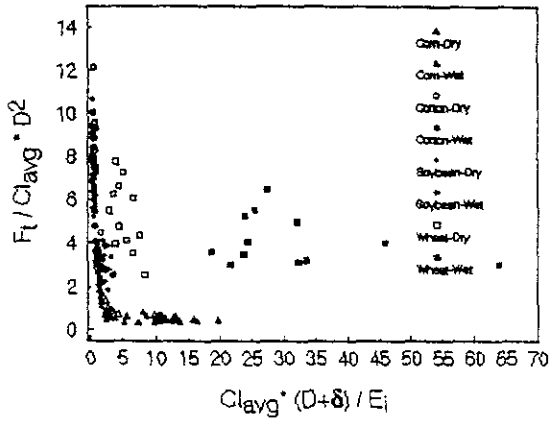

Figure 51. π_{1S} versus π_{2S} (δ included) for cutting corn, cotton, soybean, and wheat residue on a soil surface with the angled knife.

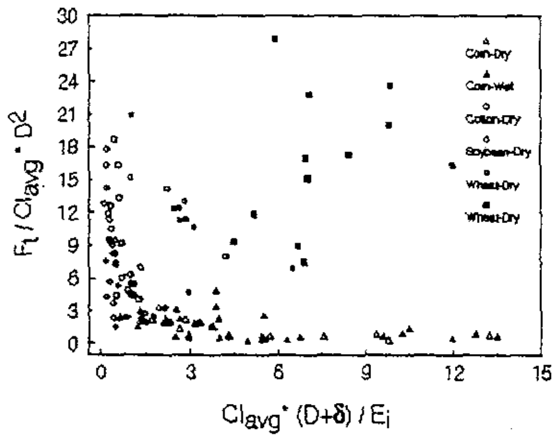

Figure 52. π_{1S} versus π_{2S} (δ included) for cutting corn, cotton, soybean, and wheat residue on a soil surface with the flat knife.

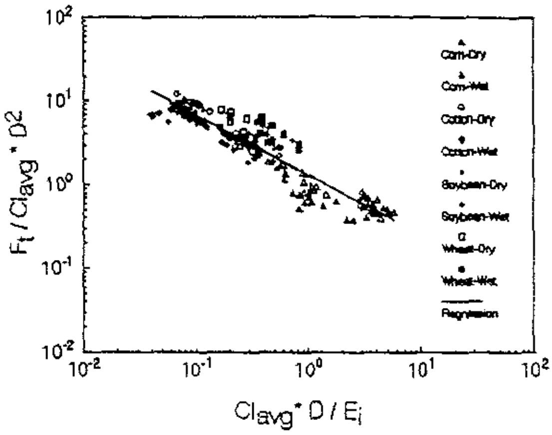

Figure 53. Log-log graph of π_{1S} versus π_{2S} for cutting residue on a soil surface with the angled knife.

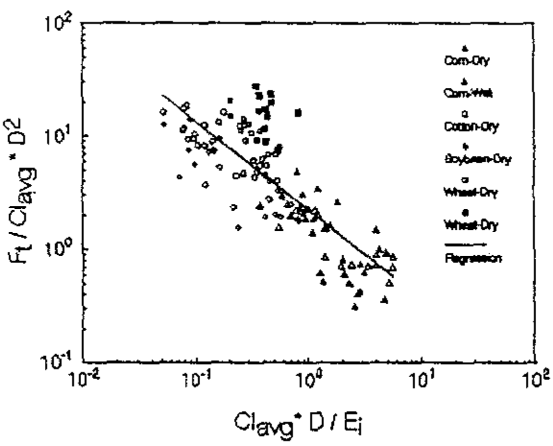

Figure 54. Log-log graph of π_{1S} versus π_{2S} for cutting residue on a soil surface with the flat knife.

The relationship appears to be a straight line in the log-log plots. The coefficient of determination (R^2) was 0.87 for cutting with an angled knife and 0.65 for cutting with a flat knife (Table 14 and 15).

By using the regression equations from Tables 14 and 15, an empirical equation for cutting residue on a soil surface with the flat or the angled knife can be written in the form of:

$$\pi_{1S}=A(\pi_{2S})^{b} \tag{30}$$

where

A = constant,

b = slope of line in the log-log plot,

and π_{1S}, and π_{2S} are defined in equations (27) and (28), respectively. Equation 30 was linearized for statistical regression purposes as:

$$\ln\pi_{1S}=lnA+b\ \ln\pi_{2S}=a+b\ \ln\pi_{2S} \tag{31}$$

where a=lnA.

Estimates of variances of the constant **a** and slope **b** were calculated as follows (Young, 1992):

$$s_a^{\,2}=s_{y.x}^{\,2}\left(\frac{1}{n}+\frac{(\bar{x})^2}{\sum (X-\bar{x})^2}\right) \tag{32}$$

and

$$s_b^{\,2}=\frac{s_{y.x}^{\,2}}{\sum (X-\bar{x})^2} \tag{33}$$

Table 14. Linear regression results of Ln π_{1s} vs. Ln π_{2s} for cutting residue on a soil surface with the angled knife.

Intercept, a	0.275
Std. Err. of Y Est., $S_{y.x}$	0.345
R Squared	0.874
No. of Observations	168
Degrees of Freedom	166
Slope, b	-0.711
Std. Err. of b, S_b	0.021

Table 15. Linear regression results of Ln π_{1s} vs. Ln π_{2s} for cutting residue on a soil surface with the flat knife.

Intercept, a	0.810
Std. Err. of Y Est. $S_{y.x}$	0.683
R Squared	0.644
No. of Observations	118
Degrees of Freedom	116
Slope, b	-0.784
Std. Err. of b, S_b	0.054

$t_{0.05} \cong 1.645$ for n=168

$t_{0.05} \cong 1.658$ for n=118

where

$$\bar{x}=\frac{\sum X}{n} \quad \text{and} \quad s_{y,x}{}^{2}=\frac{\sum_{i=1}^{n}[Y_i-(a+bX_i)]^2}{n-2}$$

The confidence intervals of constant **a** and slope **b** can be expressed as $a \pm t_{\alpha} s_a$ and $b \pm t_{\alpha} s_b$, respectively, where the t_{α} is the t-statistic value at any level of α. The 95% confidence intervals of **A** and **b** were calculated as:

$$1.236<A<1.402$$

$$-0.746<b<-0.677$$

for cutting with the angled knife, and

$$1.996<A<2.531$$

$$-0.873<b<-0.695$$

for cutting with the flat knife,

Using the means of constant **A** and slope **b**, an empirical equation can be written as:

$$\pi_{1S}=1.316(\pi_{2S})^{-0.711} \tag{36}$$

for cutting with the angled knife, and

$$\pi_{1S}=2.248(\pi_{2S})^{-0.784} \tag{37}$$

for cutting with the flat knife.

Total cutting force, F_t can be estimated from equations (36) and (37) for the angled and flat knife, respectively:

$$F_t=1.316CI_{avg}^{0.289}D^{1.289}E_i^{0.711} \tag{38}$$

$$F_t=2.248CI_{avg}^{0.216}D^{1.216}E_i^{0.784} \tag{39}$$

Comparing the predicted values to actual values, total cutting force was predicted with equations (38) and (39) within the confidence interval. Only a few predicted total cutting force values were found to be outside the confidence intervals.

Another pi term for cutting the residue on a soil surface can be written independently from the other two pi terms as:

$$\pi_{3S}=\frac{\delta}{D} \tag{40}$$

where δ, is the vertical displacement of the knife until severance of residue and D, is the diameter of the residue.

The π_{3S} term, similar to π_{2R} which was influential for cutting on a rigid surface, was found significant for cutting corn, cotton, and soybean residue with the flat knife only. The mean of π_{3S} was 1.73 with a standard deviation of 0.67 for cutting these three types of residue with the flat knife. Unlike cutting residue on a rigid surface, π_{3S} values didn't appear to be constant on wheat residue for cutting with either the flat or angled knives. For cutting corn, cotton, and soybean residue with an angled knife, the mean of π_{3S} was 3.37; minimum at 1.1 and maximum at 7.58 with a high standard deviation of 1.37.

VI. SUMMARY AND CONCLUSIONS

The nature of the residue uniquely influences the cutting characteristics of the residue. Residue strength changes rapidly with moisture from section to section of the residue. The structure of the residue and the knife type create significant differences among the residues regarding cutting behavior. Although corn residue with high moisture content is easily cut with an angled knife with reduced cutting stress and specific cutting energy, cutting cotton, soybean, and wheat residue with a flat knife became more difficult due to these residues' natural internal structure. Residue type, residue and soil strength, and knife type all played an important role in defining the mechanics of cutting plant residue.

The results from cutting residue on rigid and soil surfaces can be summarized as follows:

1. The cutting stress and specific cutting energy of all residues were independent of the cross-sectional area within a section between nodes. Although the cutting force and energy increased with an increase in the

cross-sectional area of the residue, the cutting stress and specific cutting energy remained relatively constant.

2. The residue sections influenced cutting. From the bottom to the top of the residue, cutting stress and specific cutting energy requirements decreased significantly, except for wheat residue. Section effect was not significant for wheat residue cut on a soil surface.
3. Moisture content (M.C.), which is one of the main factors that changes the strength level of the residue, had a significant effect between 10% and 20%, but not between 20% and 40%. Moisture content significantly affected cutting residue on a rigid surface with the flat or the angled knife. Similarly, M.C. significantly affected cutting residue on a soil surface with some exceptions. Cutting residue on a soil surface with the angled knife and cutting the corn residue with both knives were not significantly affected by M.C.
4. The cutting locations between the nodes and next to a node had no significant effect on cutting stress or specific cutting energy. Cutting on the node was significant compared to the other two locations. Cutting on the node increased both cutting stress and specific cutting energy for corn, soybean, and wheat

residue. Cutting locations did not influence cotton residue even cutting on the node.

5. Tensile force applied during cutting did not significantly affect cutting of cotton and soybean residue. Tensile force had a significant effect on cutting corn residue with a flat knife due to the holding effect. However, the tensile force helped to cut any residue with high M.C. with a flat knife because it enhanced penetration into the residue. Holding effect for cutting the residue on a hard soil surface was not significant. Holding the residue was required to cut the residue on a soft soil. Residue could not be cut with either the flat or angled knife without holding the residue ends on the soft soil.
6. The flat knife had higher cutting stresses but required less specific cutting energy than the angled knife.
7. The angled knife had more cutting displacement than the flat knife (approximately twice that of the flat knife) due to the sliding action.
8. Using Buckingham Pi theorem, it was found that the pi term:

$$\pi_{1R}=\frac{E_i}{S_p\ D}$$

was constant for a given knife and residue on a rigid surface. For cutting corn, cotton, and soybean residue, π_{1R} values were 0.59 and 1.14 for cutting with the flat and angled knife respectively. The linear correlation between the E_i and S_p D were 0.96 for cutting with the flat knife, and 0.91 for cutting with the angled knife. π_{1R} values were different for cutting wheat residue compared to cutting other residue. For cutting wheat residue with the flat knife, π_{1R} was 2.00 and the linear correlation between E_i and S_p D was 0.85. π_{1R} was not constant for cutting wheat residue with the angled knife.

9. Another dimensionless ratio was found influential when cutting residue on a rigid surface. This pi term was:

$$\pi_{2R}=\frac{\delta}{D}=Constant$$

where

δ = vertical travel distance of a knife for cutting

D = diameter of the residue

The mean of π_{2R} values for corn, cotton and soybean residue was 1.04 for flat knife and 1.81 for angled knife. π_{2R} values for wheat residue were different than the rest of the residue. The means for wheat residue were 2.87 for the flat knife and 3.48 for the angled knife with higher standard deviations for both knives comparing the corn, cotton, and soybean residues.

10. Two pi terms were found influential when cutting residue on a soil surface:

$$\pi_{1S}=\frac{F_t}{CI_{avg}\ D^2}$$

$$\pi_{2S}=\frac{CI_{avg}\ D}{E_i}$$

where

F_t=	total cutting force (F)
E_i=	specific cutting energy (Energy/Area)(FL^{-1})
D=	diameter of the residue (L)
CI_{avg}=	average cone index to depth of diameter of the residue plus vertical travel distance of the knife (FL^{-2})

11. The total residue cutting force, F_t, on a soil surface can be estimated with equations as follows:

$$F_t=1.316CI_{avg}^{\ \ 0.289}D^{1.289}E_i^{0.711}$$

for the angled knife; and

$$F_t=2.248CI_{avg}^{\ \ 0.216}D^{1.216}E_i^{0.784}$$

for the flat knife.

12. Another dimensionless ratio π_{3S}, δ/D, for cutting residue on a soil surface, was found influential for cutting corn, cotton, and soybean residue with the flat knife only. The mean of π_{3S} was 1.73 with a standard deviation of 0.67 for cutting these three types of residue with the flat knife.

REFERENCES

ASAE. 1994. Soil Cone Penetrometer. ASAE Standard S313.2. ASAE, St Joseph, MI.

Bilbro, J.D. and D.W. Fryrear. 1985. Effectiveness of residue from six crops for reducing wind erosion in a semiarid region. Journal of Soil and Water Conservation 40(4):385-360.

Burden, R.L. and J.D. Faires. 1989. Numerical Analysis. Fourth Edition. PWS-KENT Publishing Company, Boston, MA.

Choi, C.H. and D.C. Erbach. 1986. Cornstalk residue shearing by rolling coulters. TRANSACTIONS of the ASAE 29(6):1530-1535.

Choi, C.H. 1984. Corn residue shearing by rolling coulters. M.S. thesis. Iowa State University, Ames, IA.

Elliott, L.F., T.M. McCalla, and A. Waiss, Jr. 1978. Phytotoxicity associated with residue management. Crop Residue Management Systems. American Society of Agronomy, Special Publication Number 31, Madison, WI.

Griffin, J.L., R.W. Taylor, and R.J. Habetz. 1981. Wheat-straw residue treatment in a no-till system. Annual Progress Report, Rice Experiment Station, Crowley, Louisiana, 1981:356-358.

Grossbard, E. 1979. The decay of straw on the surface of undisturbed soil in the field and the effect of herbicide. Proceedings of a Symposium on Straw Decay and Workshop on Assessment Techniques, Chichester, U.K. April 1979:177-184.

Hayes, A.W. and L.W. Kimberlin. 1978. A guide for determining crop residue for water erosion control. Crop Residue Management Systems. American Society of Agronomy, Special Publication Number 31, Madison, WI.

Janusz, H., B. Szot, J. Korejtko, and S. Grundas. 1978. Static cutting resistance and energy of stalk of winter wheat and rye. International Conference on Physical Properties of Plan Materials and Their Influences on Technological Processes. 191-199.

Jones, J.W., F.E. Fulgham, and R.F. Colwick 1969. Effect of cotton crop residue on planter performance. ASAE Paper No. 1727.

Kushwaha, R.L., A.S. Vaishnav, and G.C. Zoerb 1986a. Performance of powered-disk coulters under no-till crop residue in the soil bin. Canadian Agricultural Engineering, Ottawa, Ontorio 28(2):85-90.

Kushwaha, R.L., A.S. Vaishnav, and G.C. Zoerb. 1986b. Soil bin evaluation of disk coulters under no-till crop residue conditions. TRANSACTIONS of the ASAE 29(1):40-44.

Larson, W.E., R.F. Holt, and C.W. Carlson. 1978. Residues for soil conservation. Crop Residue Management Systems. American Society of Agronomy, Special Publication Number 31, Madison, WI.

Larson, W.E. 1975. Crop Residues: Energy production or erosion control. A series from the Journal of Soil and Water Conservation. Soil Conservation Society of America, Ankeny, Iowa.. Special Publication No. 25. pp.4-6.

Mannering, J.V. and C.R. Richey. 1975. Tillage for moisture conservation. ASAE Paper No. 75-2523.

Miller, I., E.F. John, A.J. Richard. 1990. <u>Probability and statistics for engineers.</u> Prentice-Hall, Inc. New Jersey.

Mohsenin, N.N. 1986. <u>Physical properties of plant and animal materials.</u> Gordon and Breach Science Publishers. New York.

Murphy, G. 1950. <u>Similitude in engineering</u>. The Donald Press Co., New York.

Patterson, D.E. 1984. The machinery concept for straw incorporation on heavy soil. Workshop papers. National Agricultural Center, Stoneleigh, U.K. November 1984:9-18.

Oliphant, J.M. 1982. the effect of straw and stubble on the yield of winter wheat after cultivations or direct drilling. Experimental Husbandry 38:60-68.

Persson, S. 1987. Mechanics of cutting plant material. An ASAE Monograph Number 7 in a series published by ASAE, St. Joseph, Michigan. pp. 90-93.

Power, J.F. and J.O. Legg. 1978. Effect of crop residues on the soil chemical environment and nutrient availability. Crop Residue Management Systems. American Society of Agronomy, Special Publication Number 31, Madison, WI.

Prince, R.P., D.D. Wolf, J.W. Bartok. 1968. Mechanical properties of corn stalks. Storrs Agricultural Experiment Station, College of Agriculture, The University of Connecticut. Research Report 29.

Raimbault, B.A., T.J. Vyn, M. Tollenaar. 1991. Corn response to rye cover crop, tillage methods, and planter options. Canada Agronomy Journal 83(2):287-290.

Sakharov, V.V., R.Z. Rakhmanberdiev, G.G. Guaev. 1984. An investigation into the severing of pre-tensed mulberry stems by a screw-type cutter. Mekhanizatsiya i Elekfikikatsiya Sel'skago Khozyaistva 3:61-62.

Sitkei, G. 1986. Mechanics of agricultural materials. Elsevier Science Publishing, New York. p. 439-450.

Skidmore, E.L. and F.H. Siddoway. 1978. Crop residue requirements to control wind erosion. Crop Residue Management Systems. American Society of Agronomy, Special Publication Number 31, Madison, WI.

Vaishnav, A.S., R.L. Kushwaha, G.C. Zoerb. 1982. Measurement of shear strength of wheat straw. Canadian Society of Agricultural Engineering. Paper No. 82-305. University of British Columbia, Vancouver, B.C.

Van Doren, D.M., Jr. and R.R. Allmaras. 1978. Effect of residue management practices on the soil physical environment, microclimate, and plant growth. Crop Residue Management Systems. American Society of Agronomy, Special Publication Number 31, Madison, WI.

Young D.F. 1992. Similitude, Modeling, and Dimensional Analysis in Engineering. Lecture notes and problems for EMS 584. Iowa State University, Ames, IA.

APPENDICES

APPENDIX A

DATA TAKEN FOR CUTTING

PLANT RESIDUE ON A RIGID SURFACE

CUTTING PLANT RESIDUE ON RIGID SURFACE

CROSS SECTIONAL AREA EFFECT

RESIDUE M.C. 9.5 %

KNIFE	CROP	AREA (cm^2)	REP (5 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	COTTON	0.314	1	298.56	9.50421	1.37404789	4.374027453
FLAT	COTTON	0.314	2	289.98	9.23092	1.16779062	3.717445573
FLAT	COTTON	0.314	3	315.78	10.0522	1.25497556	3.994982699
FLAT	COTTON	0.314	4	358.75	11.4201	1.43155086	4.557077531
FLAT	COTTON	0.314	5	272.81	8.68434	0.93319543	2.970655144
FLAT	COTTON	0.537	1	287.84	5.3571	1.76066306	3.276803389
FLAT	COTTON	0.537	2	378.05	7.03601	2.06231356	3.83821086
FLAT	COTTON	0.537	3	657.31	12.2333	2.91355077	5.422464576
FLAT	COTTON	0.537	4	320.05	5.95647	2.03914674	3.795094659
FLAT	COTTON	0.537	5	425.34	7.91603	2.20723611	4.107928969
FLAT	COTTON	0.719	1	472.58	6.57115	2.39086905	3.324487248
FLAT	COTTON	0.719	2	549.89	7.64613	3.32621769	4.625083194
FLAT	COTTON	0.719	3	726.04	10.0955	3.66852569	5.101060151
FLAT	COTTON	0.719	4	534.85	7.43707	2.95595054	4.110229226
FLAT	COTTON	0.719	5	1056.8	14.6954	5.58297932	7.763094982
ANGLED	COTTON	0.314	1	244.87	7.79518	1.71901397	5.467465863
ANGLED	COTTON	0.314	2	270.67	8.61647	2.29712189	7.306185838
ANGLED	COTTON	0.314	3	285.71	9.09508	1.55980698	4.961094891
ANGLED	COTTON	0.314	4	341.53	10.8722	2.2075161	7.021187222
ANGLED	COTTON	0.314	5	292.16	9.30041	2.23617035	7.112324418
ANGLED	COTTON	0.537	1	313.6	5.8365	3.20512477	5.959997977
ANGLED	COTTON	0.537	2	358.75	6.67679	4.45371914	8.281785877
ANGLED	COTTON	0.537	3	431.74	8.03533	4.48399706	8.338088317
ANGLED	COTTON	0.537	4	274.94	5.11708	2.86879989	5.334594673
ANGLED	COTTON	0.537	5	305.01	5.67672	2.54126998	4.725545815
ANGLED	COTTON	0.719	1	668.03	9.28902	7.21640433	10.02574784
ANGLED	COTTON	0.719	2	509.1	7.07903	5.06848234	7.041640627
ANGLED	COTTON	0.719	3	522	7.2584	5.19704644	7.220254675
ANGLED	COTTON	0.719	4	646.55	8.99028	5.71851587	7.944731957
ANGLED	COTTON	0.719	5	655.18	9.11027	5.81304938	8.076067337
FLAT	CORN	1.35	1	150.35	1.109	1.14549704	0.844938003
FLAT	CORN	1.35	2	171.83	1.26748	1.61189938	1.188964267
FLAT	CORN	1.35	3	158.93	1.17233	1.2852756	0.948041038
FLAT	CORN	1.35	4	186.87	1.37838	1.66240748	1.226219894
FLAT	CORN	1.35	5	242.74	1.79048	1.70295103	1.256125503
FLAT	CORN	1.78	1	305.01	1.70659	1.73032221	0.968137597
FLAT	CORN	1.78	2	251.32	1.40619	1.64823539	0.922208963
FLAT	CORN	1.78	3	296.43	1.65855	2.33627498	1.307175989
FLAT	CORN	1.78	4	347.98	1.94701	3.13989813	1.756813505
FLAT	CORN	1.78	5	287.84	1.61052	2.35876648	1.319760269
FLAT	CORN	2.37	1	191.18	0.80805	2.44996112	1.035489349
FLAT	CORN	2.37	2	171.83	0.72627	2.17036234	0.917315411

FLAT	CORN	2.37	3	231.97	0.98045	2.38616553	1.008525799
FLAT	CORN	2.37	4	199.77	0.84433	1.81584162	0.767475308
FLAT	CORN	2.37	5	169.7	0.71724	1.42522747	0.602380119
ANGLED	CORN	1.35	1	100.97	0.74481	1.54666184	1.139864645
ANGLED	CORN	1.35	2	163.25	1.20417	2.27208088	1.674486684
ANGLED	CORN	1.35	3	111.69	0.82389	1.83551639	1.35274575
ANGLED	CORN	1.35	4	214.8	1.58445	3.32516886	2.450595416
ANGLED	CORN	1.35	5	135.31	0.99811	1.81964047	1.341045456
ANGLED	CORN	1.78	1	161.11	0.90146	2.98537865	1.668924017
ANGLED	CORN	1.78	2	174.01	0.97364	3.29094685	1.839746604
ANGLED	CORN	1.78	3	270.67	1.51447	4.17707288	2.33511995
ANGLED	CORN	1.78	4	191.18	1.06971	3.22240875	1.801431572
ANGLED	CORN	1.78	5	214.8	1.20187	3.95909181	2.213261427
ANGLED	CORN	2.37	1	167.56	0.70822	2.69177066	1.13671486
ANGLED	CORN	2.37	2	264.22	1.11677	5.66572155	2.392592353
ANGLED	CORN	2.37	3	111.69	0.47209	1.56760595	0.661988412
ANGLED	CORN	2.37	4	184.73	0.7808	3.75960997	1.587655511
ANGLED	CORN	2.37	5	152.53	0.64468	2.31509142	0.977646
FLAT	SOYBEAN	0.225	1	62.275	2.76931	0.17212401	0.764755099
FLAT	SOYBEAN	0.225	2	133.18	5.92236	0.19108918	0.849018239
FLAT	SOYBEAN	0.225	3	60.14	2.67436	0.17779406	0.789947433
FLAT	SOYBEAN	0.225	4	85.939	3.82164	0.29048713	1.290648067
FLAT	SOYBEAN	0.225	5	105.24	4.68013	0.27441512	1.21923933
FLAT	SOYBEAN	0.418	1	214.8	5.13543	1.0133813	2.420640369
FLAT	SOYBEAN	0.418	2	126.73	3.02979	0.63356916	1.513391928
FLAT	SOYBEAN	0.418	3	137.49	3.28714	0.55857929	1.334265372
FLAT	SOYBEAN	0.418	4	156.8	3.74868	0.5882859	1.405224874
FLAT	SOYBEAN	0.418	5	150.35	3.59448	0.60309016	1.440587452
FLAT	SOYBEAN	0.54	1	236.29	4.39766	0.98789093	1.837004293
FLAT	SOYBEAN	0.54	2	563.59	10.4891	1.17999554	2.19422692
ANGLED	SOYBEAN	0.54	3	240.2	4.47051	0.75393015	1.401949211
ANGLED	SOYBEAN	0.54	4	249.19	4.63774	1.11984167	2.08236951
ANGLED	SOYBEAN	0.54	5	279.26	5.19738	1.21123598	2.25231917
ANGLED	SOYBEAN	0.225	1	100.97	4.49023	0.34147652	1.517196342
ANGLED	SOYBEAN	0.225	2	107.42	4.77705	0.66739536	2.965269144
ANGLED	SOYBEAN	0.225	3	98.795	4.39331	0.21214283	0.942560633
ANGLED	SOYBEAN	0.225	4	113.83	5.0619	0.57171348	2.540150003
ANGLED	SOYBEAN	0.225	5	83.76	3.72472	0.38345998	1.703730817
ANGLED	SOYBEAN	0.418	1	201.9	4.82703	0.98353294	2.349342279
ANGLED	SOYBEAN	0.418	2	255.64	6.11168	1.65048045	3.942464316
ANGLED	SOYBEAN	0.418	3	272.81	6.52217	1.81692206	4.340039523
ANGLED	SOYBEAN	0.418	4	165.38	3.95393	0.91763921	2.191943472
ANGLED	SOYBEAN	0.418	5	244.87	5.85432	1.51297984	3.614019791
ANGLED	SOYBEAN	0.54	1	322.23	5.99711	1.85888905	3.456643899
ANGLED	SOYBEAN	0.54	2	307.19	5.71728	1.86376907	3.465718396
ANGLED	SOYBEAN	0.54	3	229.84	4.27762	1.42708956	2.653703519
ANGLED	SOYBEAN	0.54	4	322.23	5.99711	2.38308683	4.431400866
ANGLED	SOYBEAN	0.54	5	279.26	5.19738	1.51692462	2.820753725
FLAT	WHEAT	0.0103	1	4.3148	4.45981	0.01033922	1.067751701
FLAT	WHEAT	0.0103	2	8.7185	7.58822	0.02319233	2.01681479
FLAT	WHEAT	0.0103	3	6.4499	6.66673	0.02024941	2.091197435
FLAT	WHEAT	0.0103	4	10.151	7.68241	0.04125015	3.119216725

FLAT	WHEAT	0.0103	5	6.9258	7.65324	0.01889188	2.085786498
FLAT	WHEAT	0.02	1	11.943	6.71391	0.02557057	1.436181465
FLAT	WHEAT	0.02	2	10.507	5.37069	0.03205702	1.637234685
FLAT	WHEAT	0.02	3	11.223	4.88179	0.04085369	1.775543652
FLAT	WHEAT	0.02	4	10.72	5.47983	0.02243921	1.146028493
FLAT	WHEAT	0.02	5	11.343	5.79816	0.03190328	1.629382792
FLAT	WHEAT	0.038	1	33.913	6.56498	0.12323012	2.383444918
FLAT	WHEAT	0.038	2	21.734	4.54949	0.06540592	1.367931956
FLAT	WHEAT	0.038	3	22.21	5.62063	0.08037303	2.032225578
FLAT	WHEAT	0.038	4	19.35	5.18074	0.07499167	2.006105443
FLAT	WHEAT	0.038	5	18.629	4.9878	0.05840165	1.562304898
ANGLED	WHEAT	0.0103	1	5.9695	5.80136	0.01535282	1.490745674
ANGLED	WHEAT	0.0103	2	6.8057	7.03455	0.01646932	1.700819913
ANGLED	WHEAT	0.0103	3	5.7337	5.92649	0.01823864	1.883541339
ANGLED	WHEAT	0.0103	4	6.9258	6.73079	0.02276685	2.210642035
ANGLED	WHEAT	0.0103	5	8.5984	8.88744	0.02123617	2.193101843
ANGLED	WHEAT	0.02	1	8.2381	3.58346	0.02977125	1.293889242
ANGLED	WHEAT	0.02	2	10.507	5.37069	0.01610492	0.822520089
ANGLED	WHEAT	0.02	3	6.9258	3.54029	0.04116538	2.102422339
ANGLED	WHEAT	0.02	4	5.6136	3.15566	0.03937787	2.211674344
ANGLED	WHEAT	0.02	5	5.6136	2.86952	0.0199292	1.017835791
ANGLED	WHEAT	0.038	1	9.6748	2.60564	0.053309	1.434474706
ANGLED	WHEAT	0.038	2	11.463	2.98228	0.07099741	1.845499434
ANGLED	WHEAT	0.038	3	8.4783	2.28338	0.04958215	1.334189966
ANGLED	WHEAT	0.038	4	10.72	2.78901	0.09846158	2.559400575
ANGLED	WHEAT	0.038	5	11.223	3.00483	0.08991319	2.40527159

CUTTING PLANT RESIDUE ON RIGID SURFACE

CUTTING LOCATION EFFECT

RESIDUE M.C. 9 %

KNIFE	CROP	X-DISTANCE	REP (5 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	COTTON	0.5	1	287.843	8.29053	1.0783306	3.10313418
FLAT	COTTON	0.5	2	197.634	6.29137	0.7121128	2.264933527
FLAT	COTTON	0.5	3	281.393	8.95773	1.0869453	3.457119217
FLAT	COTTON	0.5	4	238.424	7.58986	1.0237459	3.256108334
FLAT	COTTON	0.5	5	247.009	7.86315	0.9510087	3.024761802
FLAT	COTTON	0.75	1	201.904	5.81528	0.7154774	2.058944044
FLAT	COTTON	0.75	2	174.014	5.01198	0.6840087	1.968385879
FLAT	COTTON	0.75	3	354.433	10.2085	1.51808	4.36861004
FLAT	COTTON	0.75	4	294.293	10.4091	1.0350471	3.657751862
FLAT	COTTON	0.75	5	182.599	6.45847	0.7251738	2.562690787
FLAT	COTTON	1	1	272.808	7.85749	1.0002912	2.878558358
FLAT	COTTON	1	2	264.223	6.91847	0.8554654	2.23802088
FLAT	COTTON	1	3	197.634	5.69229	0.9749404	2.805605845
FLAT	COTTON	1	4	337.263	8.83095	1.26239	3.302594214

FLAT	COTTON	1	5	298.563	8.59929	1.2023485	3.460022858
ANGLED	COTTON	0.5	1	94.5243	3.00904	1.1112615	3.534459074
ANGLED	COTTON	0.5	2	187.492	5.40018	1.5956548	4.591848419
ANGLED	COTTON	0.5	3	231.974	6.68136	2.0956979	6.030832739
ANGLED	COTTON	0.5	4	156.799	4.51616	1.5145381	4.358417262
ANGLED	COTTON	0.5	5	150.349	4.33039	1.2955663	3.728277816
ANGLED	COTTON	0.75	1	128.864	4.5579	0.9764643	3.450725954
ANGLED	COTTON	0.75	2	191.184	6.08604	1.4711382	4.679076432
ANGLED	COTTON	0.75	3	128.864	4.1022	0.8475318	2.695644952
ANGLED	COTTON	0.75	4	109.559	3.87508	0.648119	2.290387168
ANGLED	COTTON	0.75	5	229.838	7.31656	1.3352359	4.246828044
ANGLED	COTTON	1	1	165.384	4.76343	1.2114813	3.486304702
ANGLED	COTTON	1	2	259.375	6.79152	1.7028963	4.455022164
ANGLED	COTTON	1	3	238.424	4.80716	1.8141033	3.654465686
ANGLED	COTTON	1	4	124.594	3.2624	1.0042503	2.627263616
ANGLED	COTTON	1	5	199.769	4.77598	1.4943397	3.569494641
FLAT	CORN	0.5	1	532.716	2.1697	4.2897653	1.745656921
FLAT	CORN	0.5	2	549.886	1.94378	3.4838047	1.2304122
FLAT	CORN	0.5	3	655.175	2.31597	5.2504635	1.85436179
FLAT	CORN	0.5	4	532.716	1.88309	4.9490461	1.747907019
FLAT	CORN	0.5	5	685.245	2.19167	6.6967569	2.140012648
FLAT	CORN	0.75	1	414.572	2.04692	3.2252842	1.591074236
FLAT	CORN	0.75	2	427.472	1.80675	3.6884188	1.557592004
FLAT	CORN	0.75	3	451.092	1.44276	4.4017749	1.406629229
FLAT	CORN	0.75	4	326.498	1.54883	2.9195491	1.383766308
FLAT	CORN	0.75	5	339.398	1.38233	3.2582178	1.325883832
FLAT	CORN	1	1	616.476	2.10652	6.3346471	2.162692663
FLAT	CORN	1	2	910.769	3.57697	7.3190314	2.87199332
FLAT	CORN	1	3	663.76	1.81568	5.6833462	1.553292684
FLAT	CORN	1	4	829.144	1.90816	7.83998	1.802692667
FLAT	CORN	1	5	603.621	2.28749	7.2133839	2.731212158
ANGLED	CORN	0.5	1	410.257	1.45021	8.3009187	2.931723343
ANGLED	CORN	0.5	2	354.433	1.44357	7.0304203	2.860926182
ANGLED	CORN	0.5	3	212.668	1.00885	3.1376415	1.487134634
ANGLED	CORN	0.5	4	249.188	1.13663	4.9648005	2.26263275
ANGLED	CORN	0.5	5	429.607	1.41985	9.3087847	3.07387623
ANGLED	CORN	0.75	1	283.528	1.15478	4.1411715	1.685188841
ANGLED	CORN	0.75	2	169.699	0.90993	2.8724052	1.538856037
ANGLED	CORN	0.75	3	234.153	1.06805	4.4608626	2.03297065
ANGLED	CORN	0.75	4	427.472	1.32381	10.383745	3.212876227
ANGLED	CORN	0.75	5	390.952	1.17288	9.2642611	2.776907212
ANGLED	CORN	1	1	528.402	1.06418	12.354662	2.486012212
ANGLED	CORN	1	2	738.935	2.90211	12.641262	4.960440707
ANGLED	CORN	1	3	592.856	1.44289	13.183661	3.20585293
ANGLED	CORN	1	4	498.332	1.95716	8.5096675	3.339199784
ANGLED	CORN	1	5	552.066	1.60526	11.766468	3.418399565
FLAT	SOYBEAN	0.5	1	141.764	5.01416	0.4699148	1.660631391
FLAT	SOYBEAN	0.5	2	124.594	3.96627	0.5373803	1.709182441
FLAT	SOYBEAN	0.5	3	111.694	2.92463	0.4505941	1.17881901
FLAT	SOYBEAN	0.5	4	122.459	4.33134	0.5736391	2.027182716
FLAT	SOYBEAN	0.5	5	94.5243	3.3433	0.3320084	1.173283944
FLAT	SOYBEAN	0.75	1	113.829	4.02612	0.4054564	1.43284187

FLAT	SOYBEAN	0.75	2	141.764	5.60389	0.4586415	1.811419446
FLAT	SOYBEAN	0.75	3	90.2095	3.56595	0.3066897	1.211280857
FLAT	SOYBEAN	0.75	4	85.9392	2.73575	0.329988	1.049554031
FLAT	SOYBEAN	0.75	5	131.044	5.18013	0.4923565	1.944577636
FLAT	SOYBEAN	1	1	214.804	3.70167	1.645491	2.833177091
FLAT	SOYBEAN	1	2	199.769	3.71797	1.5282823	2.841873638
ANGLED	SOYBEAN	1	3	274.943	5.11708	2.2698584	4.22085012
ANGLED	SOYBEAN	1	4	272.808	4.70125	1.347149	2.319497156
ANGLED	SOYBEAN	1	5	253.458	5.1103	1.4041393	2.82860346
ANGLED	SOYBEAN	0.5	1	210.489	6.06255	1.1317626	3.256896539
ANGLED	SOYBEAN	0.5	2	184.734	5.88072	1.1751743	3.73773894
ANGLED	SOYBEAN	0.5	3	242.738	5.31971	1.5800797	3.45979932
ANGLED	SOYBEAN	0.5	4	169.699	4.44343	1.1729035	3.068484699
ANGLED	SOYBEAN	0.5	5	167.564	5.33414	0.837048	2.662300268
ANGLED	SOYBEAN	0.75	1	109.559	4.33084	0.7079904	2.79623058
ANGLED	SOYBEAN	0.75	2	79.4893	3.53482	0.3982788	1.76957151
ANGLED	SOYBEAN	0.75	3	120.279	4.7546	0.7829141	3.092144224
ANGLED	SOYBEAN	0.75	4	143.899	4.58082	0.9526753	3.030062535
ANGLED	SOYBEAN	0.75	5	186.869	5.94869	0.9915565	3.153727181
ANGLED	SOYBEAN	1	1	176.149	2.62432	1.4909357	2.219312458
ANGLED	SOYBEAN	1	2	180.419	3.10913	1.9378299	3.336521099
ANGLED	SOYBEAN	1	3	176.149	3.03554	1.9699887	3.391891412
ANGLED	SOYBEAN	1	4	214.804	3.43727	2.0413552	3.263716524
ANGLED	SOYBEAN	1	5	150.349	2.79821	1.4684432	2.730601408
FLAT	WHEAT	0.5	1	21.4848	10.3129	0.0301173	1.444401436
FLAT	WHEAT	0.5	2	17.1701	8.24178	0.0302294	1.449776113
FLAT	WHEAT	0.5	3	17.1701	7.88768	0.0292747	1.343670187
FLAT	WHEAT	0.5	4	17.1701	8.24178	0.014806	0.710085138
FLAT	WHEAT	0.5	5	23.6199	8.4528	0.0297575	1.063998366
FLAT	WHEAT	0.75	1	19.3497	5.98871	0.0282603	0.873892586
FLAT	WHEAT	0.75	2	23.6199	7.29094	0.0415233	1.280615325
FLAT	WHEAT	0.75	3	10.7202	3.97112	0.0417841	1.546484731
FLAT	WHEAT	0.75	4	19.3497	6.11668	0.0683091	2.157460229
FLAT	WHEAT	0.75	5	17.1701	6.53043	0.0536638	2.039268033
FLAT	WHEAT	1	1	42.9696	5.39978	0.1056665	1.326705038
FLAT	WHEAT	1	2	64.4544	8.09967	0.1497032	1.879610426
FLAT	WHEAT	1	3	42.9696	6.6664	0.072287	1.120500553
FLAT	WHEAT	1	4	60.1397	7.55746	0.1361661	1.709645293
FLAT	WHEAT	1	5	53.6898	6.74693	0.1172615	1.472286221
ANGLED	WHEAT	0.5	1	8.58503	3.88411	0.0357231	1.614809255
ANGLED	WHEAT	0.5	2	4.31475	2.3587	0.0231496	1.264391675
ANGLED	WHEAT	0.5	3	8.58503	4.49449	0.0355669	1.860403523
ANGLED	WHEAT	0.5	4	6.44989	3.52588	0.0361459	1.974226659
ANGLED	WHEAT	0.5	5	6.44989	2.3082	0.0301289	1.077277278
ANGLED	WHEAT	0.75	1	6.44989	2.23324	0.0269536	0.932442403
ANGLED	WHEAT	0.75	2	6.44989	2.16954	0.0289257	0.97212412
ANGLED	WHEAT	0.75	3	15.0349	4.98336	0.11402	3.775933661
ANGLED	WHEAT	0.75	4	6.44989	2.16954	0.0277422	0.932348581
ANGLED	WHEAT	0.75	5	4.31475	1.75102	0.020078	0.814099585
ANGLED	WHEAT	1	1	38.6549	3.67302	0.2085471	1.979909769
ANGLED	WHEAT	1	2	38.6549	3.67302	0.1933313	1.835453731
ANGLED	WHEAT	1	3	42.9696	4.89776	0.1855173	2.11272433

ANGLED	WHEAT	1	4	23.6199	3.66445	0.1843707	2.857878738
ANGLED	WHEAT	1	5	40.8345	5.68584	0.1919084	2.66983077

CUTTING PLANT RESIDUE ON RIGID SURFACE

MOISTURE CONTENT EFFECT

KNIFE	CROP	M.C. % (d.b.)	REP (5 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	COTTON	9	1	287.843	5.3571	1.7606631	3.276803389
FLAT	COTTON	9	2	378.053	7.03601	2.0623136	3.83821086
FLAT	COTTON	9	3	657.311	12.2333	2.9135508	5.422464576
FLAT	COTTON	9	4	320.048	5.95647	2.0391467	3.795094659
FLAT	COTTON	9	5	425.337	7.91603	2.2072361	4.107928969
FLAT	COTTON	20	1	814.11	14.5744	4.6994484	8.405737557
FLAT	COTTON	20	2	1419.87	21.1536	8.5467607	12.7221666
FLAT	COTTON	20	3	1119.12	16.673	7.1153626	10.59147807
FLAT	COTTON	20	4	1136.34	18.1836	6.6487368	10.62999318
FLAT	COTTON	20	5	796.94	14.8322	6.1895512	11.50960258
ANGLED	COTTON	9	1	313.598	5.8365	3.2051248	5.959997977
ANGLED	COTTON	9	2	358.747	6.67679	4.4537191	8.281785877
ANGLED	COTTON	9	3	431.742	8.03533	4.4839971	8.338088317
ANGLED	COTTON	9	4	274.943	5.11708	2.8687999	5.334594673
ANGLED	COTTON	9	5	305.013	5.67672	2.54127	4.725545815
ANGLED	COTTON	20	1	399.537	7.43595	4.4554082	8.284926671
ANGLED	COTTON	20	2	212.668	5.08438	2.0010397	4.779837067
ANGLED	COTTON	20	3	532.716	8.52448	5.9666771	9.539516736
ANGLED	COTTON	20	4	560.651	9.66159	5.2695	9.072931263
ANGLED	COTTON	20	5	455.407	8.47575	4.3610205	8.109410691
ANGLED	COTTON	30	1	397.402	7.39621	4.4079202	8.196621792
ANGLED	COTTON	30	2	517.682	10.4376	5.7007454	11.48400907
ANGLED	COTTON	30	3	470.442	8.75558	7.2281599	13.44091782
ANGLED	COTTON	30	4	893.599	12.4256	9.8313018	13.65862393
ANGLED	COTTON	30	5	698.101	10.4005	7.8085124	11.62325689
ANGLED	COTTON	40	1	274.943	6.57322	4.499618	10.74813304
ANGLED	COTTON	40	2	506.961	8.11235	5.6205711	8.986162862
ANGLED	COTTON	40	3	418.887	7.2186	6.1999377	10.67494228
ANGLED	COTTON	40	4	367.332	5.10779	4.0993679	5.695250357
ANGLED	COTTON	40	5	292.158	5.43746	4.9627865	9.228407573
FLAT	CORN	9	1	305.013	1.70659	1.7303222	0.968137597
FLAT	CORN	9	2	251.323	1.40619	1.6482354	0.922208963
FLAT	CORN	9	3	296.428	1.65855	2.336275	1.307175989
FLAT	CORN	9	4	347.983	1.94701	3.1398981	1.756813505
FLAT	CORN	9	5	287.843	1.61052	2.3587665	1.319760269
FLAT	CORN	20	1	176.149	1.29932	1.1143859	0.821284327
FLAT	CORN	20	2	255.638	1.37074	1.9764447	1.058856149
FLAT	CORN	20	3	118.144	0.79135	1.0201276	0.682708833
FLAT	CORN	20	4	158.934	0.72495	2.0746745	0.945501539
FLAT	CORN	20	5	169.699	0.9917	1.2431402	0.725845275

ANGLED	CORN	9	1	161.114	0.90146	2.9853787	1.668924017
ANGLED	CORN	9	2	174.014	0.97364	3.2909468	1.839746604
ANGLED	CORN	9	3	270.673	1.51447	4.1770729	2.33511995
ANGLED	CORN	9	4	191.184	1.06971	3.2224088	1.801431572
ANGLED	CORN	9	5	214.804	1.20187	3.9590918	2.213261427
ANGLED	CORN	20	1	163.249	0.6649	3.5547192	1.446540715
ANGLED	CORN	20	2	135.314	0.75711	2.266164	1.266859563
ANGLED	CORN	20	3	111.694	0.6824	1.8475852	1.127807698
ANGLED	CORN	20	4	186.869	0.7611	3.8917123	1.583675108
ANGLED	CORN	20	5	171.834	0.65118	3.8917351	1.47353231
ANGLED	CORN	30	1	165.384	0.75437	3.7301845	1.699975171
ANGLED	CORN	30	2	154.664	0.6537	2.9304564	1.237510078
ANGLED	CORN	30	3	146.079	0.66631	3.0465035	1.388397906
ANGLED	CORN	30	4	124.594	0.54687	2.6141034	1.14637837
ANGLED	CORN	30	5	135.314	0.6681	2.6671752	1.315751909
ANGLED	CORN	40	1	174.014	0.76378	3.4634671	1.518854935
ANGLED	CORN	40	2	137.494	0.67887	3.1993204	1.578265973
ANGLED	CORN	40	3	128.864	0.63626	3.1955468	1.576404412
ANGLED	CORN	40	4	111.694	0.57446	0.6895276	0.354327056
ANGLED	CORN	40	5	81.6245	0.60208	1.6867997	1.243143954
FLAT	SOYBEAN	9	1	214.804	5.13543	1.0133813	2.420640369
FLAT	SOYBEAN	9	2	126.729	3.02979	0.6335692	1.513391928
FLAT	SOYBEAN	9	3	137.494	3.28714	0.5585793	1.334265372
FLAT	SOYBEAN	9	4	156.799	3.74868	0.5882859	1.405224874
FLAT	SOYBEAN	9	5	150.349	3.59448	0.6030902	1.440587452
FLAT	SOYBEAN	20	1	270.673	7.08736	2.4354481	6.371483238
FLAT	SOYBEAN	20	2	174.014	5.01198	0.9375256	2.697936532
FLAT	SOYBEAN	20	3	141.764	4.51285	0.9576494	3.045882843
FLAT	SOYBEAN	20	4	176.149	4.61231	1.0551112	2.760323058
FLAT	SOYBEAN	20	5	152.529	4.39317	0.4826042	1.388800072
ANGLED	SOYBEAN	9	1	201.904	4.82703	0.9835329	2.349342279
ANGLED	SOYBEAN	9	2	255.638	6.11168	1.6504805	3.942464316
ANGLED	SOYBEAN	9	3	272.808	6.52217	1.8169221	4.340039523
ANGLED	SOYBEAN	9	4	165.384	3.95393	0.9176392	2.191943472
ANGLED	SOYBEAN	9	5	244.873	5.85432	1.5129798	3.614019791
ANGLED	SOYBEAN	20	1	152.529	4.39317	1.0595196	3.049001291
ANGLED	SOYBEAN	20	2	120.279	3.46431	1.13145	3.255996841
ANGLED	SOYBEAN	20	3	126.729	3.65009	1.2692006	3.652404531
ANGLED	SOYBEAN	20	4	223.389	5.34068	2.3095405	5.516745822
ANGLED	SOYBEAN	20	5	139.629	3.65607	0.9576387	2.505320962
ANGLED	SOYBEAN	30	1	105.244	4.16028	1.0393897	4.105102982
ANGLED	SOYBEAN	30	2	231.974	6.68136	1.6558977	4.765210742
ANGLED	SOYBEAN	30	3	167.564	4.38752	1.4294579	3.739667806
ANGLED	SOYBEAN	30	4	122.459	3.8983	1.3104608	4.168028711
ANGLED	SOYBEAN	30	5	133.179	4.23956	1.0640958	3.384444644
ANGLED	SOYBEAN	40	1	146.079	4.2074	1.2611297	3.629178832
ANGLED	SOYBEAN	40	2	124.594	3.58859	1.1440252	3.292184912
ANGLED	SOYBEAN	40	3	268.493	7.03029	2.9179009	7.633649274
ANGLED	SOYBEAN	40	4	182.599	4.7812	1.4664491	3.83644222
ANGLED	SOYBEAN	40	5	171.834	4.49934	1.1096512	2.903007614
FLAT	WHEAT	9	1	11.9434	6.71391	0.0255706	1.436181465
FLAT	WHEAT	9	2	10.5066	5.37069	0.032057	1.637234685

FLAT	WHEAT	9	3	11.2228	4.88179	0.0408537	1.775543652
FLAT	WHEAT	9	4	10.7202	5.47983	0.0224392	1.146028493
FLAT	WHEAT	9	5	11.3429	5.79816	0.0319033	1.629382792
FLAT	WHEAT	20	1	30.0698	18.0642	0.0786281	4.71941497
FLAT	WHEAT	20	2	30.0698	22.7273	0.0745118	5.62683694
FLAT	WHEAT	20	3	30.0698	19.0226	0.0774167	4.893225656
FLAT	WHEAT	20	4	27.9347	16.7815	0.0787378	4.725993977
FLAT	WHEAT	20	5	15.0349	10.051	0.0481935	3.218978418
FLAT	WHEAT	30	1	27.9347	15.2707	0.1171667	6.399444614
FLAT	WHEAT	30	2	19.3497	11.073	0.0461529	2.63884678
FLAT	WHEAT	30	3	10.7202	8.10249	0.0369696	2.791794204
FLAT	WHEAT	30	4	21.4848	12.9068	0.0364478	2.187669338
FLAT	WHEAT	30	5	10.7202	8.10249	0.028094	2.121548197
FLAT	WHEAT	40	1	19.3497	12.9354	0.0560862	3.746151041
FLAT	WHEAT	40	2	21.4848	12.2949	0.07351	4.203020221
FLAT	WHEAT	40	3	17.1701	10.3148	0.059232	3.555220366
FLAT	WHEAT	40	4	15.0349	9.0321	0.0290122	1.741368842
FLAT	WHEAT	40	5	19.2162	11.544	0.0565	3.391240655
ANGLED	WHEAT	9	1	8.23807	3.58346	0.0297712	1.293889242
ANGLED	WHEAT	9	2	10.5066	5.37069	0.0161049	0.822520089
ANGLED	WHEAT	9	3	6.92585	3.54029	0.0411654	2.102422339
ANGLED	WHEAT	9	4	5.61363	3.15566	0.0393779	2.211674344
ANGLED	WHEAT	9	5	5.61363	2.86952	0.0199292	1.017835791
ANGLED	WHEAT	20	1	12.8998	8.07516	0.136468	8.535354699
ANGLED	WHEAT	20	2	6.44989	3.69101	0.0223113	1.275674799
ANGLED	WHEAT	20	3	6.44989	3.69101	0.0391566	2.23882736
ANGLED	WHEAT	20	4	10.7202	6.78172	0.0372849	2.356644989
ANGLED	WHEAT	20	5	4.31475	2.88445	0.0136875	0.914223237
ANGLED	WHEAT	30	1	8.58503	6.48871	0.0232043	1.752298559
ANGLED	WHEAT	30	2	12.8998	6.23561	0.0463913	2.240550574
ANGLED	WHEAT	30	3	6.44989	4.31181	0.0246802	1.648458512
ANGLED	WHEAT	30	4	4.31475	2.88445	0.0142791	0.953739739
ANGLED	WHEAT	30	5	8.58503	5.73917	0.0176106	1.176263992
ANGLED	WHEAT	40	1	8.58503	5.15738	0.0230259	1.382059095
ANGLED	WHEAT	40	2	6.44989	4.57447	0.0098736	0.699660044
ANGLED	WHEAT	40	3	10.7202	5.86026	0.0377595	2.062361836
ANGLED	WHEAT	40	4	8.58503	6.08878	0.0208469	1.477241281
ANGLED	WHEAT	40	5	8.58503	6.48871	0.0294766	2.225958817

CUTTING PLANT RESIDUE ON RIGID SURFACE

TENSILE FORCE EFFECT ON DRY (10%) RESIDUE

KNIFE	CROP	TENS. FORCE (N)	REP (5 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	COTTON	0	1	209.34	5.815	0.74124	2.059
FLAT	COTTON	0	2	175.39	5.011	0.6888	1.968
FLAT	COTTON	0	3	283.25	7.868	1.08864	3.024
FLAT	COTTON	0	4	290.15	8.29	1.08605	3.103

FLAT	COTTON	0	5	220.15	6.29	0.79275	2.265
FLAT	COTTON	20	1	509.1	13.330288	2.194247	5.74046589
FLAT	COTTON	20	2	128.86	3.536871	0.750505	2.05807925
FLAT	COTTON	20	3	169.7	4.8877076	1.062669	3.05806572
FLAT	COTTON	20	4	118.14	3.4028182	0.787493	2.26618351
FLAT	COTTON	20	5	120.28	3.4643149	0.783507	2.25471485
FLAT	COTTON	40	1	193.32	5.0618988	1.102151	2.88338659
FLAT	COTTON	40	2	262.04	6.2648183	1.393941	3.32967405
FLAT	COTTON	40	3	186.87	4.0953088	1.081893	2.36895114
FLAT	COTTON	40	4	440.37	7.5888414	2.356575	4.0575084
FLAT	COTTON	40	5	171.83	4.9492044	0.8559	2.46303958
ANGLED	COTTON	0	1	108.32	3.009	1.27224	3.534
ANGLED	COTTON	0	2	189	5.4	1.6072	4.592
ANGLED	COTTON	0	3	240.52	6.681	2.17116	6.031
ANGLED	COTTON	0	4	158.06	4.516	1.5253	4.358
ANGLED	COTTON	0	5	151.55	4.33	1.30515	3.729
ANGLED	COTTON	20	1	414.57	7.7157678	3.725449	6.92755193
ANGLED	COTTON	20	2	143.9	2.6781662	2.025904	3.76721225
ANGLED	COTTON	20	3	240.6	6.3000024	1.739843	4.551681
ANGLED	COTTON	20	4	255.64	7.016361	2.182728	5.98560812
ANGLED	COTTON	20	5	384.5	8.4265293	3.596332	7.87465768
ANGLED	COTTON	40	1	380.19	6.5516997	4.010714	6.9055755
ANGLED	COTTON	40	2	163.25	4.7019363	1.484801	4.27284239
ANGLED	COTTON	40	3	352.3	8.4225701	3.252289	7.7686675
ANGLED	COTTON	40	4	167.56	4.8262109	1.708392	4.91627412
ANGLED	COTTON	40	5	174.01	5.0119823	1.218609	3.50681635
FLAT	CORN	0	1	78.084	2.169	0.6282	1.745
FLAT	CORN	0	2	68.005	1.943	0.43085	1.231
FLAT	CORN	0	3	83.34	2.315	0.66744	1.854
FLAT	CORN	0	4	65.905	1.883	0.6118	1.748
FLAT	CORN	0	5	76.685	2.191	0.749	2.14
FLAT	CORN	20	1	126.73	2.7773232	0.490423	1.07384755
FLAT	CORN	20	2	268.49	6.4190194	1.455949	3.4777905
FLAT	CORN	20	3	156.8	3.1614264	0.489109	0.98529764
FLAT	CORN	20	4	167.56	4.8262109	1.603612	4.61474616
FLAT	CORN	20	5	122.46	3.2064904	1.090234	2.85220862
FLAT	CORN	40	1	227.7	6.5583684	2.027689	5.8351223
FLAT	CORN	40	2	156.8	4.1056588	1.565313	4.09508493
FLAT	CORN	40	3	152.53	4.3931716	1.253139	3.60618463
FLAT	CORN	40	4	257.77	7.4244471	2.424752	6.97775772
FLAT	CORN	40	5	171.83	4.4993362	1.382085	3.61573372
ANGLED	CORN	0	1	52.2	1.45	1.05516	2.931
ANGLED	CORN	0	2	50.505	1.443	1.00135	2.861
ANGLED	CORN	0	3	36.288	1.008	0.53532	1.487
ANGLED	CORN	0	4	39.76	1.136	0.7917	2.262
ANGLED	CORN	0	5	49.665	1.419	1.0759	3.074
ANGLED	CORN	20	1	98.795	0.8972511	1.118046	1.01452532
ANGLED	CORN	20	2	154.66	0.7954619	2.777337	1.42718814
ANGLED	CORN	20	3	131.04	0.733216	2.05809	1.1505394
ANGLED	CORN	20	4	124.59	1.0170252	1.870482	1.52549227
ANGLED	CORN	20	5	137.49	0.9658911	1.904954	1.33706244
ANGLED	CORN	40	1	100.97	0.9694521	1.06933	1.02577033

ANGLED	CORN	40	2	94.524	0.9075268	1.402262	1.34514028
ANGLED	CORN	40	3	186.87	1.0019984	3.023584	1.61984815
ANGLED	CORN	40	4	174.01	1.0631425	3.20539	1.95664258
ANGLED	CORN	40	5	266.36	1.0461011	6.754471	2.65045959
FLAT	SOYBEAN	0	1	180.5	5.014	0.59796	1.661
FLAT	SOYBEAN	0	2	138.81	3.966	0.59815	1.709
FLAT	SOYBEAN	0	3	82.584	2.294	0.42408	1.178
FLAT	SOYBEAN	0	4	151.59	4.331	0.70945	2.027
FLAT	SOYBEAN	0	5	117.01	3.343	0.41055	1.173
FLAT	SOYBEAN	20	1	227.7	4.9902132	0.711331	1.55755568
FLAT	SOYBEAN	20	2	90.209	2.1566884	0.180522	0.43120789
FLAT	SOYBEAN	20	3	279.26	5.6304779	1.228786	2.47535782
FLAT	SOYBEAN	20	4	141.76	4.0831256	0.535214	1.54019704
FLAT	SOYBEAN	20	5	199.77	5.2307841	0.784772	2.05307716
FLAT	SOYBEAN	40	1	163.25	4.7019363	0.393806	1.13326321
FLAT	SOYBEAN	40	2	143.9	3.7678883	0.397782	1.04065455
FLAT	SOYBEAN	40	3	165.38	4.763433	0.550022	1.58280819
FLAT	SOYBEAN	40	4	139.63	4.0216289	0.514518	1.4806377
FLAT	SOYBEAN	40	5	251.32	6.5807014	0.643019	1.68223123
ANGLED	SOYBEAN	0	1	218.23	6.062	1.17252	3.257
ANGLED	SOYBEAN	0	2	205.8	5.88	1.30795	3.737
ANGLED	SOYBEAN	0	3	191.48	5.319	1.24524	3.459
ANGLED	SOYBEAN	0	4	155.51	4.443	1.0738	3.068
ANGLED	SOYBEAN	0	5	186.69	5.334	0.9317	2.662
ANGLED	SOYBEAN	20	1	195.45	4.6728249	1.304111	3.11510053
ANGLED	SOYBEAN	20	2	146.08	3.2013792	0.65478	1.43373051
ANGLED	SOYBEAN	20	3	150.35	3.5944807	1.210727	2.89203613
ANGLED	SOYBEAN	20	4	223.39	4.5040236	0.941258	1.89614145
ANGLED	SOYBEAN	20	5	249.19	5.9574795	0.839206	2.00459126
ANGLED	SOYBEAN	40	1	98.795	3.1449757	0.48223	1.53377227
ANGLED	SOYBEAN	40	2	161.11	5.1288168	0.741185	2.35739866
ANGLED	SOYBEAN	40	3	73.039	2.3251014	0.358951	1.14167273
ANGLED	SOYBEAN	40	4	137.49	3.0132348	0.483082	1.05777385
ANGLED	SOYBEAN	40	5	229.84	5.0370056	1.069075	2.34088444

CUTTING PLANT RESIDUE ON RIGID SURFACE

TENSILE FORCE EFFECT ON WET (30%) RESIDUE

KNIFE	CROP	TENS. FORCE (N)	REP (5 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	COTTON	1	1	171.8	5.4700771	0.919585	2.92481505
FLAT	COTTON	1	2	431.7	10.321902	2.356459	5.62881958
FLAT	COTTON	1	3	348	10.022683	1.855087	5.33842158
FLAT	COTTON	1	4	410.3	8.9909625	2.499305	5.47256756
FLAT	COTTON	1	5	210.5	6.0625511	1.513406	4.35515931
FLAT	COTTON	20	1	403.9	11.631847	1.89842	5.46312115
FLAT	COTTON	20	2	208.4	6.0010544	1.013648	2.91699531
FLAT	COTTON	20	3	305	10.788233	1.688268	5.96616707
FLAT	COTTON	20	4	184.7	6.5339848	0.797585	2.81858483

FLAT	COTTON	20	5	209.1	5.86058	1.356	5.285
ANGLED	COTTON	1	1	131	3.7743609	1.432397	4.12203745
ANGLED	COTTON	1	2	135.3	3.5430962	1.534809	4.01528251
ANGLED	COTTON	1	3	214.8	5.1354282	2.68782	6.42033308
ANGLED	COTTON	1	4	240.6	5.2729173	2.549923	5.58340196
ANGLED	COTTON	1	5	126.7	3.4782691	1.484441	4.07072464
ANGLED	COTTON	20	1	255.6	7.3629504	2.710172	7.79911871
ANGLED	COTTON	20	2	135.3	3.8973543	1.429075	4.11247762
ANGLED	COTTON	20	3	116	3.0376052	1.501631	3.92848381
ANGLED	COTTON	20	4	161.1	4.6404396	2.430021	6.99292067
ANGLED	COTTON	20	5	81.62	2.5983928	0.829362	2.63785512
FLAT	CORN	1	1	240.6	1.4699739	1.385111	0.84550278
FLAT	CORN	1	2	219.1	1.2805025	1.396316	0.81528156
FLAT	CORN	1	3	150.3	1.1090131	0.791489	0.58331438
FLAT	CORN	1	4	182.6	1.3468931	1.557119	1.14757137
FLAT	CORN	1	5	268.5	1.6403702	1.895085	1.15680265
FLAT	CORN	20	1	169	1.103168	1.017	0.735
FLAT	CORN	20	2	165.4	1.1618192	1.018865	0.71512815
FLAT	CORN	20	3	216.9	1.6001944	1.014518	0.74768319
FLAT	CORN	20	4	141.8	1.0456878	1.133768	0.83556857
FLAT	CORN	20	5	225.6	1.3781175	1.057942	0.64579159
ANGLED	CORN	1	1	201.9	0.9577876	4.324167	2.04950719
ANGLED	CORN	1	2	79.49	0.6488483	1.477331	1.20485347
ANGLED	CORN	1	3	143.9	0.879158	2.017485	1.23151828
ANGLED	CORN	1	4	122.5	0.9032879	2.033649	1.49876644
ANGLED	CORN	1	5	103.1	0.7995657	1.536161	1.19018781
ANGLED	CORN	20	1	133.2	0.7141117	2.124965	1.13842411
ANGLED	CORN	20	2	131	0.8006181	2.442436	1.49091794
ANGLED	CORN	20	3	139.6	0.8530686	2.187723	1.33543552
ANGLED	CORN	20	4	128.9	0.7873016	2.446915	1.49365202
ANGLED	CORN	20	5	131	0.765806	1.965207	1.14744578
FLAT	SOYBEAN	1	1	75.17	2.3930702	0.230657	0.7336231
FLAT	SOYBEAN	1	2	167.6	8.4444953	0.58141	2.92750896
FLAT	SOYBEAN	1	3	244.9	8.6611091	1.24352	4.39447504
FLAT	SOYBEAN	1	4	189	6.6865965	0.744619	2.63140985
FLAT	SOYBEAN	1	5	274.9	7.9189832	1.599983	4.60430302
FLAT	SOYBEAN	20	1	177.9	6.619008	0.904	2.45
FLAT	SOYBEAN	20	2	171.8	6.7925433	0.48636	1.92089338
FLAT	SOYBEAN	20	3	191.2	6.7621157	0.569301	2.01185236
FLAT	SOYBEAN	20	4	287.8	9.1630518	1.283796	4.08321932
FLAT	SOYBEAN	20	5	234.2	8.2819398	0.93051	3.28832809
ANGLED	SOYBEAN	1	1	107.4	3.4196832	0.960566	3.05515816
ANGLED	SOYBEAN	1	2	79.49	2.530424	0.736328	2.34195226
ANGLED	SOYBEAN	1	3	98.79	3.9053167	0.703671	2.77916951
ANGLED	SOYBEAN	1	4	103.1	3.2823295	1.01674	3.23382454
ANGLED	SOYBEAN	1	5	62.27	2.4617035	0.757664	2.99241884
ANGLED	SOYBEAN	20	1	88.07	3.1151673	0.815254	2.88102528
ANGLED	SOYBEAN	20	2	81.62	2.5983928	0.574084	1.82592101
ANGLED	SOYBEAN	20	3	96.66	3.0770069	0.916551	2.91516534
ANGLED	SOYBEAN	20	4	107.4	3.0940535	0.929379	2.67449218
ANGLED	SOYBEAN	20	5	73.04	2.3251014	0.592579	1.88474572

CUTTING PLANT RESIDUE ON RIGID SURFACE

SECTION EFFECT

RESIDUE M.C. 9.5 %

KNIFE	CROP	SECTION	REP (5 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	COTTON	SECT-1	1	700.28	14.1192	3.190988	6.428164959
FLAT	COTTON	SECT-2	1	601.44	15.7483	2.468196	6.457156753
FLAT	COTTON	SECT-3	1	515.55	13.4992	2.093848	5.477809182
FLAT	COTTON	SECT-4	1	472.58	12.374	1.973246	5.16229541
FLAT	COTTON	SECT-5	1	433.92	11.3619	1.731221	4.529123762
FLAT	COTTON	SECT-6	1	403.85	10.5745	1.822653	4.768322419
FLAT	COTTON	SECT-7	1	438.19	11.4737	1.616625	4.229325081
FLAT	COTTON	SECT-8	1	367.33	10.58	1.569252	4.51586771
FLAT	COTTON	SECT-9	1	320.05	9.2181	1.452471	4.179806739
FLAT	COTTON	SECT-10	1	266.36	7.67172	1.004086	2.889477805
FLAT	COTTON	SECT-11	1	210.49	7.44494	0.768244	2.714895276
FLAT	COTTON	SECT-12	1	169.7	6.0022	0.595594	2.104769292
FLAT	COTTON	SECT-1	2	807.66	13.9181	3.918562	6.752706395
FLAT	COTTON	SECT-2	2	637.96	12.8626	2.961506	5.971006258
FLAT	COTTON	SECT-3	2	588.59	11.397	2.761317	5.346836667
FLAT	COTTON	SECT-4	2	461.81	8.59487	2.406799	4.479339007
FLAT	COTTON	SECT-5	2	481.16	10.5447	1.885539	4.132191306
FLAT	COTTON	SECT-6	2	433.92	8.74876	1.689686	3.406755299
FLAT	COTTON	SECT-7	2	425.34	10.1687	1.827294	4.368565907
FLAT	COTTON	SECT-8	2	240.6	5.75217	1.340637	3.205099687
FLAT	COTTON	SECT-9	2	279.26	6.6763	1.193928	2.854357735
FLAT	COTTON	SECT-10	2	229.84	6.01807	1.018966	2.668052264
FLAT	COTTON	SECT-11	2	191.18	5.50646	0.847158	2.439977612
FLAT	COTTON	SECT-12	2	219.12	7.75007	0.736917	2.606428194
FLAT	COTTON	SECT-1	3	801.21	19.1548	3.078083	7.35886245
FLAT	COTTON	SECT-2	3	637.96	16.7043	2.909194	7.617409943
FLAT	COTTON	SECT-3	3	408.12	9.7571	1.734594	4.146942999
FLAT	COTTON	SECT-4	3	461.81	12.0921	1.874508	4.908196663
FLAT	COTTON	SECT-5	3	266.36	7.67163	0.9526	2.743671455
FLAT	COTTON	SECT-6	3	292.16	9.3003	1.087913	3.463168819
FLAT	COTTON	SECT-7	3	425.34	13.5398	1.5364	4.890844399
FLAT	COTTON	SECT-8	3	221.25	6.37253	0.944443	2.720176855
FLAT	COTTON	SECT-9	3	182.6	5.81269	0.730616	2.325779861
FLAT	COTTON	SECT-10	3	214.8	7.59746	0.675558	2.389405878
FLAT	COTTON	SECT-11	3	191.18	8.50168	0.775551	3.448771029
FLAT	COTTON	SECT-12	3	189.05	9.52713	0.278224	1.402115578
FLAT	COTTON	SECT-1	4	792.62	14.7517	3.946091	7.344145024
FLAT	COTTON	SECT-2	4	607.89	12.2563	3.022665	6.094313461
FLAT	COTTON	SECT-3	4	588.59	10.9543	2.761792	5.140022564
FLAT	COTTON	SECT-4	4	528.4	10.6537	2.022964	4.078711457
FLAT	COTTON	SECT-5	4	390.95	8.56779	1.9524	4.278718162
FLAT	COTTON	SECT-6	4	378.05	9.03821	1.654758	3.956078778
FLAT	COTTON	SECT-7	4	337.26	8.06303	1.799659	4.30249649

FLAT	COTTON	SECT-8	4	309.33	8.09941	1.52468	3.992208745
FLAT	COTTON	SECT-9	4	296.43	7.08679	1.280027	3.060197835
FLAT	COTTON	SECT-10	4	221.25	5.79328	0.922931	2.416593708
FLAT	COTTON	SECT-11	4	212.67	5.56849	1.009093	2.642202047
FLAT	COTTON	SECT-12	4	180.42	4.72408	0.79509	2.081857611
FLAT	COTTON	SECT-1	5	743.25	16.2884	3.619368	7.931906748
FLAT	COTTON	SECT-2	5	588.59	14.0715	2.842806	6.796378281
FLAT	COTTON	SECT-3	5	511.23	11.2037	1.9892	4.35936544
FLAT	COTTON	SECT-4	5	373.78	8.93612	1.660153	3.968977003
FLAT	COTTON	SECT-5	5	418.89	10.0145	2.127036	5.085166624
FLAT	COTTON	SECT-6	5	354.43	9.28043	1.44217	3.776166831
FLAT	COTTON	SECT-7	5	264.22	7.61013	1.211758	3.490097612
FLAT	COTTON	SECT-8	5	247.01	6.46765	1.323832	3.46631136
FLAT	COTTON	SECT-9	5	296.43	9.43624	1.413165	4.498549944
FLAT	COTTON	SECT-10	5	214.8	6.83787	0.904332	2.878773147
FLAT	COTTON	SECT-11	5	212.67	8.40662	0.823019	3.253333751
FLAT	COTTON	SECT-12	5	180.42	9.09225	0.529613	2.668996307
ANGLED	COTTON	SECT-1	1	919.35	11.9589	10.37024	13.47784705
ANGLED	COTTON	SECT-2	1	784.04	10.9021	7.631735	10.60276658
ANGLED	COTTON	SECT-3	1	579.96	8.64037	5.476604	8.152126249
ANGLED	COTTON	SECT-4	1	519.82	7.74439	4.288862	6.384127584
ANGLED	COTTON	SECT-5	1	483.52	8.33239	4.119299	7.092535471
ANGLED	COTTON	SECT-6	1	485.48	8.36612	5.086506	8.757855098
ANGLED	COTTON	SECT-7	1	423.16	7.29219	4.01097	6.906017134
ANGLED	COTTON	SECT-8	1	369.47	6.87631	4.130078	7.679968598
ANGLED	COTTON	SECT-9	1	272.81	5.07734	2.689118	5.000472365
ANGLED	COTTON	SECT-10	1	227.7	5.44383	2.446111	5.842967336
ANGLED	COTTON	SECT-11	1	206.22	5.39967	1.790153	4.683298509
ANGLED	COTTON	SECT-12	1	165.38	4.76343	1.727452	4.971124914
ANGLED	COTTON	SECT-1	2	584.27	13.9683	4.297118	10.27324381
ANGLED	COTTON	SECT-2	2	438.19	10.476	3.432271	8.20562942
ANGLED	COTTON	SECT-3	2	292.16	8.41471	2.423826	6.981086085
ANGLED	COTTON	SECT-4	2	257.77	6.74951	2.040545	5.342947211
ANGLED	COTTON	SECT-5	2	238.42	6.86706	1.674331	4.822397389
ANGLED	COTTON	SECT-6	2	221.25	5.79328	1.871951	4.901501248
ANGLED	COTTON	SECT-7	2	208.35	5.45552	1.790296	4.687695375
ANGLED	COTTON	SECT-8	2	152.53	3.9938	1.491473	3.905259556
ANGLED	COTTON	SECT-9	2	141.76	4.5128	1.297128	4.129167472
ANGLED	COTTON	SECT-10	2	146.08	4.65015	1.269936	4.042606226
ANGLED	COTTON	SECT-11	2	128.86	4.55785	1.116653	3.949529519
ANGLED	COTTON	SECT-12	2	124.59	4.92511	0.979973	3.873761085
ANGLED	COTTON	SECT-1	3	618.66	10.6611	5.03455	8.675845236
ANGLED	COTTON	SECT-2	3	418.89	7.21852	3.916134	6.748522835
ANGLED	COTTON	SECT-3	3	356.57	7.81424	3.02045	6.619367688
ANGLED	COTTON	SECT-4	3	378.05	7.62232	2.788314	5.621815048
ANGLED	COTTON	SECT-5	3	326.5	6.58287	2.387182	4.813049553
ANGLED	COTTON	SECT-6	3	189.05	4.51964	2.222896	5.314341361
ANGLED	COTTON	SECT-7	3	169.7	3.71898	1.82609	4.001908409
ANGLED	COTTON	SECT-8	3	126.73	3.02975	1.413812	3.380040276
ANGLED	COTTON	SECT-9	3	143.9	4.14458	1.291865	3.720821032
ANGLED	COTTON	SECT-10	3	113.83	3.27851	0.996685	2.87064436
ANGLED	COTTON	SECT-11	3	92.345	2.93962	0.961401	3.06044143

ANGLED	COTTON	SECT-12	3	124.59	4.40681	0.816229	2.886947942
ANGLED	COTTON	SECT-1	4	683.07	12.7127	5.532035	10.29577474
ANGLED	COTTON	SECT-2	4	485.48	11.6064	4.434779	10.60235556
ANGLED	COTTON	SECT-3	4	461.81	10.1207	3.81806	8.36734287
ANGLED	COTTON	SECT-4	4	302.88	7.93053	2.064756	5.406339986
ANGLED	COTTON	SECT-5	4	272.81	6.5221	1.755905	4.197893672
ANGLED	COTTON	SECT-6	4	262.04	6.86132	2.504711	6.558315999
ANGLED	COTTON	SECT-7	4	219.12	5.73738	2.227742	5.833102547
ANGLED	COTTON	SECT-8	4	156.8	4.10561	1.648129	4.315448271
ANGLED	COTTON	SECT-9	4	111.69	2.92459	1.33334	3.491207444
ANGLED	COTTON	SECT-10	4	103.11	2.96975	0.967527	2.786664314
ANGLED	COTTON	SECT-11	4	85.939	3.03961	0.903273	3.194818569
ANGLED	COTTON	SECT-12	4	70.904	2.50784	0.502282	1.776537619
ANGLED	COTTON	SECT-1	5	685.25	12.7532	5.474343	10.18840361
ANGLED	COTTON	SECT-2	5	509.1	11.1569	4.037649	8.848576664
ANGLED	COTTON	SECT-3	5	436.06	8.79181	3.705965	7.471987366
ANGLED	COTTON	SECT-4	5	390.95	7.27609	3.525449	6.561279036
ANGLED	COTTON	SECT-5	5	388.82	8.52099	2.882428	6.316889893
ANGLED	COTTON	SECT-6	5	294.29	7.70574	3.107894	8.137685195
ANGLED	COTTON	SECT-7	5	332.95	7.95988	2.569936	6.144020396
ANGLED	COTTON	SECT-8	5	236.29	5.64901	2.611463	6.243300873
ANGLED	COTTON	SECT-9	5	180.42	4.12776	1.811756	4.145070776
ANGLED	COTTON	SECT-10	5	146.08	3.82492	1.579033	4.134528258
ANGLED	COTTON	SECT-11	5	154.66	4.92344	1.407571	4.480741783
ANGLED	COTTON	SECT-12	5	141.76	4.5128	1.161762	3.698253548
FLAT	CORN	SECT-1	1	796.94	3.63509	6.026022	2.746268326
FLAT	CORN	SECT-2	1	650.86	2.96878	4.135438	1.88466352
FLAT	CORN	SECT-3	1	412.44	2.03638	2.995483	1.47771044
FLAT	CORN	SECT-4	1	345.85	1.93508	2.268018	1.26789609
FLAT	CORN	SECT-5	1	277.08	1.85593	1.80302	1.206650409
FLAT	CORN	SECT-8	1	165.38	2.64646	0.807724	1.29138848
FLAT	CORN	SECT-9	1	148.21	3.24817	0.601704	1.317512722
FLAT	CORN	SECT-10	1	107.42	3.79956	0.364266	1.287278667
FLAT	CORN	SECT-11	1	70.904	3.57327	0.219515	1.105301943
FLAT	CORN	SECT-1	2	1082.6	4.57568	5.977475	2.526412089
FLAT	CORN	SECT-2	2	906.5	3.83137	4.782796	2.021474747
FLAT	CORN	SECT-3	2	670.21	3.30907	3.43754	1.697239631
FLAT	CORN	SECT-4	2	416.71	2.33153	2.192055	1.226483304
FLAT	CORN	SECT-5	2	277.08	1.6928	1.607374	0.982020638
FLAT	CORN	SECT-8	2	176.15	2.29131	0.951851	1.238151125
FLAT	CORN	SECT-9	2	139.63	2.59866	0.607119	1.129921238
FLAT	CORN	SECT-10	2	103.11	2.82995	0.379905	1.042693022
FLAT	CORN	SECT-11	2	79.489	3.53478	0.232413	1.03350855
FLAT	CORN	SECT-1	3	494.06	2.34369	3.338491	1.583689656
FLAT	CORN	SECT-2	3	476.85	2.35437	2.693948	1.330100822
FLAT	CORN	SECT-3	3	461.81	2.28014	2.61557	1.291402727
FLAT	CORN	SECT-4	3	401.67	2.24741	2.182773	1.221289515
FLAT	CORN	SECT-5	3	270.67	1.65367	1.476742	0.902211141
FLAT	CORN	SECT-8	3	163.25	2.12351	0.724168	0.94198505
FLAT	CORN	SECT-9	3	103.11	1.77684	0.451637	0.77828837
FLAT	CORN	SECT-10	3	88.074	2.30613	0.266408	0.697559324
FLAT	CORN	SECT-11	3	58.005	2.05158	0.194595	0.688268993

FLAT	CORN	SECT-1	4	702.42	2.32146	5.931624	1.960378628
FLAT	CORN	SECT-2	4	594.99	1.84257	4.483457	1.388436286
FLAT	CORN	SECT-3	4	457.54	1.51216	3.649047	1.205995851
FLAT	CORN	SECT-4	4	337.26	1.27808	2.354129	0.892112417
FLAT	CORN	SECT-5	4	270.67	1.14401	1.642688	0.694291026
FLAT	CORN	SECT-8	4	165.38	1.89459	0.963273	1.103497058
FLAT	CORN	SECT-9	4	122.46	1.95955	0.583475	0.933661113
FLAT	CORN	SECT-10	4	98.795	2.36191	0.347255	0.830191754
FLAT	CORN	SECT-11	4	68.725	2.18772	0.223306	0.710851864
FLAT	CORN	SECT-1	5	631.51	2.88049	4.092253	1.866584788
FLAT	CORN	SECT-2	5	487.61	2.14019	3.650336	1.602179098
FLAT	CORN	SECT-3	5	444.64	2.28684	2.753142	1.415970373
FLAT	CORN	SECT-4	5	268.49	1.56903	1.960017	1.145398864
FLAT	CORN	SECT-5	5	225.57	1.44221	1.390236	0.888869012
FLAT	CORN	SECT-8	5	126.73	1.88803	0.677737	1.009702443
FLAT	CORN	SECT-9	5	105.24	2.12194	0.450736	0.908776605
FLAT	CORN	SECT-10	5	85.939	2.47522	0.286627	0.825541877
FLAT	CORN	SECT-11	5	70.904	3.13399	0.201992	0.892809312
ANGLED	CORN	SECT-1	1	294.29	1.34236	7.401231	3.372999041
ANGLED	CORN	SECT-2	1	345.85	1.46176	6.719523	2.837604826
ANGLED	CORN	SECT-3	1	326.5	1.48926	5.537089	2.523444586
ANGLED	CORN	SECT-4	1	199.77	0.98634	3.351977	1.653573688
ANGLED	CORN	SECT-5	1	141.76	0.82845	2.185245	1.275922079
ANGLED	CORN	SECT-8	1	118.14	1.53682	1.140573	1.482363865
ANGLED	CORN	SECT-9	1	85.939	1.48097	0.755284	1.300433685
ANGLED	CORN	SECT-10	1	75.175	1.79724	0.479032	1.144253558
ANGLED	CORN	SECT-11	1	62.275	2.4617	0.305738	1.207522098
ANGLED	CORN	SECT-1	2	302.88	1.18952	6.596814	2.590818811
ANGLED	CORN	SECT-2	2	324.36	1.1868	6.199604	2.268360493
ANGLED	CORN	SECT-3	2	264.22	1.07614	4.789973	1.950883617
ANGLED	CORN	SECT-4	2	216.94	1.07111	3.547411	1.751486862
ANGLED	CORN	SECT-5	2	122.46	0.71563	1.822751	1.065183054
ANGLED	CORN	SECT-8	2	105.24	1.46342	0.815977	1.134610327
ANGLED	CORN	SECT-9	2	81.624	1.51913	0.648468	1.206876737
ANGLED	CORN	SECT-10	2	70.904	1.85655	0.472846	1.238096149
ANGLED	CORN	SECT-11	2	55.869	1.97606	0.293546	1.038253928
ANGLED	CORN	SECT-1	3	363.02	1.32824	8.072649	2.953685333
ANGLED	CORN	SECT-2	3	347.98	1.27323	6.769561	2.476901049
ANGLED	CORN	SECT-3	3	285.71	1.12006	5.323489	2.086973078
ANGLED	CORN	SECT-4	3	182.6	0.80145	3.115138	1.367273539
ANGLED	CORN	SECT-5	3	161.11	0.79548	2.347512	1.159052735
ANGLED	CORN	SECT-8	3	124.59	1.26658	1.322002	1.343904775
ANGLED	CORN	SECT-9	3	94.524	1.40824	0.740858	1.103741208
ANGLED	CORN	SECT-10	3	77.31	1.55872	0.50922	1.026691417
ANGLED	CORN	SECT-11	3	66.59	1.91791	0.362342	1.043614485
ANGLED	CORN	SECT-1	4	386.64	1.98852	6.895925	3.546648262
ANGLED	CORN	SECT-2	4	345.85	1.85443	6.201944	3.325470418
ANGLED	CORN	SECT-3	4	247.01	1.50909	3.775568	2.306672076
ANGLED	CORN	SECT-4	4	174.01	1.16557	2.732691	1.830393808
ANGLED	CORN	SECT-5	4	103.11	0.79956	1.34517	1.043107013
ANGLED	CORN	SECT-8	4	100.97	1.87925	0.67851	1.262787159
ANGLED	CORN	SECT-9	4	77.31	2.22667	0.421544	1.214128819

ANGLED	CORN	SECT-10	4	49.42	1.95352	0.256046	1.012131421
ANGLED	CORN	SECT-11	4	34.385	2.66512	0.157023	1.217074511
ANGLED	CORN	SECT-1	5	305.01	1.33874	5.802746	2.546899144
ANGLED	CORN	SECT-2	5	285.71	1.20756	4.624099	1.954400305
ANGLED	CORN	SECT-3	5	223.39	1.01893	3.916171	1.786269071
ANGLED	CORN	SECT-4	5	186.87	0.96109	3.703857	1.904933381
ANGLED	CORN	SECT-5	5	126.73	0.77425	1.931652	1.180137254
ANGLED	CORN	SECT-8	5	111.69	1.4529	1.044929	1.359224927
ANGLED	CORN	SECT-9	5	85.939	1.48096	0.690919	1.190633652
ANGLED	CORN	SECT-10	5	70.904	1.69513	0.517115	1.236281591
ANGLED	CORN	SECT-11	5	53.69	1.89897	0.317981	1.124679445
FLAT	SOYBEAN	SECT-1	1	326.5	9.40387	0.770842	2.218266795
FLAT	SOYBEAN	SECT-2	1	283.53	8.16625	1.142055	3.286516349
FLAT	SOYBEAN	SECT-3	1	270.67	7.79599	0.899822	2.589435403
FLAT	SOYBEAN	SECT-4	1	234.15	7.45392	0.762205	2.424254968
FLAT	SOYBEAN	SECT-5	1	146.08	5.77445	0.512089	2.022510507
FLAT	SOYBEAN	SECT-6	1	161.11	6.36878	0.566225	2.236324404
FLAT	SOYBEAN	SECT-7	1	133.18	5.92236	0.51473	2.286971056
FLAT	SOYBEAN	SECT-8	1	98.795	4.13854	0.346229	1.449105402
FLAT	SOYBEAN	SECT-9	1	98.795	4.97882	0.315674	1.589480855
FLAT	SOYBEAN	SECT-10	1	90.209	4.54617	0.275358	1.386478745
FLAT	SOYBEAN	SECT-1	2	554.2	10.3143	2.22408	4.139277933
FLAT	SOYBEAN	SECT-2	2	399.54	7.43586	1.529911	2.84734645
FLAT	SOYBEAN	SECT-3	2	120.28	2.63594	0.291329	0.638452332
FLAT	SOYBEAN	SECT-4	2	184.73	4.41648	0.488706	1.168362847
FLAT	SOYBEAN	SECT-5	2	171.83	4.94915	0.811099	2.336120751
FLAT	SOYBEAN	SECT-6	2	154.66	5.47036	0.564995	1.998350796
FLAT	SOYBEAN	SECT-7	2	141.76	5.01411	0.471941	1.669225125
FLAT	SOYBEAN	SECT-8	2	143.9	5.68823	0.430316	1.701005527
FLAT	SOYBEAN	SECT-9	2	120.28	6.0615	0.305092	1.537515093
FLAT	SOYBEAN	SECT-10	2	122.46	7.05248	0.363221	2.091811958
FLAT	SOYBEAN	SECT-1	3	506.96	8.73627	2.110578	3.637077832
FLAT	SOYBEAN	SECT-2	3	416.71	7.75542	2.021386	3.762039296
FLAT	SOYBEAN	SECT-3	3	360.88	7.27613	1.633587	3.293647468
FLAT	SOYBEAN	SECT-4	3	283.53	6.77839	1.266732	3.028413603
FLAT	SOYBEAN	SECT-5	3	176.15	5.07342	0.619118	1.783179495
FLAT	SOYBEAN	SECT-6	3	191.18	6.08598	0.79918	2.544041658
FLAT	SOYBEAN	SECT-7	3	120.28	3.82887	0.42345	1.347974056
FLAT	SOYBEAN	SECT-8	3	103.11	3.64691	0.351265	1.242403248
FLAT	SOYBEAN	SECT-9	3	90.209	3.56591	0.335331	1.325536824
FLAT	SOYBEAN	SECT-10	3	111.69	5.62885	0.380707	1.918580387
FLAT	SOYBEAN	SECT-1	4	399.54	7.43586	1.599041	2.976004935
FLAT	SOYBEAN	SECT-2	4	410.26	7.63538	1.982639	3.689927385
FLAT	SOYBEAN	SECT-3	4	386.64	7.79541	1.532142	3.089112721
FLAT	SOYBEAN	SECT-4	4	214.8	5.6244	1.03604	2.712758414
FLAT	SOYBEAN	SECT-5	4	234.15	6.74407	0.883533	2.544745005
FLAT	SOYBEAN	SECT-6	4	158.93	5.05938	0.5878	1.871152408
FLAT	SOYBEAN	SECT-7	4	143.9	5.08962	0.469539	1.660728266
FLAT	SOYBEAN	SECT-8	4	111.69	4.96689	0.354423	1.576072149
FLAT	SOYBEAN	SECT-9	4	96.659	4.29831	0.373957	1.662936015
FLAT	SOYBEAN	SECT-10	4	109.56	4.87195	0.330094	1.467885283
FLAT	SOYBEAN	SECT-1	5	296.43	4.12181	0.417326	0.580288582

FLAT	SOYBEAN	SECT-2	5	453.23	7.25242	1.735711	2.777437741
FLAT	SOYBEAN	SECT-3	5	360.88	7.27613	1.172412	2.363824337
FLAT	SOYBEAN	SECT-4	5	274.94	5.54342	0.90712	1.828939897
FLAT	SOYBEAN	SECT-5	5	186.87	4.46753	0.805844	1.926553896
FLAT	SOYBEAN	SECT-6	5	148.21	4.71812	0.365761	1.164331035
FLAT	SOYBEAN	SECT-7	5	85.939	3.03961	0.307447	1.087419657
FLAT	SOYBEAN	SECT-8	5	122.46	4.84071	0.39976	1.580219834
FLAT	SOYBEAN	SECT-9	5	70.904	2.80279	0.282471	1.116586803
FLAT	SOYBEAN	SECT-10	5	68.725	3.46339	0.27398	1.380726355
ANGLED	SOYBEAN	SECT-1	1	491.93	6.84028	5.019196	6.973167188
ANGLED	SOYBEAN	SECT-2	1	386.64	6.66285	3.191626	5.495285586
ANGLED	SOYBEAN	SECT-3	1	236.29	5.64908	1.721415	4.111904532
ANGLED	SOYBEAN	SECT-4	1	171.83	5.47008	1.406115	4.472266267
ANGLED	SOYBEAN	SECT-5	1	126.73	4.48238	0.755751	2.670747285
ANGLED	SOYBEAN	SECT-6	1	120.28	4.25425	0.5536	1.956367788
ANGLED	SOYBEAN	SECT-7	1	98.795	4.13854	0.524994	2.197308455
ANGLED	SOYBEAN	SECT-8	1	73.039	2.88723	0.823435	3.25218396
ANGLED	SOYBEAN	SECT-9	1	73.039	3.68088	0.594405	2.992941163
ANGLED	SOYBEAN	SECT-10	1	64.454	4.28269	0.39663	2.633129267
ANGLED	SOYBEAN	SECT-1	2	283.53	4.22405	1.616113	2.407709915
ANGLED	SOYBEAN	SECT-2	2	448.96	7.18408	3.196054	5.114238233
ANGLED	SOYBEAN	SECT-3	2	330.81	6.15682	2.482403	4.620047626
ANGLED	SOYBEAN	SECT-4	2	315.78	7.54939	1.892176	4.523680759
ANGLED	SOYBEAN	SECT-5	2	302.88	7.93053	1.895195	4.962363595
ANGLED	SOYBEAN	SECT-6	2	193.32	6.15395	1.10949	3.531856335
ANGLED	SOYBEAN	SECT-7	2	133.18	4.71046	0.821955	2.907201364
ANGLED	SOYBEAN	SECT-8	2	116.01	4.10316	0.699284	2.473323412
ANGLED	SOYBEAN	SECT-9	2	96.659	4.29831	0.657316	2.9229933
ANGLED	SOYBEAN	SECT-10	2	81.624	3.62973	0.428367	1.904887943
ANGLED	SOYBEAN	SECT-1	3	251.32	6.00846	0.841456	2.01169239
ANGLED	SOYBEAN	SECT-2	3	221.25	4.11779	1.871645	3.483354652
ANGLED	SOYBEAN	SECT-3	3	193.32	4.62173	1.191288	2.848047043
ANGLED	SOYBEAN	SECT-4	3	171.83	4.94915	1.048901	3.021037459
ANGLED	SOYBEAN	SECT-5	3	105.24	3.35026	0.56787	1.807708225
ANGLED	SOYBEAN	SECT-6	3	94.524	3.009	0.585661	1.864342339
ANGLED	SOYBEAN	SECT-7	3	70.904	2.80279	0.382746	1.512967788
ANGLED	SOYBEAN	SECT-8	3	64.454	2.8662	0.454509	2.021141407
ANGLED	SOYBEAN	SECT-9	3	51.555	2.29256	0.289837	1.288865952
ANGLED	SOYBEAN	SECT-10	3	81.624	5.4235	0.408985	2.717485849
ANGLED	SOYBEAN	SECT-1	4	537.03	9.99479	2.297098	4.275171856
ANGLED	SOYBEAN	SECT-2	4	317.91	6.96711	2.367101	5.18754161
ANGLED	SOYBEAN	SECT-3	4	141.76	3.71194	0.528896	1.38485807
ANGLED	SOYBEAN	SECT-4	4	270.67	7.08728	1.696604	4.442374314
ANGLED	SOYBEAN	SECT-5	4	197.63	6.2913	1.141578	3.634003429
ANGLED	SOYBEAN	SECT-6	4	131.04	4.17154	0.98244	3.127415451
ANGLED	SOYBEAN	SECT-7	4	96.659	3.41878	0.696672	2.464084202
ANGLED	SOYBEAN	SECT-8	4	81.624	3.22655	0.683523	2.701914276
ANGLED	SOYBEAN	SECT-9	4	92.345	4.65372	0.558004	2.812072544
ANGLED	SOYBEAN	SECT-10	4	85.939	4.33092	0.441669	2.225798871
ANGLED	SOYBEAN	SECT-1	5	161.11	4.21859	0.743693	1.947280924
ANGLED	SOYBEAN	SECT-2	5	214.8	6.83787	1.145544	3.646629112
ANGLED	SOYBEAN	SECT-3	5	148.21	4.71812	0.693824	2.208661568

ANGLED	SOYBEAN	SECT-4	5	148.21	5.85879	0.785889	3.106561498
ANGLED	SOYBEAN	SECT-5	5	107.42	4.24639	0.552159	2.182643712
ANGLED	SOYBEAN	SECT-6	5	77.31	3.43786	0.50589	2.249626339
ANGLED	SOYBEAN	SECT-7	5	62.275	2.76928	0.539424	2.398747115
ANGLED	SOYBEAN	SECT-8	5	75.175	4.99494	0.365152	2.426238718
ANGLED	SOYBEAN	SECT-9	5	55.869	3.71222	0.321116	2.133641755
ANGLED	SOYBEAN	SECT-10	5	42.97	3.33054	0.212096	1.643940614
FLAT	WHEAT	SECT-1	1	21.485	5.94871	0.04041	1.117903736
FLAT	WHEAT	SECT-2	1	19.35	6.50862	0.04083	1.372188292
FLAT	WHEAT	SECT-3	1	21.485	8.57036	0.019558	0.779489759
FLAT	WHEAT	SECT-4	1	12.9	9.45145	0.021593	1.580708877
FLAT	WHEAT	SECT-1	2	21.485	4.83879	0.039077	0.879318354
FLAT	WHEAT	SECT-2	2	19.35	6.12582	0.066013	2.08806428
FLAT	WHEAT	SECT-3	2	12.9	4.86248	0.017972	0.676833879
FLAT	WHEAT	SECT-4	2	6.4499	3.78893	0.012553	0.736744903
FLAT	WHEAT	SECT-1	3	36.52	10.9304	0.043051	1.288517345
FLAT	WHEAT	SECT-2	3	17.17	6.2313	0.052246	1.896079154
FLAT	WHEAT	SECT-3	3	27.935	11.8354	0.035	1.482904097
FLAT	WHEAT	SECT-4	3	8.585	5.9798	0.029344	2.043929546
FLAT	WHEAT	SECT-1	4	21.485	7.91035	0.036129	1.330212693
FLAT	WHEAT	SECT-2	4	15.035	6.80384	0.041695	1.886834931
FLAT	WHEAT	SECT-3	4	15.035	5.77579	0.024138	0.927275185
FLAT	WHEAT	SECT-4	4	12.9	9.31268	0.023699	1.710881288
FLAT	WHEAT	SECT-1	5	40.834	10.1976	0.064798	1.61820684
FLAT	WHEAT	SECT-2	5	32.205	8.62471	0.050943	1.364296929
FLAT	WHEAT	SECT-3	5	34.385	9.70334	0.052708	1.487423969
FLAT	WHEAT	SECT-4	5	8.585	4.69419	0.018977	1.037639233
ANGLED	WHEAT	SECT-1	1	10.72	3.38878	0.050964	1.609624493
ANGLED	WHEAT	SECT-2	1	6.4499	2.38927	0.031825	1.177900195
ANGLED	WHEAT	SECT-3	1	4.3148	1.76018	0.022213	0.905389545
ANGLED	WHEAT	SECT-4	1	6.4499	4.98959	0.018937	1.46366
ANGLED	WHEAT	SECT-1	2	15.035	3.74448	0.082976	2.064730367
ANGLED	WHEAT	SECT-2	2	8.585	3.06721	0.051292	1.830937614
ANGLED	WHEAT	SECT-3	2	8.585	2.9009	0.044977	1.518449622
ANGLED	WHEAT	SECT-4	2	8.585	5.97838	0.028437	1.978576781
ANGLED	WHEAT	SECT-1	3	6.4499	2.67802	0.036648	1.521617997
ANGLED	WHEAT	SECT-2	3	6.4499	3.24395	0.042852	2.155218404
ANGLED	WHEAT	SECT-3	3	6.4499	3.45345	0.032674	1.749466464
ANGLED	WHEAT	SECT-4	3	6.4499	4.4926	0.031405	2.187466272
ANGLED	WHEAT	SECT-1	4	10.72	3.41629	0.061139	1.948383419
ANGLED	WHEAT	SECT-2	4	6.4499	2.43182	0.038986	1.469886187
ANGLED	WHEAT	SECT-3	4	6.4499	2.91881	0.034906	1.579613111
ANGLED	WHEAT	SECT-4	4	6.4499	4.72685	0.024495	1.795124691
ANGLED	WHEAT	SECT-1	5	8.585	3.63731	0.048382	2.049874003
ANGLED	WHEAT	SECT-2	5	6.4499	3.15709	0.032496	1.590589605
ANGLED	WHEAT	SECT-3	5	8.585	4.03218	0.029206	1.371751601
ANGLED	WHEAT	SECT-4	5	6.4499	4.65634	0.023127	1.66960879

APPENDIX B

DATA TAKEN FOR CUTTING PLANT RESIDUE ON A SOIL SURFACE

CUTTING PLANT RESIDUE ON SOIL

AREA & M.C. EFFECT

KNIFE	CROP	SOIL COMP.	M.C. (%)	AREA (cm^2)	REP (4 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)
FLAT	CORN	CI2	DRY	1.22	1	149.7	1.2218	1.02198
FLAT	CORN	CI2	DRY	1.22	2	106.8	0.87148	1.01162
FLAT	CORN	CI2	DRY	1.22	3	144.2	1.17685	0.90004
FLAT	CORN	CI2	DRY	1.22	4	164.6	1.34344	0.98252
FLAT	CORN	CI2	DRY	2.64	1	261.1	0.98956	3.35196
FLAT	CORN	CI2	DRY	2.64	2	421.2	1.5961	5.05177
FLAT	CORN	CI2	DRY	2.64	3	391.1	1.48218	4.78998
FLAT	CORN	CI2	DRY	2.64	4	382.9	1.45095	8.12126
FLAT	CORN	CI2	DRY	3.44	1	543.6	1.58062	12.6519
FLAT	CORN	CI2	DRY	3.44	2	639.5	1.85947	21.9516
FLAT	CORN	CI2	DRY	3.44	3	207.7	0.60379	2.20953
FLAT	CORN	CI2	DRY	3.44	4	408.1	1.18662	6.19229
FLAT	CORN	CI2	WET	1.22	1	467.5	3.81601	11.7191
FLAT	CORN	CI2	WET	1.22	2	238.6	1.94725	2.14704
FLAT	CORN	CI2	WET	1.22	3	202.5	1.65321	1.00587
FLAT	CORN	CI2	WET	1.22	4	139.1	1.13526	1.44026
FLAT	CORN	CI2	WET	2.64	1	373.9	1.41676	5.0593
FLAT	CORN	CI2	WET	2.64	2	696.9	2.64083	12.4692
FLAT	CORN	CI2	WET	2.64	3	436.1	1.6526	5.79496
FLAT	CORN	CI2	WET	2.64	4	391.2	1.48246	4.6113
FLAT	CORN	CI2	WET	3.44	1	403.1	1.17199	6.04188
FLAT	CORN	CI2	WET	3.44	2	417.9	1.21521	4.40865
FLAT	CORN	CI2	WET	3.44	3	711.2	2.06792	13.8861
FLAT	CORN	CI2	WET	3.44	4	606.7	1.7641	8.97492
ANGLED	CORN	CI2	DRY	1.22	1	99.96	0.81592	0.96154
ANGLED	CORN	CI2	DRY	1.22	2	136.1	1.11097	1.51106
ANGLED	CORN	CI2	DRY	1.22	3	137.1	1.11912	1.36805
ANGLED	CORN	CI2	DRY	1.22	4	153.6	1.25369	2.01228
ANGLED	CORN	CI2	DRY	2.64	1	160.5	0.60816	1.55796
ANGLED	CORN	CI2	DRY	2.64	2	183.3	0.69452	2.90251
ANGLED	CORN	CI2	DRY	2.64	3	221	0.83755	3.59513
ANGLED	CORN	CI2	DRY	2.64	4	156.5	0.59289	3.05047
ANGLED	CORN	CI2	DRY	3.44	1	217.7	0.63296	5.76047
ANGLED	CORN	CI2	DRY	3.44	2	364.7	1.06051	5.12431
ANGLED	CORN	CI2	DRY	3.44	3	215.9	0.62783	2.73544
ANGLED	CORN	CI2	DRY	3.44	4	256.9	0.747	7.16193
ANGLED	CORN	CI2	WET	1.22	1	124.7	1.01765	1.47214
ANGLED	CORN	CI2	WET	1.22	2	57.09	0.46599	0.72917
ANGLED	CORN	CI2	WET	1.22	3	106.8	0.87216	1.3881
ANGLED	CORN	CI2	WET	1.22	4	88.05	0.71872	1.17687
ANGLED	CORN	CI2	WET	2.64	1	155.3	0.58869	2.81269
ANGLED	CORN	CI2	WET	2.64	2	143.5	0.54385	2.68988
ANGLED	CORN	CI2	WET	2.64	3	127.8	0.48439	2.8776
ANGLED	CORN	CI2	WET	2.64	4	107.5	0.40744	1.71626

ANGLED	CORN	CI2	WET	3.44	1	164.8	0.47908	4.24631
ANGLED	CORN	CI2	WET	3.44	2	217.5	0.63238	5.67342
ANGLED	CORN	CI2	WET	3.44	3	135.4	0.39369	2.94209
ANGLED	CORN	CI2	WET	3.44	4	168.6	0.49033	4.25284
FLAT	COTTON	CI2	DRY	0.35	1	203.8	5.86884	2.4932
FLAT	COTTON	CI2	DRY	0.35	2	410.4	11.8206	6.09958
FLAT	COTTON	CI2	DRY	0.35	3	298.1	8.58562	3.98538
FLAT	COTTON	CI2	DRY	0.35	4	246.9	7.11091	1.61093
FLAT	COTTON	CI2	DRY	0.54	1	289.1	5.38071	6.7073
FLAT	COTTON	CI2	DRY	0.54	2	364.4	6.78127	4.66125
FLAT	COTTON	CI2	DRY	0.54	3	293	5.45291	4.65199
FLAT	COTTON	CI2	DRY	0.54	4	485.5	9.03524	5.56116
FLAT	COTTON	CI2	DRY	0.77	1	497.7	6.4734	8.25314
FLAT	COTTON	CI2	DRY	0.77	2	420.5	5.4702	5.76923
FLAT	COTTON	CI2	DRY	0.77	3	542.9	7.06195	7.08283
FLAT	COTTON	CI2	DRY	0.77	4	668.5	8.69533	11.1578
FLAT	COTTON	CI2	WET	0.35	1	398.3	11.4707	9.76484
FLAT	COTTON	CI2	WET	0.35	2	630.4	18.1571	15.3774
FLAT	COTTON	CI2	WET	0.35	3	610	17.5696	17.2182
FLAT	COTTON	CI2	WET	0.35	4	744.8	21.4513	36.3205
FLAT	COTTON	CI2	WET	0.54	1	682.9	12.7088	41.4582
FLAT	COTTON	CI2	WET	0.54	2	593.3	11.0418	15.7822
FLAT	COTTON	CI2	WET	0.54	3	533.6	9.93103	12.754
FLAT	COTTON	CI2	WET	0.54	4	503.8	9.37583	10.147
FLAT	COTTON	CI2	WET	0.77	1	579.5	7.53809	17.385
FLAT	COTTON	CI2	WET	0.77	2	645.2	8.3932	17.7248
FLAT	COTTON	CI2	WET	0.77	3	805.2	10.474	31.2274
FLAT	COTTON	CI2	WET	0.77	4	762.5	9.91781	23.9215
ANGLED	COTTON	CI2	DRY	0.35	1	197.4	5.68644	2.92847
ANGLED	COTTON	CI2	DRY	0.35	2	236.2	6.80236	4.42551
ANGLED	COTTON	CI2	DRY	0.35	3	309.5	8.91469	7.40409
ANGLED	COTTON	CI2	DRY	0.35	4	181.8	5.23747	2.53149
ANGLED	COTTON	CI2	DRY	0.54	1	294.4	5.47903	5.78133
ANGLED	COTTON	CI2	DRY	0.54	2	347.1	6.4605	6.71837
ANGLED	COTTON	CI2	DRY	0.54	3	325.7	6.06129	8.27069
ANGLED	COTTON	CI2	DRY	0.54	4	391.4	7.28381	10.4576
ANGLED	COTTON	CI2	DRY	0.77	1	501.4	6.52213	16.2244
ANGLED	COTTON	CI2	DRY	0.77	2	378.8	4.92799	9.82417
ANGLED	COTTON	CI2	DRY	0.77	3	539.8	7.02144	10.7251
ANGLED	COTTON	CI2	DRY	0.77	4	429	5.58027	9.66931
ANGLED	COTTON	CI2	WET	0.35	1	210.7	6.06948	2.598
ANGLED	COTTON	CI2	WET	0.35	2	172.3	4.96242	3.93298
ANGLED	COTTON	CI2	WET	0.35	3	211.3	6.08446	4.0294
ANGLED	COTTON	CI2	WET	0.35	4	234.3	6.74908	4.62894
ANGLED	COTTON	CI2	WET	0.54	1	361.1	6.72074	8.56237
ANGLED	COTTON	CI2	WET	0.54	2	272.1	5.06502	7.4084
ANGLED	COTTON	CI2	WET	0.54	3	195.2	3.63282	4.35428
ANGLED	COTTON	CI2	WET	0.54	4	219.8	4.08991	5.79466
ANGLED	COTTON	CI2	WET	0.77	1	479	6.23125	10.5603
ANGLED	COTTON	CI2	WET	0.77	2	348.1	4.52827	9.04895
ANGLED	COTTON	CI2	WET	0.77	3	467.6	6.08194	18.9135
ANGLED	COTTON	CI2	WET	0.77	4	464.1	6.03738	22.1201

FLAT	SOYBEAN	CI2	DRY	0.26	1	86.08	3.4025	0.65651
FLAT	SOYBEAN	CI2	DRY	0.26	2	85.44	3.37731	0.29081
FLAT	SOYBEAN	CI2	DRY	0.26	3	41.99	1.65983	0.27628
FLAT	SOYBEAN	CI2	DRY	0.26	4	58.86	2.32687	0.37277
FLAT	SOYBEAN	CI2	DRY	0.35	1	62.33	1.79515	0.26691
FLAT	SOYBEAN	CI2	DRY	0.35	2	131.5	3.78638	1.74671
FLAT	SOYBEAN	CI2	DRY	0.35	3	87.66	2.5248	0.71705
FLAT	SOYBEAN	CI2	DRY	0.35	4	178.9	5.15162	0.99689
FLAT	SOYBEAN	CI2	DRY	0.54	1	245.7	4.57367	2.8601
FLAT	SOYBEAN	CI2	DRY	0.54	2	294.4	5.48001	1.66283
FLAT	SOYBEAN	CI2	DRY	0.54	3	254.3	4.73211	2.11251
FLAT	SOYBEAN	CI2	DRY	0.54	4	165.5	3.07931	0.72433
FLAT	SOYBEAN	CI2	WET	0.26	1	216.1	8.54242	2.35933
FLAT	SOYBEAN	CI2	WET	0.26	2	171.4	6.77707	1.65391
FLAT	SOYBEAN	CI2	WET	0.26	3	177	6.8	1.6
FLAT	SOYBEAN	CI2	WET	0.26	4	177.2	7.00519	1.56729
FLAT	SOYBEAN	CI2	WET	0.35	1	121.6	3.50161	1.05204
FLAT	SOYBEAN	CI2	WET	0.35	2	372.3	10.7242	4.87035
FLAT	SOYBEAN	CI2	WET	0.35	3	408.4	11.7627	6.56473
FLAT	SOYBEAN	CI2	WET	0.35	4	479.4	13.8087	8.13548
FLAT	SOYBEAN	CI2	WET	0.54	1	556.3	10.3526	16.437
FLAT	SOYBEAN	CI2	WET	0.54	2	302.1	5.62258	3.92158
FLAT	SOYBEAN	CI2	WET	0.54	3	546.6	10.1729	11.5054
FLAT	SOYBEAN	CI2	WET	0.54	4	550	10	11
ANGLED	SOYBEAN	CI2	DRY	0.26	1	107.4	4.24666	1.13925
ANGLED	SOYBEAN	CI2	DRY	0.26	2	109.4	4.32317	1.81549
ANGLED	SOYBEAN	CI2	DRY	0.26	3	87.84	3.47207	0.52868
ANGLED	SOYBEAN	CI2	DRY	0.26	4	98.06	3.87606	1.52783
ANGLED	SOYBEAN	CI2	DRY	0.35	1	117.7	3.39054	1.09032
ANGLED	SOYBEAN	CI2	DRY	0.35	2	138	3.97563	1.58981
ANGLED	SOYBEAN	CI2	DRY	0.35	3	119.9	3.45346	1.67719
ANGLED	SOYBEAN	CI2	DRY	0.35	4	185.4	5.34053	2.48958
ANGLED	SOYBEAN	CI2	DRY	0.54	1	207.1	3.8539	1.46057
ANGLED	SOYBEAN	CI2	DRY	0.54	2	319.8	5.95204	2.45265
ANGLED	SOYBEAN	CI2	DRY	0.54	3	167.8	3.12259	2.19248
ANGLED	SOYBEAN	CI2	DRY	0.54	4	294.3	5.47775	4.97425
ANGLED	SOYBEAN	CI2	WET	0.26	1	118.4	4.68055	1.32241
ANGLED	SOYBEAN	CI2	WET	0.26	2	110.8	4.37948	1.50757
ANGLED	SOYBEAN	CI2	WET	0.26	3	87.07	3.44163	1.2215
ANGLED	SOYBEAN	CI2	WET	0.26	4	101.8	4.02332	1.3832
ANGLED	SOYBEAN	CI2	WET	0.35	1	171.4	4.93558	2.13745
ANGLED	SOYBEAN	CI2	WET	0.35	2	160.1	4.61176	3.18652
ANGLED	SOYBEAN	CI2	WET	0.35	3	137.3	3.95317	1.95403
ANGLED	SOYBEAN	CI2	WET	0.35	4	153.3	4.41411	3.44149
ANGLED	SOYBEAN	CI2	WET	0.54	1	226.8	4.22139	4.06288
ANGLED	SOYBEAN	CI2	WET	0.54	2	235.5	4.38277	6.50742
ANGLED	SOYBEAN	CI2	WET	0.54	3	258.9	4.81776	8.25209
ANGLED	SOYBEAN	CI2	WET	0.54	4	222.4	4.13925	6.25574
FLAT	WHEAT	CI2	DRY	0.07	1	13.24	1.86186	0.09369
FLAT	WHEAT	CI2	DRY	0.07	2	14.02	1.97111	0.08847
FLAT	WHEAT	CI2	DRY	0.07	3	14.01	1.96932	0.06297
FLAT	WHEAT	CI2	DRY	0.07	4	5.776	0.81218	0.04757

FLAT	WHEAT	CI2	DRY	0.087	1	18.72	2.15338	0.11166
FLAT	WHEAT	CI2	DRY	0.087	2	20.72	2.38411	0.07473
FLAT	WHEAT	CI2	DRY	0.087	3	18.82	2.16496	0.10483
FLAT	WHEAT	CI2	DRY	0.087	4	15.68	1.8043	0.0769
FLAT	WHEAT	CI2	DRY	0.11	1	17.64	1.59713	0.15397
FLAT	WHEAT	CI2	DRY	0.11	2	19.52	1.76675	0.13062
FLAT	WHEAT	CI2	DRY	0.11	3	19.72	1.78464	0.03645
FLAT	WHEAT	CI2	DRY	0.11	4	13.82	1.25122	0.09599
FLAT	WHEAT	CI2	WET	0.07	1	38.6	5.42768	0.35394
FLAT	WHEAT	CI2	WET	0.07	2	29.95	4.21056	0.3123
FLAT	WHEAT	CI2	WET	0.07	3	43.94	6.1777	0.27947
FLAT	WHEAT	CI2	WET	0.07	4	28.67	4.03165	0.26109
FLAT	WHEAT	CI2	WET	0.087	1	53.76	6.18501	0.6836
FLAT	WHEAT	CI2	WET	0.087	2	45.72	5.25978	0.35657
FLAT	WHEAT	CI2	WET	0.087	3	16.13	1.85555	0.08495
FLAT	WHEAT	CI2	WET	0.087	4	17.55	2.01874	0.16986
FLAT	WHEAT	CI2	WET	0.11	1	27.78	2.51462	0.17814
FLAT	WHEAT	CI2	WET	0.11	2	17.95	1.62505	0.14952
FLAT	WHEAT	CI2	WET	0.11	3	40.84	3.69677	0.32894
FLAT	WHEAT	CI2	WET	0.11	4	41.84	3.78687	0.40587
ANGLED	WHEAT	CI2	DRY	0.07	1	9.377	1.31845	0.08194
ANGLED	WHEAT	CI2	DRY	0.07	2	13.73	1.9305	0.19029
ANGLED	WHEAT	CI2	DRY	0.07	3	12.01	1.68853	0.10235
ANGLED	WHEAT	CI2	DRY	0.07	4	14.45	2.03161	0.1278
ANGLED	WHEAT	CI2	DRY	0.087	1	11.43	1.31549	0.07744
ANGLED	WHEAT	CI2	DRY	0.087	2	14.46	1.66405	0.15457
ANGLED	WHEAT	CI2	DRY	0.087	3	8.927	1.02703	0.10862
ANGLED	WHEAT	CI2	DRY	0.087	4	9.109	1.04802	0.14624
ANGLED	WHEAT	CI2	DRY	0.11	1	8.503	0.76964	0.12719
ANGLED	WHEAT	CI2	DRY	0.11	2	14.08	1.27481	0.12436
ANGLED	WHEAT	CI2	DRY	0.11	3	12.77	1.15566	0.14038
ANGLED	WHEAT	CI2	DRY	0.11	4	17.69	1.60122	0.15151
ANGLED	WHEAT	CI2	WET	0.07	1	8.462	1.18973	0.08928
ANGLED	WHEAT	CI2	WET	0.07	2	6.484	0.91171	0.08774
ANGLED	WHEAT	CI2	WET	0.07	3	7.768	1.09224	0.08308
ANGLED	WHEAT	CI2	WET	0.07	4	8.696	1.22266	0.10722
ANGLED	WHEAT	CI2	WET	0.087	1	8.078	0.92938	0.09032
ANGLED	WHEAT	CI2	WET	0.087	2	8.416	0.96828	0.10538
ANGLED	WHEAT	CI2	WET	0.087	3	7.987	0.91892	0.11405
ANGLED	WHEAT	CI2	WET	0.087	4	13.36	1.53739	0.12341
ANGLED	WHEAT	CI2	WET	0.11	1	20.67	1.87126	0.29552
ANGLED	WHEAT	CI2	WET	0.11	2	17.84	1.61452	0.26795
ANGLED	WHEAT	CI2	WET	0.11	3	13.33	1.20665	0.18231
ANGLED	WHEAT	CI2	WET	0.11	4	17.63	1.5956	0.27081
FLAT	CORN	CI5	DRY	1.22	1	240.2	1.96051	1.09585
FLAT	CORN	CI5	DRY	1.22	2	164	1.33905	0.89754
FLAT	CORN	CI5	DRY	1.22	3	227.6	1.8575	1.3572
FLAT	CORN	CI5	DRY	1.22	4	124.9	1.01927	0.6215
FLAT	CORN	CI5	DRY	2.64	1	274.8	1.0413	1.67465
FLAT	CORN	CI5	DRY	2.64	2	567.3	2.14997	3.73405
FLAT	CORN	CI5	DRY	2.64	3	691.2	2.61942	5.36045
FLAT	CORN	CI5	DRY	2.64	4	665.1	2.52044	4.5105

FLAT	CORN	CI5	DRY	3.44	1	724.3	2.10617	6.04857
FLAT	CORN	CI5	DRY	3.44	2	954.6	2.77555	12.4375
FLAT	CORN	CI5	DRY	3.44	3	717.1	2.08525	6.8233
FLAT	CORN	CI5	DRY	3.44	4	521.3	1.51569	3.79367
FLAT	CORN	CI5	WET	1.22	1	135.4	1.10558	1.021
FLAT	CORN	CI5	WET	1.22	2	197.7	1.61396	1.22281
FLAT	CORN	CI5	WET	1.22	3	95.52	0.77971	0.46415
FLAT	CORN	CI5	WET	1.22	4	218.3	1.78197	0.6802
FLAT	CORN	CI5	WET	2.64	1	466.1	1.76616	1.97175
FLAT	CORN	CI5	WET	2.64	2	453.3	1.71793	1.51524
FLAT	CORN	CI5	WET	2.64	3	398.5	1.51005	2.87107
FLAT	CORN	CI5	WET	2.64	4	786.5	2.98053	6.93999
FLAT	CORN	CI5	WET	3.44	1	618.9	1.79961	4.08396
FLAT	CORN	CI5	WET	3.44	2	826.1	2.40218	5.72154
FLAT	CORN	CI5	WET	3.44	3	885.4	2.57434	5.41099
FLAT	CORN	CI5	WET	3.44	4	1522	4.42468	20.6075
ANGLED	CORN	CI5	DRY	1.22	1	259.8	2.1206	3.87095
ANGLED	CORN	CI5	DRY	1.22	2	242	1.97531	3.26255
ANGLED	CORN	CI5	DRY	1.22	3	285.5	2.33026	3.42673
ANGLED	CORN	CI5	DRY	1.22	4	264.7	2.16024	4.89131
ANGLED	CORN	CI5	DRY	2.64	1	423.3	1.60402	9.75804
ANGLED	CORN	CI5	DRY	2.64	2	448.9	1.70122	10.7042
ANGLED	CORN	CI5	DRY	2.64	3	357.5	1.35459	7.23869
ANGLED	CORN	CI5	DRY	2.64	4	514.9	1.95128	9.24593
ANGLED	CORN	CI5	DRY	3.44	1	390	1.13395	8.00537
ANGLED	CORN	CI5	DRY	3.44	2	492.2	1.43128	11.3478
ANGLED	CORN	CI5	DRY	3.44	3	456.6	1.32769	11.8788
ANGLED	CORN	CI5	DRY	3.44	4	531.8	1.54619	11.4505
ANGLED	CORN	CI5	WET	1.22	1	213	1.73862	3.4466
ANGLED	CORN	CI5	WET	1.22	2	129.8	1.0599	1.50635
ANGLED	CORN	CI5	WET	1.22	3	233.7	1.90751	3.00291
ANGLED	CORN	CI5	WET	1.22	4	123.7	1.00944	0.95009
ANGLED	CORN	CI5	WET	2.64	1	409.6	1.55213	8.68834
ANGLED	CORN	CI5	WET	2.64	2	368.9	1.39787	6.86291
ANGLED	CORN	CI5	WET	2.64	3	398.7	1.51103	7.25633
ANGLED	CORN	CI5	WET	2.64	4	315.1	1.19407	5.6656
ANGLED	CORN	CI5	WET	3.44	1	455.2	1.32371	9.41191
ANGLED	CORN	CI5	WET	3.44	2	450	1.30835	9.43735
ANGLED	CORN	CI5	WET	3.44	3	561.4	1.63229	12.6397
ANGLED	CORN	CI5	WET	3.44	4	538	1.56449	13.4163
FLAT	COTTON	CI5	DRY	0.35	1	346.2	9.9706	3.59129
FLAT	COTTON	CI5	DRY	0.35	2	378.1	10.8911	1.39281
FLAT	COTTON	CI5	DRY	0.35	3	437.5	12.6014	2.15831
FLAT	COTTON	CI5	DRY	0.35	4	627.7	18.0801	2.36106
FLAT	COTTON	CI5	DRY	0.54	1	531.7	9.89488	2.69517
FLAT	COTTON	CI5	DRY	0.54	2	845.3	15.7327	4.94772
FLAT	COTTON	CI5	DRY	0.54	3	475.5	8.85043	3.61627
FLAT	COTTON	CI5	DRY	0.54	4	510.9	9.50812	3.07142
FLAT	COTTON	CI5	DRY	0.77	1	793.5	10.3221	6.43833
FLAT	COTTON	CI5	DRY	0.77	2	1071	13.9276	8.43819
FLAT	COTTON	CI5	DRY	0.77	3	1031	13.4122	6.82757
FLAT	COTTON	CI5	DRY	0.77	4	918.1	11.9428	8.9995

FLAT	COTTON	C15	WET	0.35	1	1173	33.7816	20.3456
FLAT	COTTON	C15	WET	0.35	2	1180	33.9789	14.0369
FLAT	COTTON	C15	WET	0.35	3	1487	42.8233	27.3419
FLAT	COTTON	C15	WET	0.35	4	1128	32.491	11.6066
FLAT	COTTON	C15	WET	0.54	1	1192	22.1856	19.7225
FLAT	COTTON	C15	WET	0.54	2	1524	28.3697	30.0068
FLAT	COTTON	C15	WET	0.54	3	1221	22.7191	14.5435
FLAT	COTTON	C15	WET	0.54	4	1143	21.2793	13.0708
FLAT	COTTON	C15	WET	0.77	1	1236	16.0746	21.3984
FLAT	COTTON	C15	WET	0.77	2	1154	15.0078	17.3853
FLAT	COTTON	C15	WET	0.77	3	1182	15.3703	14.6362
FLAT	COTTON	C15	WET	0.77	4	1767	22.9842	43.8318
ANGLED	COTTON	C15	DRY	0.35	1	306.2	8.81988	3.16149
ANGLED	COTTON	C15	DRY	0.35	2	391.7	11.2809	3.25266
ANGLED	COTTON	C15	DRY	0.35	3	319.1	9.19172	2.93677
ANGLED	COTTON	C15	DRY	0.35	4	332.9	9.58701	3.45606
ANGLED	COTTON	C15	DRY	0.54	1	481.5	8.96169	4.20123
ANGLED	COTTON	C15	DRY	0.54	2	483.8	9.00335	5.06787
ANGLED	COTTON	C15	DRY	0.54	3	410.1	7.63299	4.27356
ANGLED	COTTON	C15	DRY	0.54	4	605.6	11.2702	6.47086
ANGLED	COTTON	C15	DRY	0.77	1	623.9	8.1161	7.31208
ANGLED	COTTON	C15	DRY	0.77	2	621.8	8.0889	6.45761
ANGLED	COTTON	C15	DRY	0.77	3	627.3	8.16016	7.42241
ANGLED	COTTON	C15	DRY	0.77	4	628.9	8.1807	7.00377
ANGLED	COTTON	C15	WET	0.35	1	396.2	11.4104	3.78531
ANGLED	COTTON	C15	WET	0.35	2	290.8	8.37484	2.75489
ANGLED	COTTON	C15	WET	0.35	3	453.9	13.0727	5.3602
ANGLED	COTTON	C15	WET	0.35	4	349.7	10.0718	3.05117
ANGLED	COTTON	C15	WET	0.54	1	557.7	10.3804	8.84719
ANGLED	COTTON	C15	WET	0.54	2	526.6	9.80145	6.13743
ANGLED	COTTON	C15	WET	0.54	3	442.1	8.22709	4.41535
ANGLED	COTTON	C15	WET	0.54	4	529.8	9.85938	5.44105
ANGLED	COTTON	C15	WET	0.77	1	457.1	5.94611	4.64176
ANGLED	COTTON	C15	WET	0.77	2	568.6	7.39666	8.69312
ANGLED	COTTON	C15	WET	0.77	3	498.8	6.48888	7.8528
ANGLED	COTTON	C15	WET	0.77	4	523.5	6.80905	7.9172
FLAT	SOYBEAN	C15	DRY	0.26	1	175.4	6.93458	1.56055
FLAT	SOYBEAN	C15	DRY	0.26	2	194.4	7.68269	0.71982
FLAT	SOYBEAN	C15	DRY	0.26	3	100.6	3.97481	0.75278
FLAT	SOYBEAN	C15	DRY	0.26	4	147	5.81188	1.14089
FLAT	SOYBEAN	C15	DRY	0.35	1	187.2	5.39303	0.87242
FLAT	SOYBEAN	C15	DRY	0.35	2	159	4.57904	0.38841
FLAT	SOYBEAN	C15	DRY	0.35	3	147.5	4.24897	0.36446
FLAT	SOYBEAN	C15	DRY	0.35	4	138.2	3.98079	0.54467
FLAT	SOYBEAN	C15	DRY	0.54	1	246.3	4.58468	0.99001
FLAT	SOYBEAN	C15	DRY	0.54	2	165.2	3.07377	0.34009
FLAT	SOYBEAN	C15	DRY	0.54	3	297.4	5.53456	1.37682
FLAT	SOYBEAN	C15	DRY	0.54	4	218.6	4.06849	1.32892
FLAT	SOYBEAN	C15	WET	0.26	1	847.3	33.4941	5.10467
FLAT	SOYBEAN	C15	WET	0.26	2	522.9	20.6684	2.32426
FLAT	SOYBEAN	C15	WET	0.26	3	499.3	19.7369	2.43005
FLAT	SOYBEAN	C15	WET	0.26	4	340.1	13.4436	1.25189

FLAT	SOYBEAN	CI5	WET	0.35	1	769.2	22.1559	6.90221
FLAT	SOYBEAN	CI5	WET	0.35	2	473.3	13.6314	2.51774
FLAT	SOYBEAN	CI5	WET	0.35	3	533.9	15.3762	3.17594
FLAT	SOYBEAN	CI5	WET	0.35	4	590.6	17.0098	3.51367
FLAT	SOYBEAN	CI5	WET	0.54	1	606	11.2783	3.66151
FLAT	SOYBEAN	CI5	WET	0.54	2	973	18.109	8.33498
FLAT	SOYBEAN	CI5	WET	0.54	3	786.1	14.6299	7.97191
FLAT	SOYBEAN	CI5	WET	0.54	4	621.4	11.5645	5.24024
ANGLED	SOYBEAN	CI5	DRY	0.26	1	118.7	4.69047	1.21217
ANGLED	SOYBEAN	CI5	DRY	0.26	2	169.6	6.70589	1.21613
ANGLED	SOYBEAN	CI5	DRY	0.26	3	266.2	10.5238	3.22448
ANGLED	SOYBEAN	CI5	DRY	0.26	4	128.7	5.08688	1.52785
ANGLED	SOYBEAN	CI5	DRY	0.35	1	265.9	7.65985	3.70555
ANGLED	SOYBEAN	CI5	DRY	0.35	2	291.6	8.39728	3.02107
ANGLED	SOYBEAN	CI5	DRY	0.35	3	260.6	7.50442	3.78708
ANGLED	SOYBEAN	CI5	DRY	0.35	4	265.4	7.64518	1.73475
ANGLED	SOYBEAN	CI5	DRY	0.54	1	516.7	9.61732	6.15964
ANGLED	SOYBEAN	CI5	DRY	0.54	2	332.2	6.18208	5.05037
ANGLED	SOYBEAN	CI5	DRY	0.54	3	426.8	7.94359	5.83909
ANGLED	SOYBEAN	CI5	DRY	0.54	4	522.5	9.72524	5.74173
ANGLED	SOYBEAN	CI5	WET	0.26	1	276.4	10.9275	3.03908
ANGLED	SOYBEAN	CI5	WET	0.26	2	277.3	10.9617	3.3054
ANGLED	SOYBEAN	CI5	WET	0.26	3	270.6	10.6962	4.16697
ANGLED	SOYBEAN	CI5	WET	0.26	4	296.3	11.714	4.26045
ANGLED	SOYBEAN	CI5	WET	0.35	1	257.2	7.40704	3.24509
ANGLED	SOYBEAN	CI5	WET	0.35	2	322.3	9.28229	4.91934
ANGLED	SOYBEAN	CI5	WET	0.35	3	338.1	9.73817	6.12306
ANGLED	SOYBEAN	CI5	WET	0.35	4	322.1	9.27645	4.63581
ANGLED	SOYBEAN	CI5	WET	0.54	1	458.2	8.52815	5.55517
ANGLED	SOYBEAN	CI5	WET	0.54	2	418.8	7.79457	5.64777
ANGLED	SOYBEAN	CI5	WET	0.54	3	463.5	8.62661	7.15699
ANGLED	SOYBEAN	CI5	WET	0.54	4	387	7.20231	4.62625

CUTTING PLANT RESIDUE ON SOIL

AREA & M.C. EFFECT

KNIFE	CROP	SOIL COMP.	M.C. (%)	AREA (cm^2)	REP (4 Rep)	SPENERGY (J/cm^2)	T - K FORCE (N)	T - K STRESS (MPa)
FLAT	CORN	CI2	DRY	1.22	1	0.83420313	144.28	1.17773
FLAT	CORN	CI2	DRY	1.22	2	0.82574655	101.37	0.82742
FLAT	CORN	CI2	DRY	1.22	3	0.73466598	144.18	1.17685
FLAT	CORN	CI2	DRY	1.22	4	0.80199162	159.19	1.29938
FLAT	CORN	CI2	DRY	2.64	1	1.27024794	241.55	0.91537
FLAT	CORN	CI2	DRY	2.64	2	1.91440134	384.18	1.45589
FLAT	CORN	CI2	DRY	2.64	3	1.81519567	273.49	1.03642
FLAT	CORN	CI2	DRY	2.64	4	3.07760288	211.8	0.80264
FLAT	CORN	CI2	DRY	3.44	1	3.67880627	287.61	0.83629
FLAT	CORN	CI2	DRY	3.44	2	6.38285862	326.21	0.94852
FLAT	CORN	CI2	DRY	3.44	3	0.64246639	202.25	0.58809
FLAT	CORN	CI2	DRY	3.44	4	1.8005324	343.63	0.99917
FLAT	CORN	CI2	WET	1.22	1	9.56583219	287.22	2.34447
FLAT	CORN	CI2	WET	1.22	2	1.75254651	186.16	1.51954
FLAT	CORN	CI2	WET	1.22	3	0.82105533	195.33	1.59437
FLAT	CORN	CI2	WET	1.22	4	1.17562684	124.63	1.01732
FLAT	CORN	CI2	WET	2.64	1	1.91725361	237.29	0.89923
FLAT	CORN	CI2	WET	2.64	2	4.7252853	516.59	1.95766
FLAT	CORN	CI2	WET	2.64	3	2.19603622	383.69	1.45403
FLAT	CORN	CI2	WET	2.64	4	1.74748339	376.75	1.4277
FLAT	CORN	CI2	WET	3.44	1	1.75679819	350.66	1.01963
FLAT	CORN	CI2	WET	3.44	2	1.28190371	365.53	1.06285
FLAT	CORN	CI2	WET	3.44	3	4.03767177	489.41	1.42305
FLAT	CORN	CI2	WET	3.44	4	2.60963705	510.44	1.48421
ANGLED	CORN	CI2	DRY	1.22	1	0.78486561	82.569	0.67398
ANGLED	CORN	CI2	DRY	1.22	2	1.23341858	118.72	0.96903
ANGLED	CORN	CI2	DRY	1.22	3	1.11668873	119.71	0.97718
ANGLED	CORN	CI2	DRY	1.22	4	1.64254821	129.26	1.0551
ANGLED	CORN	CI2	DRY	2.64	1	0.59039935	149.44	0.56632
ANGLED	CORN	CI2	DRY	2.64	2	1.09992632	165.88	0.62862
ANGLED	CORN	CI2	DRY	2.64	3	1.36239649	179.85	0.68157
ANGLED	CORN	CI2	DRY	2.64	4	1.15599438	132.12	0.5007
ANGLED	CORN	CI2	DRY	3.44	1	1.67497226	176.53	0.51328
ANGLED	CORN	CI2	DRY	3.44	2	1.489997	301.41	0.87642
ANGLED	CORN	CI2	DRY	3.44	3	0.79538522	191.59	0.55709
ANGLED	CORN	CI2	DRY	3.44	4	2.08247382	193.59	0.56291
ANGLED	CORN	CI2	WET	1.22	1	1.20164931	113.64	0.9276
ANGLED	CORN	CI2	WET	1.22	2	0.59519588	47.086	0.38434
ANGLED	CORN	CI2	WET	1.22	3	1.13305594	96.846	0.79051
ANGLED	CORN	CI2	WET	1.22	4	0.96063565	78.048	0.63708
ANGLED	CORN	CI2	WET	2.64	1	1.06588661	133.82	0.50713
ANGLED	CORN	CI2	WET	2.64	2	1.01934829	132.48	0.50204
ANGLED	CORN	CI2	WET	2.64	3	1.09048429	106.3	0.40283
ANGLED	CORN	CI2	WET	2.64	4	0.65038626	97.514	0.36953
ANGLED	CORN	CI2	WET	3.44	1	1.23470021	119.76	0.34822

ANGLED	CORN	CI2	WET	3.44	2	1.64966156	185.04	0.53804
ANGLED	CORN	CI2	WET	3.44	3	0.85547117	124.36	0.36161
ANGLED	CORN	CI2	WET	3.44	4	1.23659981	136.19	0.39599
FLAT	COTTON	CI2	DRY	0.35	1	7.18088645	146.5	4.21951
FLAT	COTTON	CI2	DRY	0.35	2	17.5679743	289.79	8.34664
FLAT	COTTON	CI2	DRY	0.35	3	11.4786664	240.83	6.93629
FLAT	COTTON	CI2	DRY	0.35	4	4.63979893	210.15	6.05259
FLAT	COTTON	CI2	DRY	0.54	1	12.4830877	168.5	3.13593
FLAT	COTTON	CI2	DRY	0.54	2	8.67514376	307.1	5.71551
FLAT	COTTON	CI2	DRY	0.54	3	8.6579016	235.73	4.38715
FLAT	COTTON	CI2	DRY	0.54	4	10.3499728	428.21	7.96948
FLAT	COTTON	CI2	DRY	0.77	1	10.7355372	408.19	5.30966
FLAT	COTTON	CI2	DRY	0.77	2	7.50450651	363.27	4.72532
FLAT	COTTON	CI2	DRY	0.77	3	9.21321467	485.64	6.31706
FLAT	COTTON	CI2	DRY	0.77	4	14.5138876	504.28	6.55964
FLAT	COTTON	CI2	WET	0.35	1	28.1246165	207.56	5.97805
FLAT	COTTON	CI2	WET	0.35	2	44.2899179	277.57	7.99445
FLAT	COTTON	CI2	WET	0.35	3	49.5918728	313.72	9.03574
FLAT	COTTON	CI2	WET	0.35	4	104.609995	329.18	9.48112
FLAT	COTTON	CI2	WET	0.54	1	77.1586027	252.18	4.69345
FLAT	COTTON	CI2	WET	0.54	2	29.3724655	330.66	6.15404
FLAT	COTTON	CI2	WET	0.54	3	23.7367471	270.98	5.04328
FLAT	COTTON	CI2	WET	0.54	4	18.8847741	274.52	5.10913
FLAT	COTTON	CI2	WET	0.77	1	22.6141257	295.62	3.84537
FLAT	COTTON	CI2	WET	0.77	2	23.0560418	415.99	5.4111
FLAT	COTTON	CI2	WET	0.77	3	40.6200206	508.91	6.61983
FLAT	COTTON	CI2	WET	0.77	4	31.1167102	499.83	6.50164
ANGLED	COTTON	CI2	DRY	0.35	1	8.43455623	158.7	4.57084
ANGLED	COTTON	CI2	DRY	0.35	2	12.746315	178.1	5.12973
ANGLED	COTTON	CI2	DRY	0.35	3	21.325203	232.98	6.71038
ANGLED	COTTON	CI2	DRY	0.35	4	7.29118939	143.11	4.12187
ANGLED	COTTON	CI2	DRY	0.54	1	10.759744	228.94	4.26086
ANGLED	COTTON	CI2	DRY	0.54	2	12.5036856	281.68	5.24233
ANGLED	COTTON	CI2	DRY	0.54	3	15.3927316	179.89	3.3479
ANGLED	COTTON	CI2	DRY	0.54	4	19.4628511	245.57	4.57042
ANGLED	COTTON	CI2	DRY	0.77	1	21.1043651	355.61	4.62568
ANGLED	COTTON	CI2	DRY	0.77	2	12.7790993	241.92	3.14691
ANGLED	COTTON	CI2	DRY	0.77	3	13.9510136	474.33	6.17004
ANGLED	COTTON	CI2	DRY	0.77	4	12.5776622	343.6	4.46949
ANGLED	COTTON	CI2	WET	0.35	1	7.48273288	140.58	4.04895
ANGLED	COTTON	CI2	WET	0.35	2	11.3277358	93.872	2.70369
ANGLED	COTTON	CI2	WET	0.35	3	11.6054586	117.47	3.38334
ANGLED	COTTON	CI2	WET	0.35	4	13.3322395	140.54	4.04795
ANGLED	COTTON	CI2	WET	0.54	1	15.9355888	267.33	4.97533
ANGLED	COTTON	CI2	WET	0.54	2	13.7879089	152.38	2.83591
ANGLED	COTTON	CI2	WET	0.54	3	8.10383609	125.04	2.32719
ANGLED	COTTON	CI2	WET	0.54	4	10.7845534	99.983	1.8608
ANGLED	COTTON	CI2	WET	0.77	1	13.7366547	400.62	5.21115
ANGLED	COTTON	CI2	WET	0.77	2	11.7707116	228.35	2.97029
ANGLED	COTTON	CI2	WET	0.77	3	24.6022967	278.09	3.61731
ANGLED	COTTON	CI2	WET	0.77	4	28.7733793	306.56	3.9877
FLAT	SOYBEAN	CI2	DRY	0.26	1	2.59512949	67.014	2.649

FLAT	SOYBEAN	CI2	DRY	0.26	2	1.14956364	85.426	3.37684
FLAT	SOYBEAN	CI2	DRY	0.26	3	1.09209784	22.928	0.90633
FLAT	SOYBEAN	CI2	DRY	0.26	4	1.47352246	39.803	1.57337
FLAT	SOYBEAN	CI2	DRY	0.35	1	0.76875895	43.265	1.24613
FLAT	SOYBEAN	CI2	DRY	0.35	2	5.03087497	77.841	2.24197
FLAT	SOYBEAN	CI2	DRY	0.35	3	2.06525557	68.599	1.97579
FLAT	SOYBEAN	CI2	DRY	0.35	4	2.87123056	178.85	5.15128
FLAT	SOYBEAN	CI2	DRY	0.54	1	5.32298369	142.37	2.64961
FLAT	SOYBEAN	CI2	DRY	0.54	2	3.09472425	294.44	5.47979
FLAT	SOYBEAN	CI2	DRY	0.54	3	3.93163607	200.64	3.73415
FLAT	SOYBEAN	CI2	DRY	0.54	4	1.34805509	165.44	3.07909
FLAT	SOYBEAN	CI2	WET	0.26	1	9.32625812	111.79	4.41883
FLAT	SOYBEAN	CI2	WET	0.26	2	6.53777677	131.51	5.19838
FLAT	SOYBEAN	CI2	WET	0.26	3	6.5	120	4.5
FLAT	SOYBEAN	CI2	WET	0.26	4	6.19537353	116.61	4.60943
FLAT	SOYBEAN	CI2	WET	0.35	1	3.03008174	109.4	3.15088
FLAT	SOYBEAN	CI2	WET	0.35	2	14.0275341	268.03	7.71968
FLAT	SOYBEAN	CI2	WET	0.35	3	18.907683	220.5	6.35093
FLAT	SOYBEAN	CI2	WET	0.35	4	23.4317637	291.54	8.39686
FLAT	SOYBEAN	CI2	WET	0.54	1	30.5912757	302.35	5.62713
FLAT	SOYBEAN	CI2	WET	0.54	2	7.2985239	170.47	3.17265
FLAT	SOYBEAN	CI2	WET	0.54	3	21.4128399	339.8	6.32412
FLAT	SOYBEAN	CI2	WET	0.54	4	25	330	5.7
ANGLED	SOYBEAN	CI2	DRY	0.26	1	4.50338389	94.673	3.74234
ANGLED	SOYBEAN	CI2	DRY	0.26	2	7.17649623	96.608	3.81885
ANGLED	SOYBEAN	CI2	DRY	0.26	3	2.08983296	76.557	3.02625
ANGLED	SOYBEAN	CI2	DRY	0.26	4	6.03940333	85.297	3.37174
ANGLED	SOYBEAN	CI2	DRY	0.35	1	3.1403424	104.96	3.02308
ANGLED	SOYBEAN	CI2	DRY	0.35	2	4.57895461	125.28	3.60817
ANGLED	SOYBEAN	CI2	DRY	0.35	3	4.83063014	107.15	3.086
ANGLED	SOYBEAN	CI2	DRY	0.35	4	7.17047601	172.66	4.97307
ANGLED	SOYBEAN	CI2	DRY	0.54	1	2.7182986	194.32	3.61646
ANGLED	SOYBEAN	CI2	DRY	0.54	2	4.5646778	307.05	5.7146
ANGLED	SOYBEAN	CI2	DRY	0.54	3	4.08046821	155.02	2.88514
ANGLED	SOYBEAN	CI2	DRY	0.54	4	9.2576709	255.14	4.74841
ANGLED	SOYBEAN	CI2	WET	0.26	1	5.22738701	74.937	2.96221
ANGLED	SOYBEAN	CI2	WET	0.26	2	5.95931423	82.971	3.27978
ANGLED	SOYBEAN	CI2	WET	0.26	3	4.82850501	43.595	1.7233
ANGLED	SOYBEAN	CI2	WET	0.26	4	5.46768058	73.961	2.92362
ANGLED	SOYBEAN	CI2	WET	0.35	1	6.15626368	143.54	4.13431
ANGLED	SOYBEAN	CI2	WET	0.35	2	9.17778092	90.37	2.60283
ANGLED	SOYBEAN	CI2	WET	0.35	3	5.62799058	93.784	2.70115
ANGLED	SOYBEAN	CI2	WET	0.35	4	9.91216019	64.307	1.85217
ANGLED	SOYBEAN	CI2	WET	0.54	1	7.56150786	172.87	3.21732
ANGLED	SOYBEAN	CI2	WET	0.54	2	12.1110789	123.5	2.2985
ANGLED	SOYBEAN	CI2	WET	0.54	3	15.3581119	161.05	2.9974
ANGLED	SOYBEAN	CI2	WET	0.54	4	11.6426783	133.46	2.48378
FLAT	WHEAT	CI2	DRY	0.07	1	1.31738823	5.7415	0.80728
FLAT	WHEAT	CI2	DRY	0.07	2	1.24396061	6.5185	0.91653
FLAT	WHEAT	CI2	DRY	0.07	3	0.88541954	6.5058	0.91474
FLAT	WHEAT	CI2	DRY	0.07	4	0.66886184	2.9527	0.41517
FLAT	WHEAT	CI2	DRY	0.087	1	1.28457078	11.217	1.29049

FLAT	WHEAT	CI2	DRY	0.087	2	0.85976109	13.222	1.52121
FLAT	WHEAT	CI2	DRY	0.087	3	1.20601773	11.318	1.30206
FLAT	WHEAT	CI2	DRY	0.087	4	0.88469233	12.859	1.47945
FLAT	WHEAT	CI2	DRY	0.11	1	1.39373132	10.144	0.91823
FLAT	WHEAT	CI2	DRY	0.11	2	1.18232166	12.018	1.08785
FLAT	WHEAT	CI2	DRY	0.11	3	0.32989873	12.216	1.10573
FLAT	WHEAT	CI2	DRY	0.11	4	0.86890731	6.3227	0.57231
FLAT	WHEAT	CI2	WET	0.07	1	4.97651071	33.873	4.76271
FLAT	WHEAT	CI2	WET	0.07	2	4.39112348	25.217	3.54558
FLAT	WHEAT	CI2	WET	0.07	3	3.92947235	39.207	5.51272
FLAT	WHEAT	CI2	WET	0.07	4	3.67107486	9.8676	1.38743
FLAT	WHEAT	CI2	WET	0.087	1	7.86465163	31.851	3.66438
FLAT	WHEAT	CI2	WET	0.087	2	4.10227546	23.809	2.73915
FLAT	WHEAT	CI2	WET	0.087	3	0.97728637	11.399	1.31144
FLAT	WHEAT	CI2	WET	0.087	4	1.9542465	12.818	1.47463
FLAT	WHEAT	CI2	WET	0.11	1	1.61250423	23.051	2.08653
FLAT	WHEAT	CI2	WET	0.11	2	1.35343746	13.224	1.19696
FLAT	WHEAT	CI2	WET	0.11	3	2.97743475	22.035	1.9945
FLAT	WHEAT	CI2	WET	0.11	4	3.6738496	23.03	2.08461
ANGLED	WHEAT	CI2	DRY	0.07	1	1.15205521	4.1815	0.58794
ANGLED	WHEAT	CI2	DRY	0.07	2	2.67553776	8.5345	1.2
ANGLED	WHEAT	CI2	DRY	0.07	3	1.43909343	6.8136	0.95803
ANGLED	WHEAT	CI2	DRY	0.07	4	1.79692356	9.2536	1.3011
ANGLED	WHEAT	CI2	DRY	0.087	1	0.89098372	7.0755	0.81402
ANGLED	WHEAT	CI2	DRY	0.087	2	1.77832044	9.2685	1.06632
ANGLED	WHEAT	CI2	DRY	0.087	3	1.24969012	4.5682	0.52556
ANGLED	WHEAT	CI2	DRY	0.087	4	1.68250373	3.9139	0.45029
ANGLED	WHEAT	CI2	DRY	0.11	1	1.15129118	3.3073	0.29936
ANGLED	WHEAT	CI2	DRY	0.11	2	1.12563903	9.7248	0.88026
ANGLED	WHEAT	CI2	DRY	0.11	3	1.27067736	7.5718	0.68538
ANGLED	WHEAT	CI2	DRY	0.11	4	1.37140624	12.494	1.13094
ANGLED	WHEAT	CI2	WET	0.07	1	1.25537277	3.6718	0.51627
ANGLED	WHEAT	CI2	WET	0.07	2	1.23362807	1.6945	0.23826
ANGLED	WHEAT	CI2	WET	0.07	3	1.16813595	2.9785	0.41879
ANGLED	WHEAT	CI2	WET	0.07	4	1.5075773	3.9061	0.54921
ANGLED	WHEAT	CI2	WET	0.087	1	1.0391136	3.2885	0.37833
ANGLED	WHEAT	CI2	WET	0.087	2	1.21238976	3.6267	0.41724
ANGLED	WHEAT	CI2	WET	0.087	3	1.31213285	3.1976	0.36787
ANGLED	WHEAT	CI2	WET	0.087	4	1.41976452	8.5733	0.98634
ANGLED	WHEAT	CI2	WET	0.11	1	2.67495275	11.8	1.0681
ANGLED	WHEAT	CI2	WET	0.11	2	2.42539339	13.047	1.18097
ANGLED	WHEAT	CI2	WET	0.11	3	1.65025969	4.4576	0.40349
ANGLED	WHEAT	CI2	WET	0.11	4	2.45132662	8.7545	0.79244
FLAT	CORN	CI5	DRY	1.22	1	0.89450189	190.89	1.55819
FLAT	CORN	CI5	DRY	1.22	2	0.73262931	114.76	0.93674
FLAT	CORN	CI5	DRY	1.22	3	1.10783171	223.9	1.82765
FLAT	CORN	CI5	DRY	1.22	4	0.50730851	124.87	1.01927
FLAT	CORN	CI5	DRY	2.64	1	0.63462117	271.12	1.02744
FLAT	CORN	CI5	DRY	2.64	2	1.41504201	445.25	1.68731
FLAT	CORN	CI5	DRY	2.64	3	2.03137834	569.13	2.15676
FLAT	CORN	CI5	DRY	2.64	4	1.70928272	543.01	2.05778
FLAT	CORN	CI5	DRY	3.44	1	1.75874368	480.58	1.39737

FLAT	CORN	CI5	DRY	3.44	2	3.61644691	710.78	2.06675
FLAT	CORN	CI5	DRY	3.44	3	1.98401119	473.38	1.37645
FLAT	CORN	CI5	DRY	3.44	4	1.10308594	399.18	1.1607
FLAT	CORN	CI5	WET	1.22	1	0.8334017	85.695	0.69949
FLAT	CORN	CI5	WET	1.22	2	0.99813145	147.98	1.20788
FLAT	CORN	CI5	WET	1.22	3	0.37886722	95.523	0.77971
FLAT	CORN	CI5	WET	1.22	4	0.55522276	218.31	1.78197
FLAT	CORN	CI5	WET	2.64	1	0.74720912	466.06	1.76616
FLAT	CORN	CI5	WET	2.64	2	0.57420935	453.33	1.71793
FLAT	CORN	CI5	WET	2.64	3	1.0880112	348.73	1.32152
FLAT	CORN	CI5	WET	2.64	4	2.62995289	329.34	1.24806
FLAT	CORN	CI5	WET	3.44	1	1.18749464	569.16	1.65495
FLAT	CORN	CI5	WET	3.44	2	1.66365211	739.92	2.15145
FLAT	CORN	CI5	WET	3.44	3	1.57335313	799.12	2.32361
FLAT	CORN	CI5	WET	3.44	4	5.99204881	801.39	2.33021
ANGLED	CORN	CI5	DRY	1.22	1	3.15970513	184.49	1.5059
ANGLED	CORN	CI5	DRY	1.22	2	2.66309912	166.69	1.36062
ANGLED	CORN	CI5	DRY	1.22	3	2.7971058	210.17	1.71557
ANGLED	CORN	CI5	DRY	1.22	4	3.99258768	145.04	1.18394
ANGLED	CORN	CI5	DRY	2.64	1	3.6978737	266.61	1.01032
ANGLED	CORN	CI5	DRY	2.64	2	4.05644183	239.98	0.9094
ANGLED	CORN	CI5	DRY	2.64	3	2.74314986	148.51	0.56277
ANGLED	CORN	CI5	DRY	2.64	4	3.50380466	358.24	1.35758
ANGLED	CORN	CI5	DRY	3.44	1	2.32772102	181.04	0.5264
ANGLED	CORN	CI5	DRY	3.44	2	3.29958643	237.66	0.69105
ANGLED	CORN	CI5	DRY	3.44	3	3.45400455	247.67	0.72014
ANGLED	CORN	CI5	DRY	3.44	4	3.32945767	322.81	0.93864
ANGLED	CORN	CI5	WET	1.22	1	2.81332757	91.899	0.75013
ANGLED	CORN	CI5	WET	1.22	2	1.22957556	51.868	0.42338
ANGLED	CORN	CI5	WET	1.22	3	2.45116454	112.59	0.91901
ANGLED	CORN	CI5	WET	1.22	4	0.77552499	109.92	0.89721
ANGLED	CORN	CI5	WET	2.64	1	3.29250315	145.98	0.5532
ANGLED	CORN	CI5	WET	2.64	2	2.60074287	132.44	0.5019
ANGLED	CORN	CI5	WET	2.64	3	2.74983453	162.31	0.61507
ANGLED	CORN	CI5	WET	2.64	4	2.14701567	139.51	0.52866
ANGLED	CORN	CI5	WET	3.44	1	2.73670284	218.81	0.63624
ANGLED	CORN	CI5	WET	3.44	2	2.74409999	186.36	0.54188
ANGLED	CORN	CI5	WET	3.44	3	3.67523756	210.64	0.61247
ANGLED	CORN	CI5	WET	3.44	4	3.90105909	154.54	0.44936
FLAT	COTTON	CI5	DRY	0.35	1	10.3436182	140.02	4.0329
FLAT	COTTON	CI5	DRY	0.35	2	4.01155069	365.28	10.5208
FLAT	COTTON	CI5	DRY	0.35	3	6.21636241	326.75	9.41113
FLAT	COTTON	CI5	DRY	0.35	4	6.80030816	516.97	14.8898
FLAT	COTTON	CI5	DRY	0.54	1	5.01603988	518.81	9.6556
FLAT	COTTON	CI5	DRY	0.54	2	9.2082985	734.57	13.6712
FLAT	COTTON	CI5	DRY	0.54	3	6.73030573	462.69	8.61116
FLAT	COTTON	CI5	DRY	0.54	4	5.71628422	498.03	9.26885
FLAT	COTTON	CI5	DRY	0.77	1	8.37487018	587.37	7.64046
FLAT	COTTON	CI5	DRY	0.77	2	10.9762511	864.55	11.2459
FLAT	COTTON	CI5	DRY	0.77	3	8.88117993	824.93	10.7306
FLAT	COTTON	CI5	DRY	0.77	4	11.7063902	807.36	10.502
FLAT	COTTON	CI5	WET	0.35	1	58.5992048	532.59	15.3398

FLAT	COTTON	C15	WET	0.35	2	40.4290413	659.19	18.9861
FLAT	COTTON	C15	WET	0.35	3	78.7500038	549.7	15.8325
FLAT	COTTON	C15	WET	0.35	4	33.4293129	685.51	19.7439
FLAT	COTTON	C15	WET	0.54	1	36.7058794	451.49	8.40275
FLAT	COTTON	C15	WET	0.54	2	55.84626	421.54	7.84531
FLAT	COTTON	C15	WET	0.54	3	27.0672507	694.42	12.9241
FLAT	COTTON	C15	WET	0.54	4	24.3263721	622.81	11.5913
FLAT	COTTON	C15	WET	0.77	1	27.8346836	709.47	9.2286
FLAT	COTTON	C15	WET	0.77	2	22.6144425	595.7	7.74877
FLAT	COTTON	C15	WET	0.77	3	19.0385132	661.07	8.59904
FLAT	COTTON	C15	WET	0.77	4	57.0156465	651.89	8.47967
ANGLED	COTTON	C15	DRY	0.35	1	9.1057131	255.07	7.34664
ANGLED	COTTON	C15	DRY	0.35	2	9.36829515	284.7	8.19996
ANGLED	COTTON	C15	DRY	0.35	3	8.45845523	267.98	7.71847
ANGLED	COTTON	C15	DRY	0.35	4	9.95410876	225.89	6.50604
ANGLED	COTTON	C15	DRY	0.54	1	7.81898995	324.64	6.04195
ANGLED	COTTON	C15	DRY	0.54	2	9.43191654	326.88	6.08361
ANGLED	COTTON	C15	DRY	0.54	3	7.95361279	216.78	4.0345
ANGLED	COTTON	C15	DRY	0.54	4	12.0430489	412.21	7.6717
ANGLED	COTTON	C15	DRY	0.77	1	9.51141762	367.68	4.7827
ANGLED	COTTON	C15	DRY	0.77	2	8.39994879	365.59	4.75551
ANGLED	COTTON	C15	DRY	0.77	3	9.65494165	433.98	5.64509
ANGLED	COTTON	C15	DRY	0.77	4	9.11037719	372.65	4.84731
ANGLED	COTTON	C15	WET	0.35	1	10.9024254	136.66	3.93599
ANGLED	COTTON	C15	WET	0.35	2	7.93460216	83.982	2.41884
ANGLED	COTTON	C15	WET	0.35	3	15.4384039	143.58	4.13541
ANGLED	COTTON	C15	WET	0.35	4	8.78797018	223.38	6.4338
ANGLED	COTTON	C15	WET	0.54	1	16.4656646	247.45	4.60527
ANGLED	COTTON	C15	WET	0.54	2	11.4224804	267.13	4.97162
ANGLED	COTTON	C15	WET	0.54	3	8.21748606	235.26	4.37845
ANGLED	COTTON	C15	WET	0.54	4	10.1264452	322.96	6.01074
ANGLED	COTTON	C15	WET	0.77	1	6.03791923	197.61	2.57043
ANGLED	COTTON	C15	WET	0.77	2	11.3078604	154.66	2.01179
ANGLED	COTTON	C15	WET	0.77	3	10.2147833	109.68	1.42673
ANGLED	COTTON	C15	WET	0.77	4	10.2985538	316.67	4.11914
FLAT	SOYBEAN	C15	DRY	0.26	1	6.16873858	164.93	6.51949
FLAT	SOYBEAN	C15	DRY	0.26	2	2.8453878	183.85	7.2676
FLAT	SOYBEAN	C15	DRY	0.26	3	2.97569187	90.053	3.55972
FLAT	SOYBEAN	C15	DRY	0.26	4	4.50987053	136.53	5.39679
FLAT	SOYBEAN	C15	DRY	0.35	1	2.51272966	176.74	5.09058
FLAT	SOYBEAN	C15	DRY	0.35	2	1.11869585	148.48	4.27659
FLAT	SOYBEAN	C15	DRY	0.35	3	1.04970149	137.02	3.94652
FLAT	SOYBEAN	C15	DRY	0.35	4	1.56874663	127.71	3.67835
FLAT	SOYBEAN	C15	DRY	0.54	1	1.84253331	246.34	4.58468
FLAT	SOYBEAN	C15	DRY	0.54	2	0.63293916	165.16	3.07377
FLAT	SOYBEAN	C15	DRY	0.54	3	2.5624238	286.88	5.33913
FLAT	SOYBEAN	C15	DRY	0.54	4	2.47327819	208.1	3.87306
FLAT	SOYBEAN	C15	WET	0.26	1	20.1783682	406.02	16.0498
FLAT	SOYBEAN	C15	WET	0.26	2	9.18762287	365.67	14.4548
FLAT	SOYBEAN	C15	WET	0.26	3	9.6057881	203.45	8.04223
FLAT	SOYBEAN	C15	WET	0.26	4	4.9486345	182.9	7.23001
FLAT	SOYBEAN	C15	WET	0.35	1	19.8797075	241.56	6.95739

FLAT	SOYBEAN	CI5	WET	0.35	2	7.25158629	177.43	5.11038
FLAT	SOYBEAN	CI5	WET	0.35	3	9.14732433	238.01	6.8552
FLAT	SOYBEAN	CI5	WET	0.35	4	10.1200583	112.66	3.24477
FLAT	SOYBEAN	CI5	WET	0.54	1	6.81449727	448.81	8.35282
FLAT	SOYBEAN	CI5	WET	0.54	2	15.5123983	531.72	9.89586
FLAT	SOYBEAN	CI5	WET	0.54	3	14.8366763	490.23	9.1238
FLAT	SOYBEAN	CI5	WET	0.54	4	9.75270817	325.52	6.05837
ANGLED	SOYBEAN	CI5	DRY	0.26	1	4.79163107	7.8118	0.3088
ANGLED	SOYBEAN	CI5	DRY	0.26	2	4.80728131	58.797	2.32421
ANGLED	SOYBEAN	CI5	DRY	0.26	3	12.7461323	46.701	1.84605
ANGLED	SOYBEAN	CI5	DRY	0.26	4	6.0394675	17.84	0.7052
ANGLED	SOYBEAN	CI5	DRY	0.35	1	10.6726902	104.01	2.99577
ANGLED	SOYBEAN	CI5	DRY	0.35	2	8.70125341	129.62	3.7332
ANGLED	SOYBEAN	CI5	DRY	0.35	3	10.9075209	149.71	4.31183
ANGLED	SOYBEAN	CI5	DRY	0.35	4	4.99641541	154.59	4.45259
ANGLED	SOYBEAN	CI5	DRY	0.54	1	11.4638214	334.43	6.22419
ANGLED	SOYBEAN	CI5	DRY	0.54	2	9.3993413	170.23	3.16825
ANGLED	SOYBEAN	CI5	DRY	0.54	3	10.8672326	244.5	4.55047
ANGLED	SOYBEAN	CI5	DRY	0.54	4	10.6860355	340.23	6.33212
ANGLED	SOYBEAN	CI5	WET	0.26	1	12.0132633	98.746	3.90337
ANGLED	SOYBEAN	CI5	WET	0.26	2	13.0659829	141.69	5.60101
ANGLED	SOYBEAN	CI5	WET	0.26	3	16.4717274	134.98	5.33548
ANGLED	SOYBEAN	CI5	WET	0.26	4	16.8412539	160.72	6.35321
ANGLED	SOYBEAN	CI5	WET	0.35	1	9.34647779	167.78	4.83231
ANGLED	SOYBEAN	CI5	WET	0.35	2	14.1686388	144.59	4.16434
ANGLED	SOYBEAN	CI5	WET	0.35	3	17.6355855	91.154	2.6254
ANGLED	SOYBEAN	CI5	WET	0.35	4	13.3520308	75.123	2.16368
ANGLED	SOYBEAN	CI5	WET	0.54	1	10.338825	165.35	3.07741
ANGLED	SOYBEAN	CI5	WET	0.54	2	10.5111702	241.12	4.48746
ANGLED	SOYBEAN	CI5	WET	0.54	3	13.3200046	100.05	1.8621
ANGLED	SOYBEAN	CI5	WET	0.54	4	8.60999629	251.37	4.67836

CUTTING PLANT RESIDUE ON SOIL

AREA & M.C. EFFECT

KNIFE	CROP	SOIL COMP.	M.C. (%)	AREA (cm^2)	REP (4 Rep)	T - K ENERGY (N.m=J)	T - K SPENERGY (J/cm^2)
FLAT	CORN	CI2	DRY	1.22	1	1.013798	0.82752453
FLAT	CORN	CI2	DRY	1.22	2	0.99739	0.81413159
FLAT	CORN	CI2	DRY	1.22	3	0.900037	0.73466598
FLAT	CORN	CI2	DRY	1.22	4	0.970067	0.79182852
FLAT	CORN	CI2	DRY	2.64	1	3.278612	1.24245134
FLAT	CORN	CI2	DRY	2.64	2	4.874699	1.84729874
FLAT	CORN	CI2	DRY	2.64	3	4.274709	1.61992885
FLAT	CORN	CI2	DRY	2.64	4	6.932688	2.62718717
FLAT	CORN	CI2	DRY	3.44	1	9.420985	2.73934006
FLAT	CORN	CI2	DRY	3.44	2	14.41435	4.19126221
FLAT	CORN	CI2	DRY	3.44	3	2.196728	0.63874264
FLAT	CORN	CI2	DRY	3.44	4	5.788028	1.68298499
FLAT	CORN	CI2	WET	1.22	1	9.283024	7.57737849
FLAT	CORN	CI2	WET	1.22	2	1.963199	1.60248429
FLAT	CORN	CI2	WET	1.22	3	0.989246	0.80748414
FLAT	CORN	CI2	WET	1.22	4	1.360367	1.1104153
FLAT	CORN	CI2	WET	2.64	1	4.102397	1.55462995
FLAT	CORN	CI2	WET	2.64	2	10.78251	4.08610056
FLAT	CORN	CI2	WET	2.64	3	5.603828	2.1236069
FLAT	CORN	CI2	WET	2.64	4	4.549481	1.7240553
FLAT	CORN	CI2	WET	3.44	1	5.80969	1.68928376
FLAT	CORN	CI2	WET	3.44	2	4.249439	1.23560964
FLAT	CORN	CI2	WET	3.44	3	11.30378	3.28680178
FLAT	CORN	CI2	WET	3.44	4	8.596509	2.49960718
ANGLED	CORN	CI2	DRY	1.22	1	0.8283	0.67610935
ANGLED	CORN	CI2	DRY	1.22	2	1.359929	1.11005811
ANGLED	CORN	CI2	DRY	1.22	3	1.208683	0.9866015
ANGLED	CORN	CI2	DRY	1.22	4	1.774328	1.44831608
ANGLED	CORN	CI2	DRY	2.64	1	1.531044	0.5801989
ANGLED	CORN	CI2	DRY	2.64	2	2.768362	1.04908881
ANGLED	CORN	CI2	DRY	2.64	3	3.194409	1.21054187
ANGLED	CORN	CI2	DRY	2.64	4	2.79441	1.05895968
ANGLED	CORN	CI2	DRY	3.44	1	5.449756	1.5846257
ANGLED	CORN	CI2	DRY	3.44	2	4.742116	1.37886512
ANGLED	CORN	CI2	DRY	3.44	3	2.606518	0.75789743
ANGLED	CORN	CI2	DRY	3.44	4	6.437919	1.87195389
ANGLED	CORN	CI2	WET	1.22	1	1.34789	1.10023077
ANGLED	CORN	CI2	WET	1.22	2	0.678988	0.55423193
ANGLED	CORN	CI2	WET	1.22	3	1.309235	1.06867868
ANGLED	CORN	CI2	WET	1.22	4	1.130112	0.92246734
ANGLED	CORN	CI2	WET	2.64	1	2.679999	1.01560319
ANGLED	CORN	CI2	WET	2.64	2	2.564883	0.97197915
ANGLED	CORN	CI2	WET	2.64	3	2.683882	1.01707465
ANGLED	CORN	CI2	WET	2.64	4	1.611457	0.6106721
ANGLED	CORN	CI2	WET	3.44	1	3.81854	1.11031717

ANGLED	CORN	CI2	WET	3.44	2	5.390779	1.5674769
ANGLED	CORN	CI2	WET	3.44	3	2.796258	0.81306802
ANGLED	CORN	CI2	WET	3.44	4	4.01433	1.16724704
FLAT	COTTON	CI2	DRY	0.35	1	2.106199	6.06625984
FLAT	COTTON	CI2	DRY	0.35	2	4.88998	14.0840867
FLAT	COTTON	CI2	DRY	0.35	3	3.566958	10.2735258
FLAT	COTTON	CI2	DRY	0.35	4	1.506314	4.33847429
FLAT	COTTON	CI2	DRY	0.54	1	5.341683	9.94150742
FLAT	COTTON	CI2	DRY	0.54	2	4.299405	8.00170431
FLAT	COTTON	CI2	DRY	0.54	3	4.264222	7.93622513
FLAT	COTTON	CI2	DRY	0.54	4	5.234143	9.74136292
FLAT	COTTON	CI2	DRY	0.77	1	7.645115	9.94462887
FLAT	COTTON	CI2	DRY	0.77	2	5.455705	7.09668271
FLAT	COTTON	CI2	DRY	0.77	3	6.741786	8.76959472
FLAT	COTTON	CI2	DRY	0.77	4	9.945082	12.9363838
FLAT	COTTON	CI2	WET	0.35	1	7.003605	20.1717343
FLAT	COTTON	CI2	WET	0.35	2	7.837899	22.5746605
FLAT	COTTON	CI2	WET	0.35	3	11.35537	32.70567
FLAT	COTTON	CI2	WET	0.35	4	20.93802	60.3055347
FLAT	COTTON	CI2	WET	0.54	1	23.41532	43.5786899
FLAT	COTTON	CI2	WET	0.54	2	12.04608	22.419183
FLAT	COTTON	CI2	WET	0.54	3	9.001193	16.7522909
FLAT	COTTON	CI2	WET	0.54	4	7.244875	13.483575
FLAT	COTTON	CI2	WET	0.77	1	12.33895	16.050283
FLAT	COTTON	CI2	WET	0.77	2	14.38856	18.7163821
FLAT	COTTON	CI2	WET	0.77	3	24.94544	32.4485829
FLAT	COTTON	CI2	WET	0.77	4	19.66465	25.5794225
ANGLED	COTTON	CI2	DRY	0.35	1	2.530755	7.28906323
ANGLED	COTTON	CI2	DRY	0.35	2	3.865984	11.1347803
ANGLED	COTTON	CI2	DRY	0.35	3	6.411103	18.4652125
ANGLED	COTTON	CI2	DRY	0.35	4	2.113126	6.08621004
ANGLED	COTTON	CI2	DRY	0.54	1	5.149206	9.58328582
ANGLED	COTTON	CI2	DRY	0.54	2	6.01819	11.2005676
ANGLED	COTTON	CI2	DRY	0.54	3	5.681074	10.5731538
ANGLED	COTTON	CI2	DRY	0.54	4	7.673739	14.281742
ANGLED	COTTON	CI2	DRY	0.77	1	13.43553	17.4766926
ANGLED	COTTON	CI2	DRY	0.77	2	7.809458	10.1584032
ANGLED	COTTON	CI2	DRY	0.77	3	10.00738	13.0174202
ANGLED	COTTON	CI2	DRY	0.77	4	8.513391	11.0740659
ANGLED	COTTON	CI2	WET	0.35	1	2.064115	5.94505003
ANGLED	COTTON	CI2	WET	0.35	2	2.784021	8.01851638
ANGLED	COTTON	CI2	WET	0.35	3	2.597445	7.4811418
ANGLED	COTTON	CI2	WET	0.35	4	3.152526	9.07988327
ANGLED	COTTON	CI2	WET	0.54	1	7.303445	13.5925808
ANGLED	COTTON	CI2	WET	0.54	2	4.856338	9.03822254
ANGLED	COTTON	CI2	WET	0.54	3	3.588088	6.67785788
ANGLED	COTTON	CI2	WET	0.54	4	3.642958	6.77997818
ANGLED	COTTON	CI2	WET	0.77	1	9.615654	12.5078702
ANGLED	COTTON	CI2	WET	0.77	2	7.27772	9.46672724
ANGLED	COTTON	CI2	WET	0.77	3	13.65869	17.766974
ANGLED	COTTON	CI2	WET	0.77	4	16.18553	21.0538428
FLAT	SOYBEAN	CI2	DRY	0.26	1	0.599912	2.37140832

FLAT	SOYBEAN	CI2	DRY	0.26	2	0.290787	1.14945897
FLAT	SOYBEAN	CI2	DRY	0.26	3	0.241052	0.95285893
FLAT	SOYBEAN	CI2	DRY	0.26	4	0.323727	1.27966855
FLAT	SOYBEAN	CI2	DRY	0.35	1	0.239242	0.68906374
FLAT	SOYBEAN	CI2	DRY	0.35	2	1.527203	4.39863962
FLAT	SOYBEAN	CI2	DRY	0.35	3	0.678063	1.9529533
FLAT	SOYBEAN	CI2	DRY	0.35	4	0.996862	2.87115429
FLAT	SOYBEAN	CI2	DRY	0.54	1	2.46993	4.59683337
FLAT	SOYBEAN	CI2	DRY	0.54	2	1.662807	3.09468221
FLAT	SOYBEAN	CI2	DRY	0.54	3	1.967853	3.66240834
FLAT	SOYBEAN	CI2	DRY	0.54	4	0.724301	1.34801015
FLAT	SOYBEAN	CI2	WET	0.26	1	1.617442	6.39362796
FLAT	SOYBEAN	CI2	WET	0.26	2	1.449411	5.72941192
FLAT	SOYBEAN	CI2	WET	0.26	3	1.25	5.5
FLAT	SOYBEAN	CI2	WET	0.26	4	1.306454	5.16431387
FLAT	SOYBEAN	CI2	WET	0.35	1	1.026362	2.95612002
FLAT	SOYBEAN	CI2	WET	0.35	2	4.040185	11.6365115
FLAT	SOYBEAN	CI2	WET	0.35	3	4.285654	12.3435094
FLAT	SOYBEAN	CI2	WET	0.35	4	5.87567	16.923062
FLAT	SOYBEAN	CI2	WET	0.54	1	10.02035	18.6490682
FLAT	SOYBEAN	CI2	WET	0.54	2	2.655196	4.94163563
FLAT	SOYBEAN	CI2	WET	0.54	3	9.097299	16.9311548
FLAT	SOYBEAN	CI2	WET	0.54	4	9	15
ANGLED	SOYBEAN	CI2	DRY	0.26	1	0.963189	3.8074146
ANGLED	SOYBEAN	CI2	DRY	0.26	2	1.614767	6.38305412
ANGLED	SOYBEAN	CI2	DRY	0.26	3	0.472379	1.86727882
ANGLED	SOYBEAN	CI2	DRY	0.26	4	1.311462	5.18410981
ANGLED	SOYBEAN	CI2	DRY	0.35	1	0.989782	2.85076271
ANGLED	SOYBEAN	CI2	DRY	0.35	2	1.413297	4.07056753
ANGLED	SOYBEAN	CI2	DRY	0.35	3	1.504552	4.33339856
ANGLED	SOYBEAN	CI2	DRY	0.35	4	2.292177	6.60191116
ANGLED	SOYBEAN	CI2	DRY	0.54	1	1.370596	2.55084285
ANGLED	SOYBEAN	CI2	DRY	0.54	2	2.339402	4.35390622
ANGLED	SOYBEAN	CI2	DRY	0.54	3	2.014241	3.74874153
ANGLED	SOYBEAN	CI2	DRY	0.54	4	4.578913	8.52190232
ANGLED	SOYBEAN	CI2	WET	0.26	1	0.916598	3.62324173
ANGLED	SOYBEAN	CI2	WET	0.26	2	1.252664	4.95168801
ANGLED	SOYBEAN	CI2	WET	0.26	3	0.802131	3.17076231
ANGLED	SOYBEAN	CI2	WET	0.26	4	1.141187	4.51102856
ANGLED	SOYBEAN	CI2	WET	0.35	1	1.904674	5.48582789
ANGLED	SOYBEAN	CI2	WET	0.35	2	2.528674	7.28306868
ANGLED	SOYBEAN	CI2	WET	0.35	3	1.618862	4.66263433
ANGLED	SOYBEAN	CI2	WET	0.35	4	2.232254	6.42932157
ANGLED	SOYBEAN	CI2	WET	0.54	1	3.582031	6.66658655
ANGLED	SOYBEAN	CI2	WET	0.54	2	4.645299	8.64545364
ANGLED	SOYBEAN	CI2	WET	0.54	3	6.557102	12.2035471
ANGLED	SOYBEAN	CI2	WET	0.54	4	4.969795	9.24938058
FLAT	WHEAT	CI2	DRY	0.07	1	0.035036	0.49262067
FLAT	WHEAT	CI2	DRY	0.07	2	0.036893	0.51873885
FLAT	WHEAT	CI2	DRY	0.07	3	0.011239	0.15801974
FLAT	WHEAT	CI2	DRY	0.07	4	0.040686	0.57205733
FLAT	WHEAT	CI2	DRY	0.087	1	0.056412	0.64900905

FLAT	WHEAT	CI2	DRY	0.087	2	0.046607	0.536206
FLAT	WHEAT	CI2	DRY	0.087	3	0.054549	0.62757066
FLAT	WHEAT	CI2	DRY	0.087	4	0.073176	0.84187666
FLAT	WHEAT	CI2	DRY	0.11	1	0.076151	0.68929635
FLAT	WHEAT	CI2	DRY	0.11	2	0.079397	0.71867649
FLAT	WHEAT	CI2	DRY	0.11	3	0.00843	0.07630897
FLAT	WHEAT	CI2	DRY	0.11	4	0.061177	0.55375876
FLAT	WHEAT	CI2	WET	0.07	1	0.34521	4.85380957
FLAT	WHEAT	CI2	WET	0.07	2	0.300771	4.22898269
FLAT	WHEAT	CI2	WET	0.07	3	0.27386	3.85059305
FLAT	WHEAT	CI2	WET	0.07	4	0.197762	2.78062256
FLAT	WHEAT	CI2	WET	0.087	1	0.554731	6.38205587
FLAT	WHEAT	CI2	WET	0.087	2	0.219442	2.52463519
FLAT	WHEAT	CI2	WET	0.087	3	0.073414	0.84461686
FLAT	WHEAT	CI2	WET	0.087	4	0.164254	1.88970457
FLAT	WHEAT	CI2	WET	0.11	1	0.165677	1.49965957
FLAT	WHEAT	CI2	WET	0.11	2	0.137056	1.2405928
FLAT	WHEAT	CI2	WET	0.11	3	0.273347	2.47425093
FLAT	WHEAT	CI2	WET	0.11	4	0.375411	3.3981119
ANGLED	WHEAT	CI2	DRY	0.07	1	0.016631	0.23383373
ANGLED	WHEAT	CI2	DRY	0.07	2	0.141889	1.99502482
ANGLED	WHEAT	CI2	DRY	0.07	3	0.060574	0.85170253
ANGLED	WHEAT	CI2	DRY	0.07	4	0.080922	1.13780378
ANGLED	WHEAT	CI2	DRY	0.087	1	0.058091	0.66832871
ANGLED	WHEAT	CI2	DRY	0.087	2	0.112837	1.29817066
ANGLED	WHEAT	CI2	DRY	0.087	3	0.087164	1.00280461
ANGLED	WHEAT	CI2	DRY	0.087	4	0.11145	1.28220898
ANGLED	WHEAT	CI2	DRY	0.11	1	0.083734	0.75793189
ANGLED	WHEAT	CI2	DRY	0.11	2	0.113145	1.02415133
ANGLED	WHEAT	CI2	DRY	0.11	3	0.096937	0.8774408
ANGLED	WHEAT	CI2	DRY	0.11	4	0.109747	0.99339452
ANGLED	WHEAT	CI2	WET	0.07	1	0.057802	0.81271691
ANGLED	WHEAT	CI2	WET	0.07	2	0.034024	0.47839844
ANGLED	WHEAT	CI2	WET	0.07	3	0.05546	0.77979592
ANGLED	WHEAT	CI2	WET	0.07	4	0.074374	1.04572879
ANGLED	WHEAT	CI2	WET	0.087	1	0.048972	0.56340966
ANGLED	WHEAT	CI2	WET	0.087	2	0.066856	0.76916309
ANGLED	WHEAT	CI2	WET	0.087	3	0.077195	0.88811671
ANGLED	WHEAT	CI2	WET	0.087	4	0.073578	0.84649481
ANGLED	WHEAT	CI2	WET	0.11	1	0.211913	1.91817104
ANGLED	WHEAT	CI2	WET	0.11	2	0.215092	1.94694599
ANGLED	WHEAT	CI2	WET	0.11	3	0.106513	0.96412718
ANGLED	WHEAT	CI2	WET	0.11	4	0.186735	1.69026922
FLAT	CORN	CI5	DRY	1.22	1	0.982146	0.80168837
FLAT	CORN	CI5	DRY	1.22	2	0.77361	0.63146851
FLAT	CORN	CI5	DRY	1.22	3	1.351899	1.10350324
FLAT	CORN	CI5	DRY	1.22	4	0.621502	0.50730851
FLAT	CORN	CI5	DRY	2.64	1	1.668146	0.63215493
FLAT	CORN	CI5	DRY	2.64	2	3.414005	1.2937593
FLAT	CORN	CI5	DRY	2.64	3	5.045195	1.91190938
FLAT	CORN	CI5	DRY	2.64	4	4.162806	1.57752244
FLAT	CORN	CI5	DRY	3.44	1	5.519253	1.60483344

FLAT	CORN	CI5	DRY	3.44	2	11.45231	3.32998921
FLAT	CORN	CI5	DRY	3.44	3	6.254433	1.81860188
FLAT	CORN	CI5	DRY	3.44	4	3.486402	1.01374116
FLAT	CORN	CI5	WET	1.22	1	0.955429	0.7798799
FLAT	CORN	CI5	WET	1.22	2	1.147403	0.93658138
FLAT	CORN	CI5	WET	1.22	3	0.464149	0.37886722
FLAT	CORN	CI5	WET	1.22	4	0.680202	0.55522276
FLAT	CORN	CI5	WET	2.64	1	1.971754	0.74720912
FLAT	CORN	CI5	WET	2.64	2	1.515238	0.57420935
FLAT	CORN	CI5	WET	2.64	3	2.792388	1.05819366
FLAT	CORN	CI5	WET	2.64	4	4.89769	1.85601132
FLAT	CORN	CI5	WET	3.44	1	4.021674	1.1693823
FLAT	CORN	CI5	WET	3.44	2	5.563956	1.61783165
FLAT	CORN	CI5	WET	3.44	3	5.233079	1.52162248
FLAT	CORN	CI5	WET	3.44	4	15.23277	4.42923306
ANGLED	CORN	CI5	DRY	1.22	1	3.619609	2.95454875
ANGLED	CORN	CI5	DRY	1.22	2	2.895216	2.36325436
ANGLED	CORN	CI5	DRY	1.22	3	3.236578	2.6418948
ANGLED	CORN	CI5	DRY	1.22	4	4.041425	3.298861
ANGLED	CORN	CI5	DRY	2.64	1	8.348679	3.1637861
ANGLED	CORN	CI5	DRY	2.64	2	8.604842	3.26086072
ANGLED	CORN	CI5	DRY	2.64	3	5.102047	1.93345387
ANGLED	CORN	CI5	DRY	2.64	4	8.309321	3.14887116
ANGLED	CORN	CI5	DRY	3.44	1	6.356139	1.84817484
ANGLED	CORN	CI5	DRY	3.44	2	8.846086	2.57217666
ANGLED	CORN	CI5	DRY	3.44	3	9.861178	2.86733516
ANGLED	CORN	CI5	DRY	3.44	4	9.757551	2.83720349
ANGLED	CORN	CI5	WET	1.22	1	2.66738	2.17728071
ANGLED	CORN	CI5	WET	1.22	2	1.227385	1.00186764
ANGLED	CORN	CI5	WET	1.22	3	2.292767	1.87149849
ANGLED	CORN	CI5	WET	1.22	4	0.91076	0.74341835
ANGLED	CORN	CI5	WET	2.64	1	5.671065	2.14908675
ANGLED	CORN	CI5	WET	2.64	2	4.800097	1.8190278
ANGLED	CORN	CI5	WET	2.64	3	5.400292	2.04647588
ANGLED	CORN	CI5	WET	2.64	4	4.531466	1.71722833
ANGLED	CORN	CI5	WET	3.44	1	7.668712	2.22983181
ANGLED	CORN	CI5	WET	3.44	2	6.805547	1.9788491
ANGLED	CORN	CI5	WET	3.44	3	8.364167	2.43204928
ANGLED	CORN	CI5	WET	3.44	4	8.503007	2.47241967
FLAT	COTTON	CI5	DRY	0.35	1	2.798686	8.0607569
FLAT	COTTON	CI5	DRY	0.35	2	1.369931	3.94566533
FLAT	COTTON	CI5	DRY	0.35	3	1.97081	5.67631314
FLAT	COTTON	CI5	DRY	0.35	4	2.246876	6.47143647
FLAT	COTTON	CI5	DRY	0.54	1	2.66891	4.96715896
FLAT	COTTON	CI5	DRY	0.54	2	4.787199	8.90954678
FLAT	COTTON	CI5	DRY	0.54	3	3.584921	6.67196399
FLAT	COTTON	CI5	DRY	0.54	4	3.044312	5.66582649
FLAT	COTTON	CI5	DRY	0.77	1	5.939791	7.72637419
FLAT	COTTON	CI5	DRY	0.77	2	7.756601	10.0896476
FLAT	COTTON	CI5	DRY	0.77	3	6.274986	8.16238885
FLAT	COTTON	CI5	DRY	0.77	4	8.799092	11.4457016
FLAT	COTTON	CI5	WET	0.35	1	12.0043	34.5746858

FLAT	COTTON	C15	WET	0.35	2	10.17247	29.2986684
FLAT	COTTON	C15	WET	0.35	3	18.34731	52.843795
FLAT	COTTON	C15	WET	0.35	4	9.692128	27.9151993
FLAT	COTTON	C15	WET	0.54	1	13.24003	24.6412649
FLAT	COTTON	C15	WET	0.54	2	14.9881	27.8946329
FLAT	COTTON	C15	WET	0.54	3	11.40321	21.2227384
FLAT	COTTON	C15	WET	0.54	4	10.4014	19.358234
FLAT	COTTON	C15	WET	0.77	1	15.93137	20.7232412
FLAT	COTTON	C15	WET	0.77	2	11.7244	15.2508872
FLAT	COTTON	C15	WET	0.77	3	11.39919	14.82786
FLAT	COTTON	C15	WET	0.77	4	23.64627	30.7586496
ANGLED	COTTON	C15	DRY	0.35	1	2.914251	8.39360431
ANGLED	COTTON	C15	DRY	0.35	2	2.714703	7.81886788
ANGLED	COTTON	C15	DRY	0.35	3	2.661678	7.66614514
ANGLED	COTTON	C15	DRY	0.35	4	2.96256	8.53274358
ANGLED	COTTON	C15	DRY	0.54	1	3.329805	6.1971627
ANGLED	COTTON	C15	DRY	0.54	2	4.19821	7.813368
ANGLED	COTTON	C15	DRY	0.54	3	3.137956	5.84010882
ANGLED	COTTON	C15	DRY	0.54	4	5.144628	9.57476503
ANGLED	COTTON	C15	DRY	0.77	1	5.528897	7.19188957
ANGLED	COTTON	C15	DRY	0.77	2	4.714105	6.13202324
ANGLED	COTTON	C15	DRY	0.77	3	5.9406	7.72742569
ANGLED	COTTON	C15	DRY	0.77	4	5.376616	6.9938058
ANGLED	COTTON	C15	WET	0.35	1	1.6297	4.69384944
ANGLED	COTTON	C15	WET	0.35	2	1.649064	4.74962304
ANGLED	COTTON	C15	WET	0.35	3	3.163295	9.11090081
ANGLED	COTTON	C15	WET	0.35	4	2.580617	7.43267413
ANGLED	COTTON	C15	WET	0.54	1	6.162145	11.4684845
ANGLED	COTTON	C15	WET	0.54	2	4.482844	8.34310589
ANGLED	COTTON	C15	WET	0.54	3	3.418979	6.36312583
ANGLED	COTTON	C15	WET	0.54	4	4.406547	8.20110746
ANGLED	COTTON	C15	WET	0.77	1	2.990706	3.89025663
ANGLED	COTTON	C15	WET	0.77	2	4.097124	5.329465
ANGLED	COTTON	C15	WET	0.77	3	4.241275	5.51697487
ANGLED	COTTON	C15	WET	0.77	4	6.702861	8.71896134
FLAT	SOYBEAN	C15	DRY	0.26	1	1.53979	6.08667467
FLAT	SOYBEAN	C15	DRY	0.26	2	0.70321	2.77973668
FLAT	SOYBEAN	C15	DRY	0.26	3	0.725794	2.86900879
FLAT	SOYBEAN	C15	DRY	0.26	4	1.113214	4.40045199
FLAT	SOYBEAN	C15	DRY	0.35	1	0.848889	2.44496351
FLAT	SOYBEAN	C15	DRY	0.35	2	0.364882	1.0509297
FLAT	SOYBEAN	C15	DRY	0.35	3	0.343695	0.98990783
FLAT	SOYBEAN	C15	DRY	0.35	4	0.530135	1.52689107
FLAT	SOYBEAN	C15	DRY	0.54	1	0.990014	1.84253331
FLAT	SOYBEAN	C15	DRY	0.54	2	0.340085	0.63293916
FLAT	SOYBEAN	C15	DRY	0.54	3	1.353983	2.51992268
FLAT	SOYBEAN	C15	DRY	0.54	4	1.303316	2.42562541
FLAT	SOYBEAN	C15	WET	0.26	1	3.643622	14.4029661
FLAT	SOYBEAN	C15	WET	0.26	2	1.98589	7.85007314
FLAT	SOYBEAN	C15	WET	0.26	3	1.423281	5.62612456
FLAT	SOYBEAN	C15	WET	0.26	4	0.861728	3.40634773
FLAT	SOYBEAN	C15	WET	0.35	1	3.017252	8.69026838

FLAT	SOYBEAN	CI5	WET	0.35	2	1.452743	4.1841791
FLAT	SOYBEAN	CI5	WET	0.35	3	2.345504	6.75550476
FLAT	SOYBEAN	CI5	WET	0.35	4	0.627152	1.80631915
FLAT	SOYBEAN	CI5	WET	0.54	1	3.256318	6.06039453
FLAT	SOYBEAN	CI5	WET	0.54	2	6.597675	12.2790588
FLAT	SOYBEAN	CI5	WET	0.54	3	6.626441	12.3325947
FLAT	SOYBEAN	CI5	WET	0.54	4	3.949004	7.3495661
ANGLED	SOYBEAN	CI5	DRY	0.26	1	0.736659	2.91195967
ANGLED	SOYBEAN	CI5	DRY	0.26	2	0.850631	3.36248251
ANGLED	SOYBEAN	CI5	DRY	0.26	3	1.436318	5.67765788
ANGLED	SOYBEAN	CI5	DRY	0.26	4	1.06478	4.20899702
ANGLED	SOYBEAN	CI5	DRY	0.35	1	2.48533	7.15822929
ANGLED	SOYBEAN	CI5	DRY	0.35	2	2.091969	6.02527445
ANGLED	SOYBEAN	CI5	DRY	0.35	3	3.119325	8.98425724
ANGLED	SOYBEAN	CI5	DRY	0.35	4	1.463038	4.21383074
ANGLED	SOYBEAN	CI5	DRY	0.54	1	4.469399	8.31808385
ANGLED	SOYBEAN	CI5	DRY	0.54	2	3.880996	7.22299519
ANGLED	SOYBEAN	CI5	DRY	0.54	3	4.333157	8.06452102
ANGLED	SOYBEAN	CI5	DRY	0.54	4	4.105281	7.64041629
ANGLED	SOYBEAN	CI5	WET	0.26	1	1.926612	7.61575207
ANGLED	SOYBEAN	CI5	WET	0.26	2	2.408426	9.52032873
ANGLED	SOYBEAN	CI5	WET	0.26	3	3.421137	13.5234977
ANGLED	SOYBEAN	CI5	WET	0.26	4	3.297883	13.0362833
ANGLED	SOYBEAN	CI5	WET	0.35	1	2.843662	8.19029465
ANGLED	SOYBEAN	CI5	WET	0.35	2	3.438158	9.90255883
ANGLED	SOYBEAN	CI5	WET	0.35	3	3.86724	11.1383982
ANGLED	SOYBEAN	CI5	WET	0.35	4	2.980949	8.58570669
ANGLED	SOYBEAN	CI5	WET	0.54	1	3.514349	6.54062086
ANGLED	SOYBEAN	CI5	WET	0.54	2	4.421156	8.22829634
ANGLED	SOYBEAN	CI5	WET	0.54	3	2.874409	5.34961642
ANGLED	SOYBEAN	CI5	WET	0.54	4	3.909747	7.27650395

CUTTING PLANT RESIDUE ON SOIL

SECTION EFFECT

RESIDUE M.C. 9.5 %

KNIFE	CROP	SECTION	REP (3 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)	SPENERGY (J/cm^2)
FLAT	CORN	SECT-1	1	741.03	1.705354	10.898793	2.50817664
FLAT	CORN	SECT-2	1	618.59	1.594715	6.5778301	1.69575659
FLAT	CORN	SECT-3	1	710.75	1.886998	7.4842516	1.98703048
FLAT	CORN	SECT-4	1	499.58	1.547099	4.7252956	1.46332876
FLAT	CORN	SECT-5	1	488.26	1.725931	4.1024774	1.45016022
FLAT	CORN	SECT-9	1	203.47	2.06842	0.9271396	0.94250018
FLAT	CORN	SECT-10	1	143.52	1.750177	1.1877724	1.44846563
FLAT	CORN	SECT-11	1	203.97	3.514952	1.5548695	2.67944661
FLAT	CORN	SECT-1	2	954.86	2.323924	16.682066	4.06004056
FLAT	CORN	SECT-2	2	625.82	1.711881	6.7352638	1.84236962

FLAT	CORN	SECT-3	2	770.2	2.310615	9.5832731	2.87499708
FLAT	CORN	SECT-4	2	588.35	1.944489	5.5639292	1.83885693
FLAT	CORN	SECT-5	2	469.93	1.780847	3.9376683	1.49220497
FLAT	CORN	SECT-9	2	211.21	2.027795	2.3094066	2.21723543
FLAT	CORN	SECT-10	2	128.33	1.470058	0.634012	0.72630525
FLAT	CORN	SECT-11	2	175.22	3.019436	1.2839483	2.21257856
FLAT	CORN	SECT-1	3	542.2	1.791935	5.6118917	1.85470835
FLAT	CORN	SECT-2	3	894.44	3.389538	13.35055	5.05927756
FLAT	CORN	SECT-3	3	437.73	1.782801	2.6251757	1.06919445
FLAT	CORN	SECT-4	3	596.56	2.829906	5.2517954	2.49130979
FLAT	CORN	SECT-5	3	345.24	1.931647	2.6834091	1.50140198
FLAT	CORN	SECT-9	3	126.19	1.538896	0.7025505	0.85674685
FLAT	CORN	SECT-10	3	94.999	1.637083	0.3774984	0.65052852
FLAT	CORN	SECT-11	3	75.407	1.520366	0.1875361	0.37811128
ANGLED	CORN	SECT-1	1	318.72	0.798188	7.1814164	1.79846035
ANGLED	CORN	SECT-2	1	367.68	0.846165	3.6347951	0.83648783
ANGLED	CORN	SECT-3	1	244.52	0.578571	1.9639335	0.46469918
ANGLED	CORN	SECT-4	1	436.32	1.124835	4.5364208	1.16948376
ANGLED	CORN	SECT-5	1	289.56	0.957	2.1721384	0.71788329
ANGLED	CORN	SECT-9	1	230.83	1.702634	2.8959512	2.13610265
ANGLED	CORN	SECT-10	1	177.31	1.802439	1.3447429	1.36702224
ANGLED	CORN	SECT-11	1	193.46	2.359185	1.82589	2.22663782
ANGLED	CORN	SECT-1	2	473.14	1.119532	13.489804	3.19191103
ANGLED	CORN	SECT-2	2	433.68	1.151393	9.6083651	2.55097175
ANGLED	CORN	SECT-3	2	445.89	1.337688	10.961269	3.28839812
ANGLED	CORN	SECT-4	2	392.34	1.177021	7.3118576	2.19356884
ANGLED	CORN	SECT-5	2	296.31	1.047399	4.9830376	1.76142417
ANGLED	CORN	SECT-9	2	215.69	1.958915	1.8988219	1.72448958
ANGLED	CORN	SECT-10	2	222.6	2.550071	1.8921433	2.16758308
ANGLED	CORN	SECT-11	2	163.89	2.622494	1.1587585	1.85421343
ANGLED	CORN	SECT-1	3	454.39	1.137934	12.310775	3.08301862
ANGLED	CORN	SECT-2	3	449.05	1.15765	12.379669	3.19146374
ANGLED	CORN	SECT-3	3	472.6	1.374184	10.804767	3.14170263
ANGLED	CORN	SECT-4	3	453.48	1.404325	11.248131	3.48331934
ANGLED	CORN	SECT-5	3	371.72	1.313964	8.0171429	2.83393189
ANGLED	CORN	SECT-9	3	234.68	1.915574	2.1999821	1.79576143
ANGLED	CORN	SECT-10	3	205.74	2.091468	1.9883702	2.02131293
ANGLED	CORN	SECT-11	3	149.84	1.949104	1.0999657	1.43081568
FLAT	COTTON	SECT-1	1	656.97	8.011568	7.4622464	9.10006639
FLAT	COTTON	SECT-2	1	652.21	7.953598	8.8246291	10.761466
FLAT	COTTON	SECT-3	1	516.61	6.299927	4.9238983	6.00459953
FLAT	COTTON	SECT-4	1	503.72	6.552347	5.9777685	7.77577411
FLAT	COTTON	SECT-5	1	761.27	9.283553	7.3143362	8.91969272
FLAT	COTTON	SECT-6	1	567.96	7.387969	5.162822	6.71570627
FLAT	COTTON	SECT-7	1	373.63	5.195313	3.6829667	5.12114031
FLAT	COTTON	SECT-8	1	559.75	7.783223	3.751513	5.21645348
FLAT	COTTON	SECT-9	1	654.91	11.28575	3.5901245	6.1867232
FLAT	COTTON	SECT-10	1	460.93	8.578371	2.8068768	5.2239317
FLAT	COTTON	SECT-11	1	423.08	7.874073	3.1817565	5.9216273
FLAT	COTTON	SECT-12	1	343.81	9.002317	1.4666191	3.8401833
FLAT	COTTON	SECT-1	2	551.53	6.725836	6.4497194	7.86530918
FLAT	COTTON	SECT-2	2	671.02	8.728555	10.295238	13.3918609

FLAT	COTTON	SECT-3	2	637.45	7.773581	7.010409	8.54905939
FLAT	COTTON	SECT-4	2	472.71	6.573001	3.7523888	5.21767129
FLAT	COTTON	SECT-5	2	447.65	6.669159	3.336656	4.97100196
FLAT	COTTON	SECT-6	2	424.7	7.31866	3.6394548	6.27173218
FLAT	COTTON	SECT-7	2	429.9	8.000866	3.2456765	6.04059004
FLAT	COTTON	SECT-8	2	423.91	7.305046	2.9107285	5.01594618
FLAT	COTTON	SECT-9	2	297.58	5.999825	3.0744801	6.19878446
FLAT	COTTON	SECT-10	2	188.97	4.947904	0.5878927	1.53933342
FLAT	COTTON	SECT-11	2	167.39	4.82126	1.0053474	2.89559441
FLAT	COTTON	SECT-12	2	344.51	10.96693	1.3011312	4.14191052
FLAT	COTTON	SECT-1	3	372.28	11.85076	1.9798529	6.30249563
FLAT	COTTON	SECT-2	3	291.93	9.292907	2.13495	6.79621873
FLAT	COTTON	SECT-3	3	319.92	11.3152	1.7879187	6.32375228
FLAT	COTTON	SECT-4	3	250.53	8.861115	2.7790407	9.82928632
FLAT	COTTON	SECT-5	3	407.96	14.42944	2.1569759	7.62908359
FLAT	COTTON	SECT-6	3	386.96	13.68656	2.4234034	8.57142024
FLAT	COTTON	SECT-7	3	347.4	12.28734	1.5424452	5.45552851
FLAT	COTTON	SECT-8	3	308.92	12.21152	1.9592598	7.74480741
FLAT	COTTON	SECT-9	3	232.18	10.32453	1.6111859	7.16472521
FLAT	COTTON	SECT-10	3	138.96	4.914893	0.4826635	1.7071493
FLAT	COTTON	SECT-11	3	189.23	7.480013	1.7024241	6.72955499
FLAT	COTTON	SECT-12	3	110.97	4.934564	0.6492654	2.88719513
ANGLED	COTTON	SECT-1	1	647.34	8.420447	10.452239	13.5960848
ANGLED	COTTON	SECT-2	1	639.64	8.894088	14.010666	19.4817364
ANGLED	COTTON	SECT-3	1	603.86	8.396632	9.9692011	13.8621067
ANGLED	COTTON	SECT-4	1	520.36	8.967132	8.993784	15.4986413
ANGLED	COTTON	SECT-5	1	510.82	8.173928	7.546353	12.0754665
ANGLED	COTTON	SECT-6	1	469.18	6.989903	5.2554357	7.82962971
ANGLED	COTTON	SECT-7	1	364.44	6.280176	4.4987254	7.75248004
ANGLED	COTTON	SECT-8	1	403.05	6.945527	4.0147993	6.91854894
ANGLED	COTTON	SECT-9	1	371.64	6.916679	4.6161196	8.59114778
ANGLED	COTTON	SECT-10	1	362.53	7.309387	3.6649854	7.38936445
ANGLED	COTTON	SECT-11	1	317.4	8.310871	2.7728061	7.26029263
ANGLED	COTTON	SECT-12	1	258.66	7.449985	1.8304672	5.27209847
ANGLED	COTTON	SECT-1	2	950.77	8.634807	19.072096	17.3210723
ANGLED	COTTON	SECT-2	2	846.92	8.131184	13.071891	12.5501763
ANGLED	COTTON	SECT-3	2	739.55	7.100354	11.27585	10.8258172
ANGLED	COTTON	SECT-4	2	803.67	7.71592	12.542642	12.0420505
ANGLED	COTTON	SECT-5	2	715.48	6.869226	11.152999	10.7078691
ANGLED	COTTON	SECT-6	2	657.7	6.685993	11.780324	11.9754971
ANGLED	COTTON	SECT-7	2	614.76	5.902242	10.483962	10.065535
ANGLED	COTTON	SECT-8	2	644.32	6.549903	9.7974483	9.95976944
ANGLED	COTTON	SECT-9	2	603.96	6.918817	10.901354	12.4882671
ANGLED	COTTON	SECT-10	2	622.46	8.096895	8.3275006	10.8322635
ANGLED	COTTON	SECT-11	2	589.56	7.668914	8.0336408	10.4500159
ANGLED	COTTON	SECT-12	2	375.88	5.226586	5.4277573	7.54725979
ANGLED	COTTON	SECT-1	3	503.35	9.367942	6.4145999	11.9383335
ANGLED	COTTON	SECT-2	3	423.84	7.888133	4.7958021	8.92555822
ANGLED	COTTON	SECT-3	3	432.19	8.043655	4.5579834	8.4829494
ANGLED	COTTON	SECT-4	3	392.99	9.395261	3.9399828	9.41943117
ANGLED	COTTON	SECT-5	3	279.02	6.114871	2.636163	5.77719639
ANGLED	COTTON	SECT-6	3	262.49	5.752473	2.9528076	6.47112843

ANGLED	COTTON	SECT-7	3	246.08	5.392925	2.1553178	4.72341585
ANGLED	COTTON	SECT-8	3	210.58	5.513714	1.6732935	4.38133796
ANGLED	COTTON	SECT-9	3	187.04	5.387087	1.1530061	3.32087981
ANGLED	COTTON	SECT-10	3	183.08	6.475388	1.2997616	4.59717245
ANGLED	COTTON	SECT-11	3	192.5	8.560133	1.6225955	7.21546227
ANGLED	COTTON	SECT-12	3	152.33	6.021527	1.2780609	5.05207911
FLAT	SOYBEAN	SECT-1	1	323.89	8.480828	1.3939918	3.6500167
FLAT	SOYBEAN	SECT-2	1	269.24	7.049663	0.687092	1.79907598
FLAT	SOYBEAN	SECT-3	1	236.26	6.186189	0.6884626	1.80266475
FLAT	SOYBEAN	SECT-4	1	212.59	6.123107	0.709816	2.0444069
FLAT	SOYBEAN	SECT-5	1	185.92	5.354959	0.7746818	2.23123306
FLAT	SOYBEAN	SECT-6	1	139.2	4.009228	0.5614416	1.61706021
FLAT	SOYBEAN	SECT-7	1	92.843	2.955477	0.2559	0.81461036
FLAT	SOYBEAN	SECT-8	1	86.793	2.762886	0.2268058	0.72199419
FLAT	SOYBEAN	SECT-9	1	89.614	2.852684	0.2983029	0.94959227
FLAT	SOYBEAN	SECT-10	1	78.108	2.48643	0.3882109	1.23579767
FLAT	SOYBEAN	SECT-1	2	212.17	7.504412	0.6867894	2.42912959
FLAT	SOYBEAN	SECT-2	2	155.89	5.513567	0.3730317	1.31938882
FLAT	SOYBEAN	SECT-3	2	123.61	4.37207	0.4049086	1.43213538
FLAT	SOYBEAN	SECT-4	2	129.2	4.569688	1.242702	4.39535623
FLAT	SOYBEAN	SECT-5	2	101.06	3.574298	0.2972932	1.05150685
FLAT	SOYBEAN	SECT-6	2	79.995	2.829387	0.6549566	2.31653878
FLAT	SOYBEAN	SECT-7	2	67.487	2.386981	0.1544341	0.54622328
FLAT	SOYBEAN	SECT-8	2	63.764	2.835483	0.5348376	2.3783502
FLAT	SOYBEAN	SECT-9	2	51.904	2.615693	0.3260036	1.64290113
FLAT	SOYBEAN	SECT-10	2	99.234	6.593538	0.3078031	2.04518522
FLAT	SOYBEAN	SECT-1	3	188.4	4.932979	0.7616125	1.99419984
FLAT	SOYBEAN	SECT-2	3	273.2	7.153351	0.9850465	2.57923777
FLAT	SOYBEAN	SECT-3	3	326.51	8.549382	1.5869897	4.1553607
FLAT	SOYBEAN	SECT-4	3	257.75	6.748857	1.4380367	3.76534341
FLAT	SOYBEAN	SECT-5	3	164.1	4.72637	0.4388154	1.26387299
FLAT	SOYBEAN	SECT-6	3	95.325	3.03451	0.2700033	0.85950567
FLAT	SOYBEAN	SECT-7	3	97.527	3.1046	0.4876551	1.55236002
FLAT	SOYBEAN	SECT-8	3	119.32	3.798303	0.4843934	1.54197684
FLAT	SOYBEAN	SECT-9	3	86.335	2.748301	0.6486617	2.0648947
FLAT	SOYBEAN	SECT-10	3	69.191	2.447237	0.211433	0.74782464
ANGLED	SOYBEAN	SECT-1	1	384.46	6.152009	4.119904	6.59255704
ANGLED	SOYBEAN	SECT-2	1	145.9	3.197364	1.3826717	3.03014881
ANGLED	SOYBEAN	SECT-3	1	207.14	4.952047	1.8785575	4.49112188
ANGLED	SOYBEAN	SECT-4	1	175.01	3.835374	1.284679	2.81539599
ANGLED	SOYBEAN	SECT-5	1	160.44	4.200853	1.5401646	4.03275433
ANGLED	SOYBEAN	SECT-6	1	155.13	4.468069	1.1150751	3.2116315
ANGLED	SOYBEAN	SECT-7	1	169.72	4.443982	1.7354906	4.54419428
ANGLED	SOYBEAN	SECT-8	1	137.1	3.948875	1.2220687	3.5197936
ANGLED	SOYBEAN	SECT-9	1	167.14	5.320506	1.2966327	4.12759053
ANGLED	SOYBEAN	SECT-10	1	167.65	5.929736	1.1531737	4.07870036
ANGLED	SOYBEAN	SECT-1	2	471.23	6.129652	5.0426008	6.5593247
ANGLED	SOYBEAN	SECT-2	2	396.65	5.515404	4.2140836	5.85965479
ANGLED	SOYBEAN	SECT-3	2	324.91	5.59897	3.3403987	5.7563804
ANGLED	SOYBEAN	SECT-4	2	314.47	6.34027	4.6087211	9.29212974
ANGLED	SOYBEAN	SECT-5	2	188.98	4.518043	1.9121859	4.57151815
ANGLED	SOYBEAN	SECT-6	2	244.41	6.399611	2.5606249	6.70471921

ANGLED	SOYBEAN	SECT-7	2	119.31	3.124122	0.8512904	2.22901176
ANGLED	SOYBEAN	SECT-8	2	139.57	4.443011	1.233449	3.92645683
ANGLED	SOYBEAN	SECT-9	2	173.33	6.130473	1.4934168	5.28211823
ANGLED	SOYBEAN	SECT-10	2	170.98	6.758783	1.4995299	5.92752948
ANGLED	SOYBEAN	SECT-1	3	214.2	5.608667	0.9546864	2.4997429
ANGLED	SOYBEAN	SECT-2	3	262.91	6.884109	2.2521326	5.89696556
ANGLED	SOYBEAN	SECT-3	3	193.73	5.07261	2.5359111	6.64000875
ANGLED	SOYBEAN	SECT-4	3	215.87	6.217368	1.5720329	4.52775807
ANGLED	SOYBEAN	SECT-5	3	207.55	5.977945	1.8128071	5.22123408
ANGLED	SOYBEAN	SECT-6	3	135.05	3.889674	0.840926	2.42202907
ANGLED	SOYBEAN	SECT-7	3	180.76	5.206341	1.1392406	3.28123254
ANGLED	SOYBEAN	SECT-8	3	142.17	4.525661	0.8738246	2.78165907
ANGLED	SOYBEAN	SECT-9	3	134.52	4.757724	1.1380691	4.02527645
ANGLED	SOYBEAN	SECT-10	3	111.9	4.976122	0.8584595	3.8174532
FLAT	WHEAT	SECT-1	1	30.048	2.555118	0.213158	1.81256805
FLAT	WHEAT	SECT-2	1	32.357	2.742142	0.1518474	1.2868422
FLAT	WHEAT	SECT-3	1	38.507	3.263303	0.2298141	1.94757719
FLAT	WHEAT	SECT-4	1	14.562	2.077292	0.0601772	0.85844856
FLAT	WHEAT	SECT-1	2	30.752	2.125212	0.075489	0.52169336
FLAT	WHEAT	SECT-2	2	41.516	3.091315	0.1788629	1.33181612
FLAT	WHEAT	SECT-3	2	25.488	2.239735	0.1253984	1.10191875
FLAT	WHEAT	SECT-4	2	16.34	2.802796	0.0582323	0.99883834
FLAT	WHEAT	SECT-1	3	43.78	3.474627	0.2009341	1.59471486
FLAT	WHEAT	SECT-2	3	53.071	4.178836	0.2445306	1.92543761
FLAT	WHEAT	SECT-3	3	38.305	3.016178	0.121016	0.95288224
FLAT	WHEAT	SECT-4	3	26.545	4.698311	0.0768985	1.36103593
ANGLED	WHEAT	SECT-1	1	38.232	3.676195	0.2630193	2.52903213
ANGLED	WHEAT	SECT-2	1	32.186	2.915431	0.3055785	2.76792137
ANGLED	WHEAT	SECT-3	1	34.523	2.841402	0.3024796	2.48954405
ANGLED	WHEAT	SECT-4	1	27.443	4.691168	0.1969226	3.36619828
ANGLED	WHEAT	SECT-1	2	35.099	2.752894	0.1868365	1.46538435
ANGLED	WHEAT	SECT-2	2	35.132	2.977298	0.2290425	1.94103779
ANGLED	WHEAT	SECT-3	2	33.458	3.220258	0.2604244	2.50649104
ANGLED	WHEAT	SECT-4	2	25.699	4.794607	0.2901584	5.41340371
ANGLED	WHEAT	SECT-1	3	36.709	3.482865	0.4309005	4.08823994
ANGLED	WHEAT	SECT-2	3	30.559	3.358142	0.2341003	2.57253082
ANGLED	WHEAT	SECT-3	3	30.432	3.240875	0.2884694	3.07209118
ANGLED	WHEAT	SECT-4	3	21.162	3.948213	0.1506383	2.81041518

CUTTING PLANT RESIDUE ON SOIL

HOLDING EFFECT

KNIFE	CROP	HOLDING 0=NO 1=YES	M.C. (%)	REP (3 Rep)	FORCE (N)	STRESS (MPa)	ENERGY (N.m=J)
FLAT	CORN	0	10	1	639.498	1.85947	21.95157
FLAT	CORN	0	10	2	207.651	0.60379	2.209534
FLAT	CORN	0	10	3	408.097	1.18662	6.19229
FLAT	CORN	1	10	1	279.802	0.72133	5.669538
FLAT	CORN	1	10	2	364.665	0.9401	6.480159

FLAT	CORN	1	10	3	423.979	1.09301	11.15639
FLAT	CORN	0	25	1	417.928	1.21521	4.408651
FLAT	CORN	0	25	2	711.187	2.06792	13.88613
FLAT	CORN	0	25	3	606.699	1.7641	8.974917
FLAT	CORN	1	25	1	374.865	0.93878	3.135374
FLAT	CORN	1	25	2	216.276	0.54163	2.702898
FLAT	CORN	1	25	3	316.885	0.77123	3.760614
ANGLED	CORN	0	10	1	364.724	1.06051	5.124314
ANGLED	CORN	0	10	2	215.921	0.62783	2.735444
ANGLED	CORN	0	10	3	256.904	0.747	7.161927
ANGLED	CORN	1	10	1	235.222	0.58907	6.937524
ANGLED	CORN	1	10	2	320.984	0.7812	9.587024
ANGLED	CORN	1	10	3	188.832	0.48681	5.307105
ANGLED	CORN	0	25	1	217.484	0.63238	5.673423
ANGLED	CORN	0	25	2	135.397	0.39369	2.942088
ANGLED	CORN	0	25	3	168.63	0.49033	4.252845
ANGLED	CORN	1	25	1	203.312	0.52414	6.29124
ANGLED	CORN	1	25	2	164.841	0.42496	3.953651
ANGLED	CORN	1	25	3	195.215	0.50326	5.274064
FLAT	COTTON	0	10	1	420.532	5.4702	5.769227
FLAT	COTTON	0	10	2	542.9	7.06195	7.082827
FLAT	COTTON	0	10	3	668.469	8.69533	11.15782
FLAT	COTTON	1	10	1	537.511	6.15757	10.81826
FLAT	COTTON	1	10	2	527.785	5.69048	10.5465
FLAT	COTTON	1	10	3	511.28	5.85707	10.43038
FLAT	COTTON	0	25	1	645.243	8.3932	17.72475
FLAT	COTTON	0	25	2	805.206	10.474	31.22738
FLAT	COTTON	0	25	3	762.45	9.91781	23.92154
FLAT	COTTON	1	25	1	1081.65	12.391	32.37623
FLAT	COTTON	1	25	2	993.926	12.1207	33.0927
FLAT	COTTON	1	25	3	963.306	11.7473	30.58414
ANGLED	COTTON	0	10	1	378.848	4.92799	9.824166
ANGLED	COTTON	0	10	2	539.786	7.02144	10.7251
ANGLED	COTTON	0	10	3	428.994	5.58027	9.669308
ANGLED	COTTON	1	10	1	417.109	5.08657	7.997927
ANGLED	COTTON	1	10	2	469.116	6.52303	13.11901
ANGLED	COTTON	1	10	3	422.524	5.49611	7.803507
ANGLED	COTTON	0	25	1	348.119	4.52827	9.04895
ANGLED	COTTON	0	25	2	467.56	6.08194	18.91347
ANGLED	COTTON	0	25	3	464.135	6.03738	22.12006
ANGLED	COTTON	1	25	1	558.076	6.80563	13.93554
ANGLED	COTTON	1	25	2	545.365	7.58327	12.50965
ANGLED	COTTON	1	25	3	338.895	4.40829	7.827304
FLAT	SOYBEAN	0	10	1	131.463	3.78638	1.746715
FLAT	SOYBEAN	0	10	2	87.6609	2.5248	0.717055
FLAT	SOYBEAN	0	10	3	178.864	5.15162	0.996888
FLAT	SOYBEAN	1	10	1	154.612	4.04834	1.507791
FLAT	SOYBEAN	1	10	2	193.939	5.07809	1.824304
FLAT	SOYBEAN	1	10	3	125.816	3.29437	0.30256
FLAT	SOYBEAN	0	25	1	372.344	10.7242	4.870345
FLAT	SOYBEAN	0	25	2	408.401	11.7627	6.564728
FLAT	SOYBEAN	0	25	3	479.435	13.8087	8.135484

FLAT	SOYBEAN	1	25	1	466.002	12.2018	7.417583
FLAT	SOYBEAN	1	25	2	291.588	8.3983	2.335771
FLAT	SOYBEAN	1	25	3	475.176	11.3602	5.97297
ANGLED	SOYBEAN	0	10	1	138.034	3.97563	1.589808
ANGLED	SOYBEAN	0	10	2	119.904	3.45346	1.67719
ANGLED	SOYBEAN	0	10	3	185.423	5.34053	2.489582
ANGLED	SOYBEAN	1	10	1	142.899	3.74166	3.097151
ANGLED	SOYBEAN	1	10	2	141.155	3.696	2.092832
ANGLED	SOYBEAN	1	10	3	177.649	4.65155	2.450287
ANGLED	SOYBEAN	0	25	1	160.12	4.61176	3.186516
ANGLED	SOYBEAN	0	25	2	137.254	3.95317	1.954033
ANGLED	SOYBEAN	0	25	3	153.257	4.41411	3.441492
ANGLED	SOYBEAN	1	25	1	174.267	5.54748	2.343936
ANGLED	SOYBEAN	1	25	2	253.176	8.0594	4.869577
ANGLED	SOYBEAN	1	25	3	127.719	4.0657	1.61954

CUTTING PLANT RESIDUE ON SOIL

HOLDING EFFECT

KNIFE	CROP	HOLDING 0=NO 1=YES	M.C. (%)	REP (3 Rep)	SPENERGY (J/cm^2)	T - K FORCE (N)	T - K STRESS (MPa)
FLAT	CORN	0	10	1	6.38285862	326.21	0.94852
FLAT	CORN	0	10	2	0.64246639	202.25	0.58809
FLAT	CORN	0	10	3	1.8005324	343.63	0.99917
FLAT	CORN	1	10	1	1.46159998	215.16	0.55468
FLAT	CORN	1	10	2	1.67057704	300.03	0.77346
FLAT	CORN	1	10	3	2.87610271	167.82	0.43264
FLAT	CORN	0	25	1	1.28190371	365.53	1.06285
FLAT	CORN	0	25	2	4.03767177	489.41	1.42305
FLAT	CORN	0	25	3	2.60963705	510.44	1.48421
FLAT	CORN	1	25	1	0.78519965	369.29	0.92483
FLAT	CORN	1	25	2	0.6768936	196.53	0.49217
FLAT	CORN	1	25	3	0.91524915	311.32	0.75767
ANGLED	CORN	0	10	1	1.489997	301.41	0.87642
ANGLED	CORN	0	10	2	0.79538522	191.59	0.55709
ANGLED	CORN	0	10	3	2.08247382	193.59	0.56291
ANGLED	CORN	1	10	1	1.7373817	154.43	0.38674
ANGLED	CORN	1	10	2	2.33326642	257.03	0.62556
ANGLED	CORN	1	10	3	1.36816514	163.86	0.42243
ANGLED	CORN	0	25	1	1.64966156	185.04	0.53804
ANGLED	CORN	0	25	2	0.85547117	124.36	0.36161
ANGLED	CORN	0	25	3	1.23659981	136.19	0.39599
ANGLED	CORN	1	25	1	1.62187409	101.7	0.26218
ANGLED	CORN	1	25	2	1.01924646	84.048	0.21668
ANGLED	CORN	1	25	3	1.3596473	114.42	0.29498
FLAT	COTTON	0	10	1	7.50450651	363.27	4.72532
FLAT	COTTON	0	10	2	9.21321467	485.64	6.31706
FLAT	COTTON	0	10	3	14.5138876	504.28	6.55964

FLAT	COTTON	1	10	1	12.3930821	271.44	3.10949
FLAT	COTTON	1	10	2	11.3710326	275.3	2.96824
FLAT	COTTON	1	10	3	11.948732	258.8	2.96468
FLAT	COTTON	0	25	1	23.0560418	415.99	5.4111
FLAT	COTTON	0	25	2	40.6200206	508.91	6.61983
FLAT	COTTON	0	25	3	31.1167102	499.83	6.50164
FLAT	COTTON	1	25	1	37.0892436	721.06	8.26026
FLAT	COTTON	1	25	2	40.3559145	615.77	7.50922
FLAT	COTTON	1	25	3	37.296769	585.15	7.13581
ANGLED	COTTON	0	10	1	12.7790993	241.92	3.14691
ANGLED	COTTON	0	10	2	13.9510136	474.33	6.17004
ANGLED	COTTON	0	10	3	12.5776622	343.6	4.46949
ANGLED	COTTON	1	10	1	9.75331877	314.3	3.83277
ANGLED	COTTON	1	10	2	18.2418886	310.63	4.31933
ANGLED	COTTON	1	10	3	10.1506615	357.07	4.6447
ANGLED	COTTON	0	25	1	11.7707116	228.35	2.97029
ANGLED	COTTON	0	25	2	24.6022967	278.09	3.61731
ANGLED	COTTON	0	25	3	28.7733793	306.56	3.9877
ANGLED	COTTON	1	25	1	16.9941177	472.68	5.76428
ANGLED	COTTON	1	25	2	17.3945844	479.91	6.67314
ANGLED	COTTON	1	25	3	10.1816167	307.55	4.00058
FLAT	SOYBEAN	0	10	1	5.03087497	77.841	2.24197
FLAT	SOYBEAN	0	10	2	2.06525557	68.599	1.97579
FLAT	SOYBEAN	0	10	3	2.87123056	178.85	5.15128
FLAT	SOYBEAN	1	10	1	3.94798706	100.99	2.64431
FLAT	SOYBEAN	1	10	2	4.77674326	140.32	3.67406
FLAT	SOYBEAN	1	10	3	0.79222004	125.82	3.29437
FLAT	SOYBEAN	0	25	1	14.0275341	268.03	7.71968
FLAT	SOYBEAN	0	25	2	18.907683	220.5	6.35093
FLAT	SOYBEAN	0	25	3	23.4317637	291.54	8.39686
FLAT	SOYBEAN	1	25	1	19.4221376	362.62	9.49481
FLAT	SOYBEAN	1	25	2	6.72746991	188.21	5.42071
FLAT	SOYBEAN	1	25	3	14.2797519	343.44	8.21083
ANGLED	SOYBEAN	0	10	1	4.57895461	125.28	3.60817
ANGLED	SOYBEAN	0	10	2	4.83063014	107.15	3.086
ANGLED	SOYBEAN	0	10	3	7.17047601	172.66	4.97307
ANGLED	SOYBEAN	1	10	1	8.10955429	103.71	2.71556
ANGLED	SOYBEAN	1	10	2	5.47985368	126.04	3.30015
ANGLED	SOYBEAN	1	10	3	6.41581144	150.28	3.93494
ANGLED	SOYBEAN	0	25	1	9.17778092	90.37	2.60283
ANGLED	SOYBEAN	0	25	2	5.62799058	93.784	2.70115
ANGLED	SOYBEAN	0	25	3	9.91216019	64.307	1.85217
ANGLED	SOYBEAN	1	25	1	7.46148733	146.9	4.67626
ANGLED	SOYBEAN	1	25	2	15.5013995	182.83	5.82
ANGLED	SOYBEAN	1	25	3	5.15550643	114.96	3.65957

CUTTING PLANT RESIDUE ON SOIL

HOLDING EFFECT

KNIFE	CROP	HOLDING 0=NO 1=YES	M.C. (%)	REP (3 Rep)	T - K ENERGY (N.m=J)	T - K SPENERGY (J/cm^2)
FLAT	CORN	0	10	1	14.41435	4.19126221
FLAT	CORN	0	10	2	2.196728	0.63874264
FLAT	CORN	0	10	3	5.788028	1.68298499
FLAT	CORN	1	10	1	5.263764	1.35699194
FLAT	CORN	1	10	2	6.272149	1.61695247
FLAT	CORN	1	10	3	8.188895	2.11108718
FLAT	CORN	0	25	1	4.249439	1.23560964
FLAT	CORN	0	25	2	11.30378	3.28680178
FLAT	CORN	0	25	3	8.596509	2.49960718
FLAT	CORN	1	25	1	3.127666	0.78326923
FLAT	CORN	1	25	2	2.650005	0.66364739
FLAT	CORN	1	25	3	3.751071	0.91292644
ANGLED	CORN	0	10	1	4.742116	1.37886512
ANGLED	CORN	0	10	2	2.606518	0.75789743
ANGLED	CORN	0	10	3	6.437919	1.87195389
ANGLED	CORN	1	10	1	5.899933	1.47753524
ANGLED	CORN	1	10	2	8.825038	2.14781615
ANGLED	CORN	1	10	3	5.039105	1.29907507
ANGLED	CORN	0	25	1	5.390779	1.5674769
ANGLED	CORN	0	25	2	2.796258	0.81306802
ANGLED	CORN	0	25	3	4.01433	1.16724704
ANGLED	CORN	1	25	1	4.998322	1.28856143
ANGLED	CORN	1	25	2	2.738438	0.70596599
ANGLED	CORN	1	25	3	4.590266	1.18336502
FLAT	COTTON	0	10	1	5.455705	7.09668271
FLAT	COTTON	0	10	2	6.741786	8.76959472
FLAT	COTTON	0	10	3	9.945082	12.9363838
FLAT	COTTON	1	10	1	7.997467	9.16166016
FLAT	COTTON	1	10	2	7.66992	8.26956108
FLAT	COTTON	1	10	3	8.229441	9.42740225
FLAT	COTTON	0	25	1	14.38856	18.7163821
FLAT	COTTON	0	25	2	24.94544	32.4485829
FLAT	COTTON	0	25	3	19.66465	25.5794225
FLAT	COTTON	1	25	1	25.40293	29.1008381
FLAT	COTTON	1	25	2	24.24548	29.5669026
FLAT	COTTON	1	25	3	21.32761	26.0086164
ANGLED	COTTON	0	10	1	7.809458	10.1584032
ANGLED	COTTON	0	10	2	10.00738	13.0174202
ANGLED	COTTON	0	10	3	8.513391	11.0740659
ANGLED	COTTON	1	10	1	6.935643	8.45788376
ANGLED	COTTON	1	10	2	9.914835	13.7865112
ANGLED	COTTON	1	10	3	7.213848	9.38364374
ANGLED	COTTON	0	25	1	7.27772	9.46672724
ANGLED	COTTON	0	25	2	13.65869	17.766974
ANGLED	COTTON	0	25	3	16.18553	21.0538428

ANGLED	COTTON	1	25	1	12.80359	15.6137297
ANGLED	COTTON	1	25	2	11.79936	16.4069311
ANGLED	COTTON	1	25	3	7.45966	9.70339147
FLAT	SOYBEAN	0	10	1	1.527203	4.39863962
FLAT	SOYBEAN	0	10	2	0.678063	1.9529533
FLAT	SOYBEAN	0	10	3	0.996862	2.87115429
FLAT	SOYBEAN	1	10	1	1.338972	3.50595271
FLAT	SOYBEAN	1	10	2	1.663809	4.35650318
FLAT	SOYBEAN	1	10	3	0.30256	0.79222004
FLAT	SOYBEAN	0	25	1	4.040185	11.6365115
FLAT	SOYBEAN	0	25	2	4.285654	12.3435094
FLAT	SOYBEAN	0	25	3	5.87567	16.923062
FLAT	SOYBEAN	1	25	1	6.979199	18.2742764
FLAT	SOYBEAN	1	25	2	1.806122	5.2019784
FLAT	SOYBEAN	1	25	3	5.156289	12.3272889
ANGLED	SOYBEAN	0	10	1	1.413297	4.07056753
ANGLED	SOYBEAN	0	10	2	1.504552	4.33339856
ANGLED	SOYBEAN	0	10	3	2.292177	6.60191116
ANGLED	SOYBEAN	1	10	1	2.604674	6.82005659
ANGLED	SOYBEAN	1	10	2	1.794239	4.69801986
ANGLED	SOYBEAN	1	10	3	2.128675	5.57370582
ANGLED	SOYBEAN	0	25	1	2.528674	7.28306868
ANGLED	SOYBEAN	0	25	2	1.618862	4.66263433
ANGLED	SOYBEAN	0	25	3	2.232254	6.42932157
ANGLED	SOYBEAN	1	25	1	2.051926	6.53192681
ANGLED	SOYBEAN	1	25	2	3.56626	11.3525304
ANGLED	SOYBEAN	1	25	3	1.486832	4.73305472

APPENDIX C

STATISTICAL ANALYSIS RESULTS FOR CUTTING PLANT RESIDUE ON A RIGID SURFACE

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CROSS SECTIONAL AREA EFFECT

CORN

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	40617.2398	20308.6199	11.84	0.0003
KNIFE	1	18512.2584	18512.2584	10.80	0.0031
AREA*KNIFE	2	8334.8320	4167.4160	2.43	0.1094
Error	24	41155.5916	1714.8163		
Corrected Total	29	108619.9219			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	250.04	10	1.78
B	184.52	10	2.37
B			
B	163.67	10	1.35

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	2.00993927	1.00496963	17.23	0.0001
KNIFE	1	0.64006413	0.64006413	10.97	0.0029
AREA*KNIFE	2	0.26991447	0.13495723	2.31	0.1205
Error	24	1.39980480	0.05832520		
Corrected Total	29	4.31972267			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	1.3991	10	1.78
A			
A	1.2071	10	1.35
B	0.7798	10	2.37

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	6.26600000	3.13300000	4.74	0.0184
KNIFE	1	8.32133333	8.32133333	12.59	0.0016
AREA*KNIFE	2	0.60466667	0.30233333	0.46	0.6383

Error	24	15.8600000	0.6608333
Corrected Total	29	31.0520000	

Duncan Grouping (α=0.05)	Mean	N	AREA
A	2.8800	10	1.78
A			
A	2.6300	10	2.37
B	1.8100	10	1.35

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	1.25266667	0.62633333	3.71	0.0396
KNIFE	1	2.46533333	2.46533333	14.59	0.0008
AREA*KNIFE	2	0.06066667	0.03033333	0.18	0.8368
Error	24	4.05600000	0.16900000		
Corrected Total	29	7.83466667			

Duncan Grouping (α=0.05)		Mean	N	AREA
	A	1.6100	10	1.78
	A			
B	A	1.3400	10	1.35
B				
B		1.1100	10	2.37

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CROSS SECTIONAL AREA EFFECT

COTTON

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	622307.924	311153.962	20.85	0.0001
KNIFE	1	22675.951	22675.951	1.52	0.2296
AREA*KNIFE	2	4643.256	2321.628	0.16	0.8568
Error	24	358150.921	14922.955		
Corrected Total	29	1007778.053			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	634.10	10	0.719

B	375.26	10	0.537
B			
B	297.08	10	0.314

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	32.9569286	16.4784643	4.29	0.0256
KNIFE	1	7.5942945	7.5942945	1.98	0.1727
AREA*KNIFE	2	0.7899817	0.3949908	0.10	0.9028
Error	24	92.2654004	3.8443917		
Corrected Total	29	133.6066052			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	9.4565	10	0.314
A			
A	8.8180	10	0.719
B	6.9837	10	0.537

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	48.0320000	24.0160000	42.82	0.0001
KNIFE	1	15.2653333	15.2653333	27.22	0.0001
AREA*KNIFE	2	2.6346667	1.3173333	2.35	0.1170
Error	24	13.4600000	0.5608333		
Corrected Total	29	79.3920000			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	4.7000	10	0.719
B	2.8600	10	0.537
C	1.6200	10	0.314

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	11.0206667	5.5103333	3.55	0.0447
KNIFE	1	52.5363333	52.5363333	33.81	0.0001
AREA*KNIFE	2	0.6406667	0.3203333	0.21	0.8151

Error	24	37.2960000	1.5540000
Corrected Total	29	101.4936667	

Duncan Grouping (α=0.05)	Mean	N	AREA
A	6.5100	10	0.719
B	5.3000	10	0.537
B			
B	5.1600	10	0.314

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CROSS SECTIONAL AREA EFFECT

SOYBEAN

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	216118.347	108059.173	32.61	0.0001
KNIFE	1	15144.770	15144.770	4.57	0.0429
AREA*KNIFE	2	21282.025	10641.012	3.21	0.0581
Error	24	79525.077	3313.545		
Corrected Total	29	332070.218			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	302.93	10	0.54
B	192.68	10	0.418
C	95.15	10	0.225

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	10.6111571	5.3055785	3.41	0.0496
KNIFE	1	2.6319931	2.6319931	1.69	0.2055
AREA*KNIFE	2	13.3686045	6.6843023	4.30	0.0253
Error	24	37.3039632	1.5543318		
Corrected Total	29	63.9157179			

Duncan Grouping (α=0.05)	Mean	N	AREA

Duncan Grouping		Mean	N	AREA
	A	5.6380	10	0.54
	A			
B	A	4.6064	10	0.418
B				
B		4.2314	10	0.225

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	6.18066667	3.09033333	25.80	0.0001
KNIFE	1	2.73800000	2.73800000	22.86	0.0001
AREA*KNIFE	2	0.00000000	0.00000000	0.00	1.0000
Error	24	2.87500000	0.11979167		
Corrected Total	29	10.66966667			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	1.4400	10	0.54
B	1.0300	10	0.418
C	0.3400	10	0.225

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	8.3546667	4.1773333	7.26	0.0034
KNIFE	1	12.0125000	12.0125000	20.88	0.0001
AREA*KNIFE	2	0.0000000	0.0000000	0.00	1.0000
Error	24	13.8067500	0.5752812		
Corrected Total	29	32.3816667			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	2.6700	10	0.54
A			
A	2.4300	10	0.418
B	1.4500	10	0.225

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CROSS SECTIONAL AREA EFFECT

WHEAT

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	514.854667	257.427333	30.45	0.0001
KNIFE	1	244.483359	244.483359	28.92	0.0001
AREA*KNIFE	2	204.793798	102.396899	12.11	0.0002
Error	24	202.919634	8.454985		
Corrected Total	29	1167.051458			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	16.740	10	0.038
B	9.263	10	0.02
B			
B	7.059	10	0.0103

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	42.7999321	21.3999660	23.20	0.0001
KNIFE	1	17.0765985	17.0765985	18.51	0.0002
AREA*KNIFE	2	9.9189661	4.9594830	5.38	0.0118
Error	24	22.1385428	0.9224393		
Corrected Total	29	91.9340395			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	6.8430	10	0.0103
B	4.6765	10	0.02
B			
B	4.0569	10	0.038

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	0.01780647	0.00890323	37.54	0.0001
KNIFE	1	0.00014520	0.00014520	0.61	0.4416
AREA*KNIFE	2	0.00005180	0.00002590	0.11	0.8970
Error	24	0.00569240	0.00023718		
Corrected Total	29	0.02369587			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	0.076300	10	0.038

B	0.029900	10	0.02
B			
B	0.020600	10	0.0103

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	1.28452667	0.64226333	2.48	0.1053
KNIFE	1	0.02640333	0.02640333	0.10	0.7525
AREA*KNIFE	2	0.06752667	0.03376333	0.13	0.8786
Error	24	6.22548000	0.25939500		
Corrected Total	29	7.60393667			

Duncan Grouping (α=0.05)	Mean	N	AREA
A	1.9860	10	0.0103
A			
A	1.8930	10	0.038
A			
A	1.5080	10	0.02

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CUTTING LOCATION EFFECT

CORN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	2.32332380	1.16166190	5.94	0.0080
KNIFE	1	2.92468963	2.92468963	14.95	0.0007
XDIST*KNIFE	2	0.12849087	0.06424543	0.33	0.7232
Error	24	4.69383200	0.19557633		
Corrected Total	29	10.07033630			

Duncan Grouping (α=0.05)		Mean	N	XDIST
	A	2.0666	10	1
	A			
B	A	1.6965	10	0.5
B				
B		1.3858	10	0.75

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	5.33120667	2.66560333	7.23	0.0035
KNIFE	1	6.70241333	6.70241333	18.18	0.0003
XDIST*KNIFE	2	0.37644667	0.18822333	0.51	0.6065
Error	24	8.8461200	0.3685883		
Corrected Total	29	21.2561867			

Duncan Grouping (α=0.05)	Mean	N	XDIST
A	2.8530	10	1
B	2.1330	10	0.5
B			
B	1.8520	10	0.75

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CUTTING LOCATION EFFECT

COTTON

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	0.1208312	0.0604156	0.02	0.9757
KNIFE	1	54.7317147	54.7317147	22.33	0.0001
XDIST*KNIFE	2	0.4774200	0.2387100	0.10	0.9076
Error	24	58.8339804	2.4514158		
Corrected Total	29	114.1639463			

Duncan Grouping (α=0.05)	Mean	N	XDIST
A	6.3843	10	0.75
A			
A	6.2929	10	0.5
A			
A	6.2297	10	1

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	1.74650000	0.87325000	1.33	0.2842

KNIFE	1	5.63333333	5.63333333	8.56	0.0074
XDIST*KNIFE	2	1.18808667	0.59404333	0.90	0.4190
Error	24	15.80240000	0.65843333		
Corrected Total	29	24.37032000			

Duncan Grouping (α=0.	Mean	N	XDIST
A	3.7340	10	0.5
A			
A	3.2490	10	1
A			
A	3.1990	10	0.75

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CUTTING LOCATION EFFECT

SOYBEAN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	4.64043980	2.32021990	2.70	0.0879
KNIFE	1	1.40715125	1.40715125	1.64	0.2132
XDIST*KNIFE	2	4.57833285	2.28916643	2.66	0.0905
Error	24	20.6538516	0.8605771		
Corrected Total	29	31.2797755			

Duncan Grouping (α=0.05)		Mean	N	XDIST
	A	4.6620	10	0.5
	A			
B	A	4.4263	10	0.75
B				
B		3.7352	10	1

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	3.9749067	1.9874533	7.83	0.0024
KNIFE	1	11.8067222	11.8067222	46.50	0.0001
XDIST*KNIFE	2	0.0000000	0.0000000	0.00	1.0000
Error	24	6.0935775	0.2538991		
Corrected Total	29	21.3542667			

Duncan Grouping (α=0.05)	Mean	N	XDIST

A	2.9980	10	1
B	2.3940	10	0.5
B			
B	2.1280	10	0.75

CUTTING PLANT RESIDUES ON A RIGID SURFACE

CUTTING LOCATION EFFECT

WHEAT

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	15.030035	7.515017	6.44	0.0058
KNIFE	1	104.649099	104.649099	89.63	0.0001
XDIST*KNIFE	2	10.020777	5.010388	4.29	0.0255
Error	24	28.020142	1.167506		
Corrected Total	29	157.720052			

Duncan Grouping (α=0.05)	Mean	N	XDIST
A	5.9706	10	0.5
A			
A	5.6064	10	1
B	4.3205	10	0.75

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
XDIST	2	1.42100667	0.71050333	1.72	0.1997
KNIFE	1	0.91875000	0.91875000	2.23	0.1484
XDIST*KNIFE	2	0.98138000	0.49069000	1.19	0.3213
Error	24	9.89020000	0.41209167		
Corrected Total	29	13.21133667			

Duncan Grouping (α=0.05)	Mean	N	XDIST
A	1.8970	10	1
A			
A	1.5320	10	0.75
A			
A	1.3780	10	0.5

CUTTING PLANT RESIDUES ON A RIGID SURFACE

MOISTURE CONTENT EFFECT

CORN

Dependent Variable: STRESS

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	1.75318500	0.58439500	17.97	0.0001
KNIFE	1	0.94612500	0.94612500	29.09	0.0001
MOISTURE*KNIFE	1	0.05304500	0.05304500	1.63	0.2138
Error	24	0.78056000	0.03252333		
Corrected Total	29	4.72249667			

Duncan Grouping (α=0.05)	Mean	N	MOISTURE
A	1.39900	10	9
B	0.86800	10	20
C	0.65800	5	30
C			
C	0.65000	5	40

Dependent Variable: SPENERGY

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	1.95889500	0.65296500	6.85	0.0017
KNIFE	1	1.94688000	1.94688000	20.41	0.0001
MOISTURE*KNIFE	1	0.04232000	0.04232000	0.44	0.5117
Error	24	2.28920000	0.09538333		
Corrected Total	29	5.57815000			

Duncan Grouping (α=0.05)		Mean	N	MOISTURE
	A	1.6140	10	9
	A			
B	A	1.3600	5	30
B	A			
B	A	1.2540	5	40
B				
B		1.1140	10	20

CUTTING PLANT RESIDUES ON A RIGID SURFACE

MOISTURE CONTENT EFFECT

COTTON

Dependent Variable: STRESS

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	185.316735	61.772245	15.36	0.0001
KNIFE	1	142.791680	142.791680	35.50	0.0001
MOISTURE*KNIFE	1	76.832000	76.832000	19.10	0.0002
Error	24	96.541800	4.022575		
Corrected Total	29	511.045070			

Duncan Grouping (α=0.05)	Mean	N	MOISTURE
A	12.468	10	20
B	9.872	5	30
C	6.984	10	9
C			
C	6.490	5	40

Dependent Variable: SPENERGY

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	148.105640	49.368547	16.09	0.0001
KNIFE	1	0.169280	0.169280	0.06	0.8163
MOISTURE*KNIFE	1	34.374420	34.374420	11.20	0.0027
Error	24	73.656600	3.069025		
Corrected Total	29	268.851067			

Duncan Grouping (α=0.05)	Mean	N	MOISTURE
A	11.6800	5	30
B	9.3590	10	20
B			
B	9.0640	5	40
C	5.3090	10	9

CUTTING PLANT RESIDUES ON A RIGID SURFACE

MOISTURE CONTENT EFFECT

SOYBEAN

Dependent Variable: STRESS

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	0.05880500	0.01960167	0.02	0.9967
KNIFE	1	0.56112500	0.56112500	0.51	0.4834
MOISTURE*KNIFE	1	9.20724500	9.20724500	8.31	0.0082
Error	24	26.57696000	1.10737333		
Corrected Total	29	36.52995000			

Duncan Grouping (α=0.05)	Mean	N	MOISTURE
A	4.8220	5	40
A			
A	4.6740	5	30
A			
A	4.6110	10	20
A			
A	4.6060	10	9

Dependent Variable: SPENERGY

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	7.32744000	2.44248000	1.49	0.2431
KNIFE	1	5.04008000	5.04008000	3.07	0.0925
MOISTURE*KNIFE	1	2.17800000	2.17800000	1.33	0.2608
Error	24	39.4060000	1.6419167		
Corrected Total	29	61.1696800			

Duncan Grouping (α=0.05)		Mean	N	MOISTURE
	A	4.2580	5	40
	A			
	A	4.0340	5	30
	A			
B	A	3.4260	10	20
B				
B		2.4540	10	9

CUTTING PLANT RESIDUES ON A RIGID SURFACE

MOISTURE CONTENT EFFECT

WHEAT

Dependent Variable: STRESS

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	236.354907	78.784969	15.55	0.0001
KNIFE	1	698.979603	698.979603	137.99	0.0001
MOISTURE*KNIFE	3	149.624407	49.874802	9.85	0.0001
Error	32	162.09456	5.06546		
Corrected Total	39	1247.05348			

Duncan Grouping (α=0.05)	Mean	N	MOISTURE
A	11.182	10	20
B	6.388	10	40
B			
B	6.327	10	30
B			
B	4.676	10	9

Dependent Variable: SPENERGY

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MOISTURE	3	27.6868050	9.2289350	3.67	0.0262
KNIFE	1	3.2481800	3.2481800	1.29	0.2668
MOISTURE*KNIFE	1	2.9337800	2.9337800	1.17	0.2907
Error	24	60.3165200	2.5131883		
Corrected Total	29	96.3791867			

Duncan Grouping (α=0.05)		Mean	N	MOISTURE
	A	3.8520	10	20
	A			
B	A	3.3280	5	40
B	A			
B	A	3.2280	5	30
B				
B		1.5080	10	9

CUTTING PLANT RESIDUES ON A RIGID SURFACE

TENSILE FORCE EFFECT

CORN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
DTENSILE	2	11.2739654	5.6369827	7.26	0.0034
KNIFE	1	58.8504108	58.8504108	75.76	0.0001
DTENSILE*KNIFE	2	16.6898342	8.3449171	10.74	0.0005
Error	24	18.6420528	0.7767522		
Corrected Total	29	105.4562632			

Duncan Grouping (α=0.05)		Mean	N	DTENSILE
	A	3.1968	10	40
	A			
B	A	2.4797	10	20
B				
B		1.6957	10	0

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
DTENSILE	2	10.3677267	5.1838633	5.45	0.0111
KNIFE	1	11.0292033	11.0292033	11.61	0.0023
DTENSILE*KNIFE	2	18.9103267	9.4551633	9.95	0.0007
Error	24	22.8081600	0.9503400		
Corrected Total	29	63.1154167			

Duncan Grouping (α=0.05)	Mean	N	DTENSILE
A	3.2760	10	40
B	2.1330	10	0
B			
B	1.9460	10	20

CUTTING PLANT RESIDUES ON A RIGID SURFACE

TENSILE FORCE EFFECT

COTTON

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
DTENSILE	2	0.78167607	0.39083803	0.07	0.9288
KNIFE	1	0.60719413	0.60719413	0.12	0.7373
DTENSILE*KNIFE	2	9.58995527	4.79497763	0.91	0.4162
Error	24	126.5441540	5.2726731		

Corrected Total	29	137.5229795

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
DTENSILE	2	5.3940467	2.6970233	1.59	0.2243
KNIFE	1	42.7929633	42.7929633	25.25	0.0001
DTENSILE*KNIFE	2	0.7814067	0.3907033	0.23	0.7958
Error	24	40.6665200	1.6944383		
Corrected Total	29	89.6349367			

CUTTING PLANT RESIDUES ON A RIGID SURFACE

TENSILE FORCE EFFECT

SOYBEAN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
DTENSILE	2	0.61594607	0.30797303	0.25	0.7802
KNIFE	1	0.25043603	0.25043603	0.20	0.6556
DTENSILE*KNIFE	2	8.98749527	4.49374763	3.66	0.0410
Error	24	29.47569560	1.22815398		
Corrected Total	29	39.32957297			

Duncan Grouping (*=0.05)	Mean	N	DTENSILE
A	4.5986	10	0
A			
A	4.4020	10	20
A			
A	4.2485	10	40

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
DTENSILE	2	3.70184000	1.85092000	5.92	0.0081
KNIFE	1	5.84325333	5.84325333	18.70	0.0002
DTENSILE*KNIFE	2	2.58698667	1.29349333	4.14	0.0286
Error	24	7.5004400	0.3125183		
Corrected Total	29	19.6325200			

Duncan Grouping (*=0.05)	Mean	N	DTENSILE

	A	2.3940	10	0
	A			
B	A	1.9400	10	20
B				
B		1.5340	10	40

CUTTING PLANT RESIDUES ON A RIGID SURFACE

TENSILE FORCE EFFECT ON WET RESIDUE

CORN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
WTENSILE	1	0.03411380	0.03411380	1.25	0.2801
KNIFE	1	1.26303380	1.26303380	46.27	0.0001
WTENSILE*KNIFE	1	0.00420500	0.00420500	0.15	0.6999
Error	16	0.43677160	0.02729822		
Corrected Total	19	1.73812420			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
WTENSILE	1	0.12800000	0.12800000	2.26	0.1526
KNIFE	1	1.56800000	1.56800000	27.63	0.0001
WTENSILE*KNIFE	1	0.00800000	0.00800000	0.14	0.7123
Error	16	0.90800000	0.05675000		
Corrected Total	19	2.61200000			

CUTTING PLANT RESIDUES ON A RIGID SURFACE

TENSILE FORCE EFFECT ON WET RESIDUE

COTTON

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
WTENSILE	1	0.0040612	0.0040612	0.00	0.9759
KNIFE	1	75.8200741	75.8200741	17.51	0.0007
WTENSILE*KNIFE	1	0.0072581	0.0072581	0.00	0.9679
Error	16	69.2976456	4.3311029		
Corrected Total	19	145.1290389			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
WTENSILE	1	0.00000000	0.00000000	0.00	1.0000
KNIFE	1	0.57800000	0.57800000	0.24	0.6323
WTENSILE*KNIFE	1	0.28800000	0.28800000	0.12	0.7351
Error	16	38.87200000	2.42950000		
Corrected Total	19	39.73800000			

CUTTING PLANT RESIDUES ON A RIGID SURFACE

TENSILE FORCE EFFECT ON WET RESIDUE

SOYBEAN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
WTENSILE	1	0.2257812	0.2257812	0.11	0.7490
KNIFE	1	87.8433613	87.8433613	41.24	0.0001
WTENSILE*KNIFE	1	1.2029513	1.2029513	0.56	0.4633
Error	16	34.0790032	2.1299377		
Corrected Total	19	123.3510970			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
WTENSILE	1	0.64800000	0.64800000	0.68	0.4202
KNIFE	1	0.28800000	0.28800000	0.30	0.5888
WTENSILE*KNIFE	1	0.03200000	0.03200000	0.03	0.8564
Error	16	15.14400000	0.94650000		
Corrected Total	19	16.11200000			

CUTTING PLANT RESIDUES ON A RIGID SURFACE

SECTION OF THE RESIDUE EFFECT

CORN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	8	14.8306972	1.8538372	7.98	0.0001
KNIFE	1	21.0172674	21.0172674	90.51	0.0001
SECTION*KNIFE	8	2.2648522	0.2831065	1.22	0.3003
Error	72	16.7184896	0.2322012		
Corrected Total	89	54.8313064			

Duncan Grouping (α=0.05)			Mean	N	SECTION
	A		2.5402	10	SECT-11
	A				
B	A		2.2944	10	SECT-1
B	A				
B	A		2.2635	10	SECT-10
B					
B	C		2.0121	10	SECT-2
B	C				
B	C		1.9822	10	SECT-9
B	C				
B	C	D	1.8443	10	SECT-8
	C	D			
	C	D	1.7637	10	SECT-3
		D			
	E	D	1.4346	10	SECT-4
	E				
	E		1.1702	10	SECT-5

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	8	24.9904689	3.1238086	45.36	0.0001
KNIFE	1	4.6376100	4.6376100	67.34	0.0001
SECTION*KNIFE	8	1.9458200	0.2432275	3.53	0.0017
Error	72	4.9582400	0.0688644		
Corrected Total	89	36.5321389			

Duncan Grouping (α=0.05)		Mean	N	SECTION
	A	2.5700	10	SECT-1
	B	2.1090	10	SECT-2
	C	1.7760	10	SECT-3
	D	1.4260	10	SECT-4
	D			
E	D	1.2150	10	SECT-8
E				

E	1.1080	10	SECT-9
E			
E	1.0400	10	SECT-5
E			
E	1.0350	10	SECT-10
E			
E	1.0060	10	SECT-11

CUTTING PLANT RESIDUES ON A RIGID SURFACE

SECTION OF THE RESIDUE EFFECT

COTTON

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	11	847.703808	77.063983	34.87	0.0001
KNIFE	1	287.850675	287.850675	130.23	0.0001
SECTION*KNIFE	11	8.848520	0.804411	0.36	0.9668
Error	96	212.18328	2.21024		
Corrected Total	119	1356.58629			

Duncan Grouping (α=0.05)		Mean	N	SECTION
	A	14.0280	10	SECT-1
	B	12.3009	10	SECT-2
	C	10.0588	10	SECT-3
	C			
D	C	8.9964	10	SECT-4
D				
D		8.4975	10	SECT-5
D				
D		8.1017	10	SECT-7
D				
D		8.0183	10	SECT-6
	E	6.0927	10	SECT-8
	E			
	E	5.9018	10	SECT-9
	E			
	E	5.8211	10	SECT-12
	E			
	E	5.6289	10	SECT-11
	E			

E	5.4086	10	SECT-10

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	11	368.147167	33.467924	33.49	0.0001
KNIFE	1	91.770030	91.770030	91.84	0.0001
SECTION*KNIFE	11	20.138390	1.830763	1.83	0.0588
Error	96	95.923960	0.999208		
Corrected Total	119	575.979547			

Duncan Grouping (α=0.05)		Mean	N	SECTION
	A	8.8790	10	SECT-1
	B	7.7950	10	SECT-2
	C	6.2070	10	SECT-3
	D	5.3050	10	SECT-6
	D			
	D	5.1910	10	SECT-4
	D			
	D	4.8850	10	SECT-7
	D			
	D	4.8010	10	SECT-5
	D			
E	D	4.3440	10	SECT-8
E				
E	F	3.7410	10	SECT-9
	F			
	F	3.3850	10	SECT-11
	F			
	F	3.2920	10	SECT-10
	F			
	F	2.8070	10	SECT-12

CUTTING PLANT RESIDUES ON A RIGID SURFACE

SECTION OF THE RESIDUE EFFECT

SOYBEAN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F

SECTION	9	121.120102	13.457789	7.49	0.0001
KNIFE	1	22.365333	22.365333	12.44	0.0007
SECTION*KNIFE	9	8.621394	0.957933	0.53	0.8465
Error	80	143.803294	1.797541		
Corrected Total	99	295.910123			

Duncan Grouping (α=0.05)			Mean	N	SECTION
	A		7.1294	10	SECT-1
	A				
B	A		7.0014	10	SECT-2
B	A				
B	A	C	6.0729	10	SECT-4
B		C			
B	D	C	5.7637	10	SECT-3
	D	C			
E	D	C	5.3308	10	SECT-5
E	D	C			
E	D	C	4.8729	10	SECT-6
E	D				
E	D		4.6561	10	SECT-10
E					
E			4.1360	10	SECT-8
E					
E			4.0735	10	SECT-7
E					
E			4.0345	10	SECT-9

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	9	39.7870650	4.4207850	5.60	0.0001
KNIFE	1	21.4276410	21.4276410	27.13	0.0001
SECTION*KNIFE	9	2.8342490	0.3149166	0.40	0.9322
Error	80	63.1843200	0.7898040		
Corrected Total	99	127.2332750			

Duncan Grouping (α=0.05)		Mean	N	SECTION
	A	3.9300	10	SECT-2
	B	3.1180	10	SECT-1
	B			
	B	3.0720	10	SECT-4
	B			
C	B	2.7140	10	SECT-3
C	B			
C	B	2.5860	10	SECT-5
C	B			

C	B	2.2540	10	SECT-6
C				
C		2.0420	10	SECT-8
C				
C		1.9540	10	SECT-7
C				
C		1.9380	10	SECT-9
C				
C		1.9370	10	SECT-10

CUTTING PLANT RESIDUES ON A RIGID SURFACE

SECTION OF THE RESIDUE EFFECT

WHEAT

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	3	5.394967	1.798322	0.59	0.6257
KNIFE	1	148.375188	148.375188	48.72	0.0001
SECTION*KNIFE	3	17.387874	5.795958	1.90	0.1489
Error	32	97.450872	3.045340		
Corrected Total	39	268.608901			

Duncan Grouping (α=0.05)	Mean	N	SECTION
A	5.8071	10	SECT-4
A			
A	5.6692	10	SECT-1
A			
A	5.5816	10	SECT-3
A			
A	4.8534	10	SECT-2

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	3	1.10994750	0.36998250	2.97	0.0463
KNIFE	1	1.00172250	1.00172250	8.05	0.0078
SECTION*KNIFE	3	0.59226750	0.19742250	1.59	0.2118
Error	32	3.98124000	0.12441375		
Corrected Total	39	6.68517750			

Duncan Grouping (α=0.05)		Mean	N	SECTION
	A	1.6840	10	SECT-2
	A			
	A	1.6210	10	SECT-4
	A			
B	A	1.5430	10	SECT-1
B				
B		1.2490	10	SECT-3

APPENDIX D

STATISTICAL ANALYSIS RESULTS FOR CUTTING PLANT RESIDUE ON A SOIL SURFACE

CUTTING THE PLANT RESIDUES ON A SOIL SURFACE

CROSS SECTIONAL AREA AND M.C. EFFECT

CORN

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	758800.62	758800.62	38.01	0.0001
MOISTURE	1	6990.51	6990.51	0.35	0.5564
SOIL*MOISTURE	1	917.36	917.36	0.05	0.8310
REP(SOIL*MOISTURE)	12	211259.46	17604.95	0.88	0.5696
KNIFE	1	773415.25	773415.25	38.74	0.0001
KNIFE*SOIL	1	20215.33	20215.33	1.01	0.3186
KNIFE*MOISTURE	1	104797.59	104797.59	5.25	0.0257
KNIFE*SOIL*MOISTURE	1	6160.01	6160.01	0.31	0.5808
KNIF*REP(SOIL*MOIST)	12	264782.68	22065.22	1.11	0.3744
AREA	2	1800499.52	900249.76	45.09	0.0001
KNIFE*AREA	2	353558.88	176779.44	8.85	0.0005
MOISTURE*AREA	2	27607.73	13803.86	0.69	0.5051
KNIFE*MOISTURE*AREA	2	9726.20	4863.10	0.24	0.7846
Error	56	1117973.80	19963.82		
Corrected Total	95	5456704.95			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	773415.245	773415.245	35.05	0.0001
KNIFE*SOIL	1	20215.332	20215.332	0.92	0.3574
KNIFE*MOISTURE	1	104797.594	104797.594	4.75	0.0500
KNIFE*SOIL*MOISTURE	1	6160.010	6160.010	0.28	0.6069

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	9.75375000	9.75375000	35.45	0.0001
MOISTURE	1	0.03375000	0.03375000	0.12	0.7275
SOIL*MOISTURE	1	0.30375000	0.30375000	1.10	0.2979
REP(SOIL*MOISTURE)	12	2.56833333	0.21402778	0.78	0.6703
KNIFE	1	9.37500000	9.37500000	34.07	0.0001
KNIFE*SOIL	1	1.21500000	1.21500000	4.42	0.0401
KNIFE*MOISTURE	1	2.16000000	2.16000000	7.85	0.0070
KNIFE*SOIL*MOISTURE	1	0.20166667	0.20166667	0.73	0.3956
KNIF*REP(SOIL*MOIST)	12	4.05833333	0.33819444	1.23	0.2871

AREA	2	0.03062500	0.01531250	0.06	0.9459
KNIFE*AREA	2	2.53312500	1.26656250	4.60	0.0141
MOISTURE*AREA	2	0.32687500	0.16343750	0.59	0.5556
KNIFE*MOISTURE*AREA	2	0.26687500	0.13343750	0.48	0.6183
Error	56	15.4091667	0.2751637		
Corrected Total	95	48.2362500			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	9.37500000	9.37500000	27.72	0.0002
KNIFE*SOIL	1	1.21500000	1.21500000	3.59	0.0824
KNIFE*MOISTURE	1	2.16000000	2.16000000	6.39	0.0266
KNIFE*SOIL*MOISTURE	1	0.20166667	0.20166667	0.60	0.4549

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	40.729176	40.729176	3.86	0.0544
MOISTURE	1	0.280584	0.280584	0.03	0.8711
SOIL*MOISTURE	1	1.547876	1.547876	0.15	0.7032
REP(SOIL*MOISTURE)	12	109.438479	9.119873	0.86	0.5865
KNIFE	1	0.001426	0.001426	0.00	0.9908
KNIFE*SOIL	1	242.983884	242.983884	23.03	0.0001
KNIFE*MOISTURE	1	10.713384	10.713384	1.02	0.3180
KNIFE*SOIL*MOISTURE	1	0.042926	0.042926	0.00	0.9494
KNIF*REP(SOIL*MOIST)	12	101.913163	8.492764	0.80	0.6441
AREA	2	651.462381	325.731191	30.87	0.0001
KNIFE*AREA	2	11.975252	5.987626	0.57	0.5702
MOISTURE*AREA	2	1.632619	0.816309	0.08	0.9257
KNIFE*MOISTURE*AREA	2	7.396106	3.698053	0.35	0.7059
Error	56	590.94991	10.55268		
Corrected Total	95	1771.06717			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	0.001426	0.001426	0.00	0.9899
KNIFE*SOIL	1	242.983884	242.983884	28.61	0.0002
KNIFE*MOISTURE	1	10.713384	10.713384	1.26	0.2833
KNIFE*SOIL*MOISTURE	1	0.042926	0.042926	0.01	0.9445

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F

SOIL	1	4.4634375	4.4634375	2.61	0.1120
MOISTURE	1	0.0009375	0.0009375	0.00	0.9814
SOIL*MOISTURE	1	2.2509375	2.2509375	1.32	0.2564
REP(SOIL*MOISTURE)	12	14.7637500	1.2303125	0.72	0.7270
KNIFE	1	0.2501042	0.2501042	0.15	0.7037
KNIFE*SOIL	1	42.5334375	42.5334375	24.85	0.0001
KNIFE*MOISTURE	1	4.7259375	4.7259375	2.76	0.1022
KNIFE*SOIL*MOISTURE	1	0.1134375	0.1134375	0.07	0.7978
KNIF*REP(SOIL*MOIST)	12	16.9954167	1.4162847	0.83	0.6221
AREA	2	11.0689583	5.5344792	3.23	0.0469
KNIFE*AREA	2	2.0377083	1.0188542	0.60	0.5549
MOISTURE*AREA	2	0.6131250	0.3065625	0.18	0.8365
KNIFE*MOISTURE*AREA	2	4.2868750	2.1434375	1.25	0.2937
Error	56	95.853333	1.711667		
Corrected Total	95	199.957396			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	0.2501042	0.2501042	0.18	0.6817
KNIFE*SOIL	1	42.5334375	42.5334375	30.03	0.0001
KNIFE*MOISTURE	1	4.7259375	4.7259375	3.34	0.0927
KNIFE*SOIL*MOISTURE	1	0.1134375	0.1134375	0.08	0.7820

CUTTING THE PLANT RESIDUES ON A SOIL SURFACE

CROSS SECTIONAL AREA AND M.C. EFFECT

COTTON

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	2282499.24	2282499.24	151.36	0.0001
MOISTURE	1	931081.13	931081.13	61.74	0.0001
SOIL*MOISTURE	1	251197.65	251197.65	16.66	0.0001
REP(SOIL*MOISTURE)	12	90376.38	7531.36	0.50	0.9063
KNIFE	1	2790778.10	2790778.10	185.07	0.0001
KNIFE*SOIL	1	583393.39	583393.39	38.69	0.0001
KNIFE*MOISTURE	1	1243082.93	1243082.93	82.43	0.0001
KNIFE*SOIL*MOISTURE	1	201016.36	201016.36	13.33	0.0006
KNIF*REP(SOIL*MOIST)	12	91499.96	7625.00	0.51	0.9024
AREA	2	859398.93	429699.47	28.49	0.0001
KNIFE*AREA	2	24392.18	12196.09	0.81	0.4505
MOISTURE*AREA	2	124869.55	62434.77	4.14	0.0210
KNIFE*MOISTURE*AREA	2	43044.24	21522.12	1.43	0.2486

Error	56	844473.50	15079.88
Corrected Total	95	10361103.54	

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	2790778.10	2790778.10	366.00	0.0001
KNIFE*SOIL	1	583393.39	583393.39	76.51	0.0001
KNIFE*MOISTURE	1	1243082.93	1243082.93	163.03	0.0001
KNIFE*SOIL*MOISTURE	1	201016.36	201016.36	26.36	0.0002

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	867.60375	867.60375	113.90	0.0001
MOISTURE	1	455.01042	455.01042	59.74	0.0001
SOIL*MOISTURE	1	127.42042	127.42042	16.73	0.0001
REP(SOIL*MOISTURE)	12	40.14500	3.34542	0.44	0.9402
KNIFE	1	1131.62667	1131.62667	148.57	0.0001
KNIFE*SOIL	1	214.80167	214.80167	28.20	0.0001
KNIFE*MOISTURE	1	552.96000	552.96000	72.60	0.0001
KNIFE*SOIL*MOISTURE	1	89.70667	89.70667	11.78	0.0011
KNIF*REP(SOIL*MOIST)	12	34.53167	2.87764	0.38	0.9661
AREA	2	327.37937	163.68969	21.49	0.0001
KNIFE*AREA	2	145.76646	72.88323	9.57	0.0003
MOISTURE*AREA	2	177.54521	88.77260	11.65	0.0001
KNIFE*MOISTURE*AREA	2	125.67562	62.83781	8.25	0.0007
Error	56	426.55333	7.61702		
Corrected Total	95	4716.72625			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	1131.62667	1131.62667	393.25	0.0001
KNIFE*SOIL	1	214.80167	214.80167	74.65	0.0001
KNIFE*MOISTURE	1	552.96000	552.96000	192.16	0.0001
KNIFE*SOIL*MOISTURE	1	89.70667	89.70667	31.17	0.0001

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	69.42632	69.42632	1.76	0.1903
MOISTURE	1	1578.83048	1578.83048	39.97	0.0001
SOIL*MOISTURE	1	1.82795	1.82795	0.05	0.8305

REP(SOIL*MOISTURE)	12	110.74689	9.22891	0.23	0.9957
KNIFE	1	892.88751	892.88751	22.61	0.0001
KNIFE*SOIL	1	28.55038	28.55038	0.72	0.3988
KNIFE*MOISTURE	1	1346.91926	1346.91926	34.10	0.0001
KNIFE*SOIL*MOISTURE	1	1.36780	1.36780	0.03	0.8530
KNIF*REP(SOIL*MOIST)	12	50.13080	4.17757	0.11	0.9999
AREA	2	518.71145	259.35572	6.57	0.0027
KNIFE*AREA	2	15.40487	7.70243	0.20	0.8234
MOISTURE*AREA	2	5.36518	2.68259	0.07	0.9344
KNIFE*MOISTURE*AREA	2	5.73361	2.86680	0.07	0.9301
Error	56	2211.89658	39.49815		
Corrected Total	95	6837.79906			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	892.88751	892.88751	213.73	0.0001
KNIFE*SOIL	1	28.55038	28.55038	6.83	0.0226
KNIFE*MOISTURE	1	1346.91926	1346.91926	322.42	0.0001
KNIFE*SOIL*MOISTURE	1	1.36780	1.36780	0.33	0.5777

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	223.56510	223.56510	1.44	0.2358
MOISTURE	1	6290.46260	6290.46260	40.42	0.0001
SOIL*MOISTURE	1	7.65010	7.65010	0.05	0.8253
REP(SOIL*MOISTURE)	12	522.12292	43.51024	0.28	0.9904
KNIFE	1	3948.81760	3948.81760	25.37	0.0001
KNIFE*SOIL	1	43.33594	43.33594	0.28	0.5998
KNIFE*MOISTURE	1	5724.22594	5724.22594	36.78	0.0001
KNIFE*SOIL*MOISTURE	1	0.49594	0.49594	0.00	0.9552
KNIF*REP(SOIL*MOIST)	12	218.89958	18.24163	0.12	0.9999
AREA	2	369.60083	184.80042	1.19	0.3126
KNIFE*AREA	2	813.35583	406.67792	2.61	0.0822
MOISTURE*AREA	2	605.44333	302.72167	1.95	0.1525
KNIFE*MOISTURE*AREA	2	829.53000	414.76500	2.66	0.0784
Error	56	8715.6767	155.6371		
Corrected Total	95	28313.1824			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	3948.81760	3948.81760	216.47	0.0001
KNIFE*SOIL	1	43.33594	43.33594	2.38	0.1492
KNIFE*MOISTURE	1	5724.22594	5724.22594	313.80	0.0001

KNIFE*SOIL*MOISTURE	1	0.49594	0.49594	0.03	0.8718

CUTTING THE PLANT RESIDUES ON A SOIL SURFACE

CROSS SECTIONAL AREA AND M.C. EFFECT

SOYBEAN

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	615211.468	615211.468	84.46	0.0001
MOISTURE	1	722108.776	722108.776	99.14	0.0001
SOIL*MOISTURE	1	127049.874	127049.874	17.44	0.0001
REP(SOIL*MOISTURE)	12	64574.151	5381.179	0.74	0.7079
KNIFE	1	160212.883	160212.883	22.00	0.0001
KNIFE*SOIL	1	664.706	664.706	0.09	0.7637
KNIFE*MOISTURE	1	542713.901	542713.901	74.51	0.0001
KNIFE*SOIL*MOISTURE	1	65559.648	65559.648	9.00	0.0040
KNIF*REP(SOIL*MOIST)	12	67315.092	5609.591	0.77	0.6777
AREA	2	551604.775	275802.387	37.87	0.0001
KNIFE*AREA	2	406.304	203.152	0.03	0.9725
MOISTURE*AREA	2	3258.650	1629.325	0.22	0.8003
KNIFE*MOISTURE*AREA	2	38146.548	19073.274	2.62	0.0818
Error	56	407886.70	7283.69		
Corrected Total	95	3366713.48			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	160212.883	160212.883	28.56	0.0002
KNIFE*SOIL	1	664.706	664.706	0.12	0.7366
KNIFE*MOISTURE	1	542713.901	542713.901	96.75	0.0001
KNIFE*SOIL*MOISTURE	1	65559.648	65559.648	11.69	0.0051

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	528.563204	528.563204	70.71	0.0001
MOISTURE	1	582.726150	582.726150	77.96	0.0001
SOIL*MOISTURE	1	119.215838	119.215838	15.95	0.0002
REP(SOIL*MOISTURE)	12	61.952258	5.162688	0.69	0.7533
KNIFE	1	129.921067	129.921067	17.38	0.0001
KNIFE*SOIL	1	5.292204	5.292204	0.71	0.4037
KNIFE*MOISTURE	1	386.082817	386.082817	51.65	0.0001
KNIFE*SOIL*MOISTURE	1	49.622504	49.622504	6.64	0.0126

KNIF*REP(SOIL*MOIST)	12	80.050075	6.670840	0.89	0.5596
AREA	2	11.275590	5.637795	0.75	0.4751
KNIFE*AREA	2	7.989652	3.994826	0.53	0.5890
MOISTURE*AREA	2	31.853819	15.926909	2.13	0.1283
KNIFE*MOISTURE*AREA	2	2.068765	1.034382	0.14	0.8711
Error	56	418.58964	7.47482		
Corrected Total	95	2415.20358			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	129.921067	129.921067	19.48	0.0008
KNIFE*SOIL	1	5.292204	5.292204	0.79	0.3906
KNIFE*MOISTURE	1	386.082817	386.082817	57.88	0.0001
KNIFE*SOIL*MOISTURE	1	49.622504	49.622504	7.44	0.0184

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	2.094800	2.094800	0.65	0.4248
MOISTURE	1	183.687301	183.687301	56.69	0.0001
SOIL*MOISTURE	1	4.072620	4.072620	1.26	0.2670
REP(SOIL*MOISTURE)	12	19.303634	1.608636	0.50	0.9082
KNIFE	1	2.975456	2.975456	0.92	0.3420
KNIFE*SOIL	1	31.830915	31.830915	9.82	0.0027
KNIFE*MOISTURE	1	47.159075	47.159075	14.56	0.0003
KNIFE*SOIL*MOISTURE	1	1.526365	1.526365	0.47	0.4953
KNIF*REP(SOIL*MOIST)	12	28.632180	2.386015	0.74	0.7102
AREA	2	178.538781	89.269391	27.55	0.0001
KNIFE*AREA	2	0.550081	0.275041	0.08	0.9187
MOISTURE*AREA	2	39.991550	19.995775	6.17	0.0038
KNIFE*MOISTURE*AREA	2	22.762787	11.381394	3.51	0.0365
Error	56	181.441005	3.240018		
Corrected Total	95	744.566549			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	2.9754563	2.9754563	1.25	0.2860
KNIFE*SOIL	1	31.8309150	31.8309150	13.34	0.0033
KNIFE*MOISTURE	1	47.1590753	47.1590753	19.76	0.0008
KNIFE*SOIL*MOISTURE	1	1.5263648	1.5263648	0.64	0.4394

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SOIL	1	46.87215	46.87215	2.54	0.1165
MOISTURE	1	1182.74364	1182.74364	64.15	0.0001
SOIL*MOISTURE	1	5.91232	5.91232	0.32	0.5735
REP(SOIL*MOISTURE)	12	132.71876	11.05990	0.60	0.8330
KNIFE	1	26.49571	26.49571	1.44	0.2356
KNIFE*SOIL	1	198.61657	198.61657	10.77	0.0018
KNIFE*MOISTURE	1	266.72667	266.72667	14.47	0.0004
KNIFE*SOIL*MOISTURE	1	21.32689	21.32689	1.16	0.2867
KNIF*REP(SOIL*MOIST)	12	209.82502	17.48542	0.95	0.5073
AREA	2	103.94515	51.97257	2.82	0.0682
KNIFE*AREA	2	16.74535	8.37267	0.45	0.6373
MOISTURE*AREA	2	49.60288	24.80144	1.35	0.2688
KNIFE*MOISTURE*AREA	2	68.45633	34.22817	1.86	0.1657
Error	56	1032.42251	18.43612		
Corrected Total	95	3362.40996			

Tests of Hypotheses using the Anova MS for
KNIF*REP(SOIL*MOIST) as an error term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
KNIFE	1	26.495712	26.495712	1.52	0.2419
KNIFE*SOIL	1	198.616574	198.616574	11.36	0.0056
KNIFE*MOISTURE	1	266.726670	266.726670	15.25	0.0021
KNIFE*SOIL*MOISTURE	1	21.326891	21.326891	1.22	0.2911

CUTTING THE PLANT RESIDUES ON A SOIL SURFACE

CROSS SECTIONAL AREA AND M.C. EFFECT

WHEAT

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	87.71602	43.85801	0.84	0.4395
KNIFE	1	1991.23515	1991.23515	38.19	0.0001
MOISTURE	1	860.45888	860.45888	16.50	0.0003
KNIFE*AREA	2	75.85983	37.92992	0.73	0.4901
MOISTURE*AREA	2	20.10917	10.05458	0.19	0.8255
KNIFE*MOISTURE	1	997.90129	997.90129	19.14	0.0001
KNIFE*MOISTURE*AREA	2	162.96162	81.48081	1.56	0.2234
Error	36	1876.94455	52.13735		
Corrected Total	47	6073.18651			

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	2.2604167	1.1302083	1.68	0.2012
KNIFE	1	28.2133333	28.2133333	41.86	0.0001
MOISTURE	1	11.2133333	11.2133333	16.64	0.0002
KNIFE*AREA	2	2.7079167	1.3539583	2.01	0.1489
MOISTURE*AREA	2	0.7754167	0.3877083	0.58	0.5677
KNIFE*MOISTURE	1	14.9633333	14.9633333	22.20	0.0001
KNIFE*MOISTURE*AREA	2	4.6179167	2.3089583	3.43	0.0435
Error	36	24.2650000	0.6740278		
Corrected Total	47	89.0166667			

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	0.01471200	0.00735600	0.91	0.4116
KNIFE	1	0.03499200	0.03499200	4.33	0.0447
MOISTURE	1	0.15985208	0.15985208	19.77	0.0001
KNIFE*AREA	2	0.02499650	0.01249825	1.55	0.2269
MOISTURE*AREA	2	0.00390217	0.00195108	0.24	0.7868
KNIFE*MOISTURE	1	0.10101675	0.10101675	12.50	0.0011
KNIFE*MOISTURE*AREA	2	0.02974650	0.01487325	1.84	0.1735
Error	36	0.29102200	0.00808394		
Corrected Total	47	0.66024000			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
AREA	2	1.0066667	0.5033333	0.50	0.6115
KNIFE	1	5.8800000	5.8800000	5.82	0.0210
MOISTURE	1	20.2800000	20.2800000	20.09	0.0001
KNIFE*AREA	2	3.8400000	1.9200000	1.90	0.1640
MOISTURE*AREA	2	0.0350000	0.0175000	0.02	0.9828
KNIFE*MOISTURE	1	16.1008333	16.1008333	15.95	0.0003
KNIFE*MOISTURE*AREA	2	5.8716667	2.9358333	2.91	0.0675
Error	36	36.3450000	1.0095833		
Corrected Total	47	89.3591667			

CUTTING PLANT RESIDUES ON A SOIL SURFACE

SECTION OF THE RESIDUE EFFECT

CORN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	7	4.83946667	0.69135238	3.23	0.0105
KNIFE	1	3.69630000	3.69630000	17.27	0.0002
SECTION*KNIFE	7	3.37500000	0.48214286	2.25	0.0554
Error	32	6.8472000	0.2139750		
Corrected Total	47	18.7579667			

Duncan Grouping (α=0.05)	Mean	N	SECTION
A	2.4967	6	SECT-11
B	1.8833	6	SECT-10
B			
B	1.8700	6	SECT-9
B			
B	1.6700	6	SECT-4
B			
B	1.6417	6	SECT-2
B			
B	1.5450	6	SECT-3
B			
B	1.4800	6	SECT-1
B			
B	1.4600	6	SECT-5

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	7	9.61666667	1.37380952	1.40	0.2403
KNIFE	1	0.52083333	0.52083333	0.53	0.4719
SECTION*KNIFE	7	2.35583333	0.33654762	0.34	0.9280
Error	32	31.4466667	0.9827083		
Corrected Total	47	43.9400000			

Duncan Grouping (α=0.05)		Mean	N	SECTION
	A	2.7667	6	SECT-1
	A			
B	A	2.5333	6	SECT-2
B	A			
B	A	2.1500	6	SECT-3
B	A			
B	A	2.1167	6	SECT-4
B	A			
B	A	1.8000	6	SECT-11

B	A			
B	A	1.6333	6	SECT-5
B	A			
B	A	1.6000	6	SECT-9
B		1.4000	6	SECT-10

CUTTING PLANT RESIDUES ON A SOIL SURFACE

SECTION OF THE RESIDUE EFFECT

COTTON

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	11	26.1261111	2.3751010	0.61	0.8103
KNIFE	1	21.1250000	21.1250000	5.43	0.0240
SECTION*KNIFE	11	52.0550000	4.7322727	1.22	0.3018
Error	48	186.6066667	3.8876389		
Corrected Total	71	285.9127778			

Duncan Grouping (α=0.05)	Mean	N	SECTION
A	8.850	6	SECT-1
A			
A	8.533	6	SECT-5
A			
A	8.483	6	SECT-2
A			
A	8.100	6	SECT-3
A			
A	8.033	6	SECT-4
A			
A	8.033	6	SECT-6
A			
A	7.700	6	SECT-9
A			
A	7.667	6	SECT-8
A			
A	7.467	6	SECT-11
A			
A	7.250	6	SECT-12
A			
A	7.133	6	SECT-7
A			
A	6.717	6	SECT-10

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	11	325.724444	29.611313	4.68	0.0001
KNIFE	1	175.468889	175.468889	27.73	0.0001
SECTION*KNIFE	11	44.724444	4.065859	0.64	0.7833
Error	48	303.693333	6.326944		
Corrected Total	71	849.611111			

Duncan Grouping (α=0.05)				Mean	N	SECTION
		A		11.950	6	SECT-2
		A				
B		A		11.050	6	SECT-1
B		A				
B		A	C	9.867	6	SECT-4
B		A	C			
B		A	C	9.050	6	SECT-3
B			C			
B		D	C	8.383	6	SECT-5
B		D	C			
B	E	D	C	7.983	6	SECT-6
	E	D	C			
	E	D	C	7.250	6	SECT-9
	E	D	C			
	E	D	C	6.667	6	SECT-11
	E	D	C			
	E	D	C	6.533	6	SECT-8
	E	D	C			
	E	D	C	6.517	6	SECT-7
	E	D				
	E	D		5.233	6	SECT-10
	E					
	E			4.783	6	SECT-12

CUTTING PLANT RESIDUES ON A SOIL SURFACE

SECTION OF THE RESIDUE EFFECT

SOYBEAN

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	9	56.4640000	6.2737778	4.48	0.0004

KNIFE	1	4.3740000	4.3740000	3.13	0.0847
SECTION*KNIFE	9	28.3293333	3.1477037	2.25	0.0384
Error	40	55.9800000	1.3995000		
Corrected Total	59	145.1473333			

Duncan Grouping (α=0.05)			Mean	N	SECTION
	A		6.4667	6	SECT-1
	A				
B	A		5.8833	6	SECT-2
B	A				
B	A		5.8000	6	SECT-3
B	A				
B	A		5.6167	6	SECT-4
B					
B	C		4.8667	6	SECT-10
B	C				
B	C		4.7333	6	SECT-5
	C				
	C		4.1000	6	SECT-6
	C				
	C		4.0667	6	SECT-9
	C				
	C		3.7000	6	SECT-8
	C				
	C		3.5333	6	SECT-7

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	9	28.980167	3.220019	1.71	0.1188
KNIFE	1	108.541500	108.541500	57.62	0.0001
SECTION*KNIFE	9	3.106833	0.345204	0.18	0.9948
Error	40	75.353333	1.883833		
Corrected Total	59	215.981833			

Duncan Grouping (α=0.05)			Mean	N	SECTION
	A		4.4667	6	SECT-4
	A				
B	A		4.0500	6	SECT-3
B	A				
B	A	C	3.9667	6	SECT-1
B	A	C			
B	A	C	3.4167	6	SECT-2
B	A	C			
B	A	C	3.0667	6	SECT-5
B	A	C			
B	A	C	3.0000	6	SECT-9

B	A	C			
B	A	C	2.9500	6	SECT-10
B	A	C			
B	A	C	2.8500	6	SECT-6
B		C			
B		C	2.4667	6	SECT-8
		C			
		C	2.1500	6	SECT-7

CUTTING PLANT RESIDUES ON A SOIL SURFACE

SECTION OF THE RESIDUE EFFECT

WHEAT

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	3	2.86833333	0.95611111	2.00	0.1551
KNIFE	1	1.30666667	1.30666667	2.73	0.1180
SECTION*KNIFE	3	1.80333333	0.60111111	1.26	0.3229
Error	16	7.66000000	0.47875000		
Corrected Total	23	13.63833333			

Duncan Grouping (α=0.05)	Mean	N	SECTION
A	3.8333	6	SECT-4
A			
A	3.2167	6	SECT-2
A			
A	3.0333	6	SECT-1
A			
A	2.9500	6	SECT-3

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
SECTION	3	1.0833333	0.3611111	0.60	0.6262
KNIFE	1	15.6816667	15.6816667	25.92	0.0001
SECTION*KNIFE	3	2.8483333	0.9494444	1.57	0.2357
Error	16	9.6800000	0.6050000		
Corrected Total	23	29.2933333			

Duncan Grouping (α=0.05)	Mean	N	SECTION
A	2.4833	6	SECT-4
A			
A	2.0167	6	SECT-3
A			
A	2.0000	6	SECT-1
A			
A	1.9667	6	SECT-2

CUTTING PLANT RESIDUES ON A SOIL SURFACE

HOLDING THE RESIDUE EFFECT

CORN

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	47277.127	47277.127	4.07	0.0608
MOISTURE	1	1314.240	1314.240	0.11	0.7411
KNIFE	1	220493.340	220493.340	18.97	0.0005
HOLDING*MOISTURE	1	10693.482	10693.482	0.92	0.3518
HOLDING*KNIFE	1	38704.602	38704.602	3.33	0.0868
MOISTURE*KNIFE	1	27866.535	27866.535	2.40	0.1411
HOLDIN*MOISTUR*KNIFE	1	25038.960	25038.960	2.15	0.1616
Error	16	186015.000	11625.937		
Corrected Total	23	557403.285			

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	0.78264817	0.78264817	8.40	0.0105
MOISTURE	1	0.00770417	0.00770417	0.08	0.7774
KNIFE	1	1.72914017	1.72914017	18.56	0.0005
HOLDING*MOISTURE	1	0.07981067	0.07981067	0.86	0.3684
HOLDING*KNIFE	1	0.38709600	0.38709600	4.15	0.0584
MOISTURE*KNIFE	1	0.20535000	0.20535000	2.20	0.1571
HOLDIN*MOISTUR*KNIFE	1	0.24280817	0.24280817	2.61	0.1260
Error	16	1.49075067	0.09317192		
Corrected Total	23	4.92530800			

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F

HOLDING	1	9.7028167	9.7028167	0.50	0.4881
MOISTURE	1	26.7970667	26.7970667	1.39	0.2555
KNIFE	1	26.8816667	26.8816667	1.40	0.2547
HOLDING*MOISTURE	1	9.1266667	9.1266667	0.47	0.5011
HOLDING*KNIFE	1	48.7350000	48.7350000	2.53	0.1313
MOISTURE*KNIFE	1	2.9260167	2.9260167	0.15	0.7019
HOLDIN*MOISTUR*KNIFE	1	1.7388167	1.7388167	0.09	0.7677
Error	16	308.206733	19.262921		
Corrected Total	23	434.114783			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	2.06506667	2.06506667	1.31	0.2693
MOISTURE	1	1.80950417	1.80950417	1.15	0.2999
KNIFE	1	2.40286817	2.40286817	1.52	0.2349
HOLDING*MOISTURE	1	0.52451267	0.52451267	0.33	0.5721
HOLDING*KNIFE	1	3.92041667	3.92041667	2.49	0.1344
MOISTURE*KNIFE	1	0.25338150	0.25338150	0.16	0.6938
HOLDIN*MOISTUR*KNIFE	1	0.15424067	0.15424067	0.10	0.7585
Error	16	25.2284040	1.5767753		
Corrected Total	23	36.3583945			

CUTTING PLANT RESIDUES ON A SOIL SURFACE

HOLDING THE RESIDUE EFFECT

COTTON

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	33353.670	33353.670	4.98	0.0403
MOISTURE	1	185416.260	185416.260	27.68	0.0001
KNIFE	1	395805.850	395805.850	59.09	0.0001
HOLDING*MOISTURE	1	48879.400	48879.400	7.30	0.0157
HOLDING*KNIFE	1	17458.220	17458.220	2.61	0.1260
MOISTURE*KNIFE	1	162970.720	162970.720	24.33	0.0001
HOLDIN*MOISTUR*KNIFE	1	19272.334	19272.334	2.88	0.1092
Error	16	107169.073	6698.067		
Corrected Total	23	970325.530			

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	1.3461607	1.3461607	1.18	0.2936
MOISTURE	1	30.1907802	30.1907802	26.45	0.0001
KNIFE	1	47.8668015	47.8668015	41.93	0.0001
HOLDING*MOISTURE	1	7.6772282	7.6772282	6.72	0.0196
HOLDING*KNIFE	1	0.2072042	0.2072042	0.18	0.6758
MOISTURE*KNIFE	1	26.6704167	26.6704167	23.36	0.0002
HOLDIN*MOISTUR*KNIFE	1	2.9596327	2.9596327	2.59	0.1269
Error	16	18.266023	1.141626		
Corrected Total	23	135.184247			

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	7.981067	7.981067	0.53	0.4783
MOISTURE	1	797.414817	797.414817	52.68	0.0001
KNIFE	1	275.268267	275.268267	18.19	0.0006
HOLDING*MOISTURE	1	0.052267	0.052267	0.00	0.9539
HOLDING*KNIFE	1	96.240150	96.240150	6.36	0.0227
MOISTURE*KNIFE	1	322.373400	322.373400	21.30	0.0003
HOLDIN*MOISTUR*KNIFE	1	37.951350	37.951350	2.51	0.1329
Error	16	242.19067	15.13692		
Corrected Total	23	1779.47198			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	0.30038	0.30038	0.01	0.9167
MOISTURE	1	1273.98625	1273.98625	47.93	0.0001
KNIFE	1	332.53093	332.53093	12.51	0.0027
HOLDING*MOISTURE	1	0.64846	0.64846	0.02	0.8778
HOLDING*KNIFE	1	88.85417	88.85417	3.34	0.0862
MOISTURE*KNIFE	1	507.51805	507.51805	19.10	0.0005
HOLDIN*MOISTUR*KNIFE	1	50.69517	50.69517	1.91	0.1862
Error	16	425.24079	26.57755		
Corrected Total	23	2679.77420			

CUTTING PLANT RESIDUES ON A SOIL SURFACE

HOLDING THE RESIDUE EFFECT

SOYBEAN

Dependent Variable: FORCE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	1230.374	1230.374	0.43	0.5191
MOISTURE	1	123473.153	123473.153	43.61	0.0001
KNIFE	1	88131.792	88131.792	31.13	0.0001
HOLDING*MOISTURE	1	12.673	12.673	0.00	0.9475
HOLDING*KNIFE	1	227.920	227.920	0.08	0.7803
MOISTURE*KNIFE	1	96221.072	96221.072	33.99	0.0001
HOLDIN*MOISTUR*KNIFE	1	1498.472	1498.472	0.53	0.4774
Error	16	45298.074	2831.130		
Corrected Total	23	356093.531			

Dependent Variable: STRESS

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	0.016960	0.016960	0.01	0.9239
MOISTURE	1	104.817681	104.817681	58.15	0.0001
KNIFE	1	55.876017	55.876017	31.00	0.0001
HOLDING*MOISTURE	1	0.000294	0.000294	0.00	0.9900
HOLDING*KNIFE	1	2.274273	2.274273	1.26	0.2779
MOISTURE*KNIFE	1	61.998061	61.998061	34.40	0.0001
HOLDIN*MOISTUR*KNIFE	1	4.736594	4.736594	2.63	0.1245
Error	16	28.838245	1.802390		
Corrected Total	23	258.558125			

Dependent Variable: ENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	0.1001042	0.1001042	0.06	0.8172
MOISTURE	1	43.2285042	43.2285042	23.84	0.0002
KNIFE	1	5.5970042	5.5970042	3.09	0.0981
HOLDING*MOISTURE	1	1.3207042	1.3207042	0.73	0.4061
HOLDING*KNIFE	1	1.4065042	1.4065042	0.78	0.3915
MOISTURE*KNIFE	1	24.3815042	24.3815042	13.44	0.0021
HOLDIN*MOISTUR*KNIFE	1	0.2340375	0.2340375	0.13	0.7241
Error	16	29.0173333	1.8135833		
Corrected Total	23	105.2856958			

Dependent Variable: SPENERGY

Source	DF	Anova SS	Mean Square	F Value	Pr > F
HOLDING	1	3.814443	3.814443	0.28	0.6027
MOISTURE	1	364.743660	364.743660	26.97	0.0001
KNIFE	1	30.060817	30.060817	2.22	0.1554

HOLDING*MOISTURE	1	10.036267	10.036267	0.74	0.4017
HOLDING*KNIFE	1	22.461480	22.461480	1.66	0.2158
MOISTURE*KNIFE	1	155.367171	155.367171	11.49	0.0037
HOLDIN*MOISTUR*KNIFE	1	9.966548	9.966548	0.74	0.4033
Error	16	216.388595	13.524287		
Corrected Total	23	812.838980			